Received: 31 August 2018 | Revised: 10 December 2018 | Accepted: 27 December 2018

DOI: 10.1111/obr.12833

WILEY obesityreviews

A systematic review of strategies to increase drinking-water access and consumption among 0- to 5-year-olds

Angie L. Cradock[1] | Mary Kathryn Poole[1] | Kaylan E. Agnew[2] | Chasmine Flax[1] | Kaela Plank[3] | Nicole Capdarest-Arest[4] | Anisha I. Patel[2,5]

[1] Department of Social and Behavioral Sciences, Harvard T.H. Chan School of Public Health, Boston, MA, USA

[2] Philip R. Lee Institute for Health Policy Studies, University of California, San Francisco, CA, USA

[3] Nutrition Policy Institute, Division of Agriculture and Natural Resources, University of California, Berkeley, CA, USA

[4] Blaisdell Medical Library, University of California, Davis, Sacramento, CA, USA

[5] Department of Pediatrics, Stanford University, Stanford, CA, USA

Correspondence
Angie Cradock, Department of Social and Behavioral Sciences, Harvard T.H. Chan School of Public Health, 677 Huntington Avenue, Boston, MA 02215, USA.
Email: acradock@hsph.harvard.edu

Funding information
Healthy Eating Research, a national program of the Robert Wood Johnson Foundation

Summary

The objective of this study is to identify promising strategies for improving drinking-water access and consumption among children aged 0 to 5 years. MEDLINE/PubMed, Embase, ERIC, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Web of Science, and Cochrane Central Register of Controlled Trials (CENTRAL) databases were searched in this review. Studies included peer-reviewed, full-text studies from high-income countries, published in English between January 1, 2000, and January 12, 2018, that evaluated interventions to increase water access or consumption in children aged 0 to 5 years. Twenty-five studies met inclusion criteria; 19 used an effective intervention strategy to increase water access or water consumption. Three studies addressed both water access and consumption. Frequently used strategies included policy and practice changes, increasing water access and convenience, and education, training, or social support for caregivers. Studies were of fair methodological quality (average score: 18.8 of 26) for randomized studies and of moderate quality (5.1 of 9) for non-randomized studies. To date, few high-quality studies with objectively measured outcomes have clearly demonstrated strategies that may influence water intake and consumption among young children aged 0 to 5 years.

KEYWORDS

children's health, systematic review, water access, water consumption

1 | INTRODUCTION

Drinking water instead of sugar-sweetened beverages (SSBs), such as sodas or fruit drinks with added sugar, can help decrease intake of calories and added sugar, thereby preventing health conditions such as obesity and dental caries.[1] Consumption of water can also promote adequate hydration for optimal cognitive functioning.[2] While drinking water is critical for all age groups, it is particularly important to encourage young children to drink water. Fluoridated water may protect teeth from dental caries.[3] Also, as children form dietary preferences early,[4] exposing young children to water, rather than SSBs and juice, may help promote a preference for water, which is important when small shifts in caloric intake can help prevent obesity.[5] However, given their small body size and developing brain, young children should drink water that is free of contaminants that can have adverse effects on child development, behaviour, and health.[6]

Despite these many benefits of drinking water, many children do not drink enough water. According to nationally representative data, one in two children in the United States is inadequately hydrated,[7] and one in six children does not drink any tap water;[8] these statistics are more pronounced among minority populations as compared with whites. Inadequate access to drinking water in locations where

Abbreviations: BMI, body mass index; CENTRAL, Cochrane Central Register of Controlled Trials; CINAHL, Cumulative Index to Nursing and Allied Health Literature; OECD, Organisation for Economic Co-operation and Development; PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses; SSBs, sugar-sweetened beverages; WIC, Special Supplemental Nutrition Program for Women, Infants, and Children

children spend substantial time could play a role in low water intake. Many schools do not provide drinking water to students at lunch,[9] and when schools do provide access to drinking water, appealing water sources (eg, reusable water bottle stations) and cups that promote water intake are often lacking.[10-12] Drinking water contaminated with lead in Flint, Michigan,[13] and the nitrates, arsenic, and bacteria found in other geographic areas suggest that the quality of drinking water is a consideration, especially in areas with lower income populations.[14,15]

To date, there is a paucity of information regarding strategies to promote accessibility to or intake of drinking water among young children. Recent reviews have focussed on associations between water intake and health outcomes[16] or interventions to increase water intake among children and adults, though excluded children younger than 3 years of age and only included studies that reported water intake in volume.[17] This study addresses these gaps.

1.1 | Project objective

The objective of this systematic review is to identify promising strategies that improve drinking water access and consumption among children 0 to 5 years and to summarize the knowledge gaps and research and policy-relevant recommendations in the existing literature. This review was conducted as a companion to a review focussed on interventions to decrease SSB consumption.[18]

2 | METHODS

2.1 | Literature search

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses Statement (PRISMA) was used to guide this review.[19] A medical librarian searched six databases for relevant studies (MEDLINE/PubMed, Embase, ERIC, Cumulative Index to Nursing and Allied Health Literature [CINAHL], Web of Science, and Cochrane Central Register of Controlled Trials [CENTRAL]) from January 1, 2000, to January 12, 2018. As more recent studies were hypothesized to be more salient to policymakers, January 1, 2000, was selected as the start date for publications in our search. Search terms were developed to identify studies that examined strategies to increase water access and/or water intake among children 0 to 5 years (Appendix A). Studies were also identified by hand-searching reference lists of papers included in extraction and published review articles. The study protocol is available on the Prospero International Prospective Register of Systematic Reviews (#86055).

2.2 | Study selection

Studies were included if they met the following criteria: (1) peer-reviewed; (2) published in English; (3) full-text article; (4) included infants or children aged 0 to 5 years or studies of interventions that target the entire population (including children 0-5 y); (5) took place in a high-income country as defined by Organisation for Economic Co-operation and Development (OECD); (6) if a school-based study, grades included transitional kindergarten, pre-kindergarten, or lower grades; (7) included a strategy or intervention focussed on increasing water access or intake; and (8) examined either water access or consumption as an outcome.

Studies were excluded if they met any of the following characteristics: (1) not a full-text manuscript; (2) design was a simulation study; (3) did not include original data (eg, if more than one article was published from the same cohort, only the study with the largest sample size was included, unless a different outcome variable was used); (4) published before January 1, 2000; (5) no intervention was implemented to increase water access or intake; (6) conducted in a school setting that only had students in kindergarten and higher grades; and (7) outcome did not include water access or consumption.

2.3 | Primary outcomes

In this study, water was defined as any plain water without added sugar or artificial sweeteners and could include bottled, tap, or filtered water. Water consumption was classified as (1) observed selection of water by an individual without quantification of the amount of water consumed or (2) measurement of the amount of water consumed. An example of observed selection of water includes the proportion of children in a child-care facility that filled up water bottles at a sink. Quantification of water consumed included measures such as the number of water servings per day or the volume of water consumed.

Water access was categorized as (1) physical access to drinking water in the environment or (2) physical access to water at the moment before consumption occurs. Examples of physical water access in the environment include access to a reusable water-bottle filling station in a school cafeteria or water listed as a beverage on a child-care menu. Water access just before the moment of consumption could include a cup of water that is visible on a table next to a child during mealtimes.

2.4 | Secondary outcomes

Secondary outcomes included consumption of SSBs, 100% fruit juice, or milk and weight-related outcomes such as body mass index (BMI) or BMI *z* score, weight gain, or prevalence of overweight/obesity.

2.5 | Data extraction

References obtained from the search were uploaded into Covidence, a web-based software platform for systematic reviews and meta-analysis, endorsed, and used by Cochrane.[20] After duplicates were removed, two trained researchers independently reviewed titles and abstracts to exclude studies that did not meet study inclusion criteria. Two trained researchers independently extracted data from final full-text studies into a form in Microsoft Excel. Extracted fields included the following characteristics: general study information, study design, population, setting, intervention, outcomes related to water and/or SSBs, and follow-up. See Figure 1 for study selection flow diagram. To evaluate the methodological quality, validity, and risk of bias in each study, researchers used the Downs and Black[21] checklist to

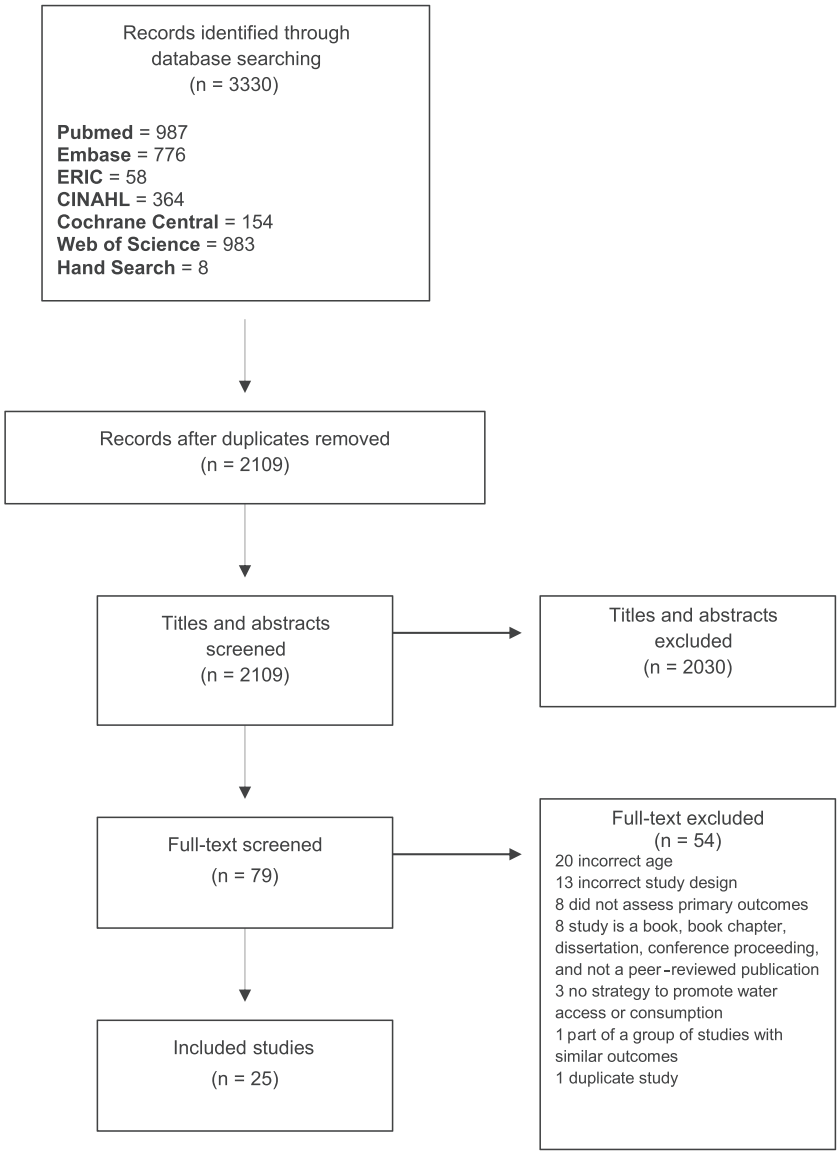

FIGURE 1 Study selection

assess randomized studies (maximum score of 28) and the Newcastle-Ottawa Scale[22] to assess non-randomized studies (maximum score of 9) with modifications based on predefined study protocols.[18] The first (AC) or senior (AP) author resolved any disagreements between initial reviewers.

Researchers characterized studies descriptively. Intervention strategies were categorized as (1) policy-level or community-wide initiatives (eg, SSB excise taxes or multimedia campaigns), (2) organizational systems and operations (eg, training/education/technical assistance), or (3) setting-specific environmental availability, marketing, and promotion (eg, increased access to water stations and posters promoting water). Studies were categorized as individual- or population-level, having a focus on (1) water, (2) broader nutrition (eg, all beverages or multiple dietary components), or (3) multiple-component dietary-related and physical activity-related strategies. Reseachers noted whether studies were conducted with populations or in a setting composed of a majority of racial and ethnic minority residents (>50% racial or ethnic nonmajority population) or in a setting with greater than the US average proportion[23] of residents in poverty (>12.7%) or described as low-income in the country in which the study was conducted. Authors classified "effective studies" as those with at least one significant result at any follow-up, for either water access or water intake as an outcome among any subgroup population.

3 | RESULTS

3.1 | Overview

Three-thousand three hundred thirty records were identified in six databases and from hand searches of previous reviews and studies meeting inclusion criteria. After the removal of duplicates (n = 1221), 2109 titles and abstracts were screened (Figure 1) of which 2030 were excluded. After the review of 79 remaining full-text articles, 54 were excluded leaving 25 articles for inclusion in this study.[12,24-47]

Table 1 provides an overview of each study. Of these 25 studies, we identified 19 studies that had one or more significant findings (ie, effective). Of the effective studies, most were conducted at the individual level, and eight studies were conducted at the population level. The strategies that were used in identified studies fell into three

TABLE 1 Studies identified in systematic review of drinking-water access and consumption among children 0-to 5- years old

Author, Year	Study Design and Country	Age Range (years)	% Female or Male		Sample Size and Notable Characteristics	Water Definition (Access or Consumption)	Assessment	Intervention		
			I	C				Name, Setting, and Target	Delivered by	Length (months)
Anand, 2007	Cluster-RCT Canada	5-70	F: 62.5%	F: 60.5%	51 households, 159 individuals Aboriginal reserve	Consumption: Amount: water consumed Servings per day	Self-report child and parent: 24 recall	SHARE-ACTION Home Households	Aboriginal Health Counselors	6 to 12
Beets, 2017	Cluster-RCT US	5-12	M: 53.3%	M: 52.4%	20 ASPs Low-income, minority	Access: at point of selection: water provided during snack Water served at snack on more than or equal to 1-day observed	Visual estimation by trained research personnel	Strategies to enhance practice for healthy eating (STEPs-HE) ASPs	ASP site leaders; technical assistance from research staff	12+
Bell, 2014	Quasi-experimental controlled trial Australia	6 wk-6 y	NR	NR	431 child-care centres Low-income, indigenous population; I: Hunter New England region, C: New South Wales	Access: providing only water or plain milk Proportion of services providing only water or plain milk Access: water with every eating occasion Number of times water was listed on daily menu	Self-report by centre administrator Menu analysis	Good for Kids Good for Life programme Child-care Child-care centres	Hunter New England Population Health staff	12+
Colchero, 2017	Quasi-experiment: natural experiment, no control Mexico	All ages	NR	NR	85118 households None	Access: Physical access: bottled water purchases Absolute change in purchases per capita Liter per week Relative % change in purchases per capita Liter per week versus projected estimate with no tax	Self-report: household members (ages 12+) completed National Income and Expenditure Survey	NR community: country-wide Mexican population	Government	12+
De Bourdeaudhuij, 2015	Quasi-experimental controlled trial Belgium, Cyprus, Estonia, Germany, Hungary, Italy, Spain, and Sweden	2-9.9	M: n = 7457 to 7814 F: n = 7268 to 7575		I: 7746 C: 8482 None	Consumption: Opportunity: occasions per week of drinking water	FFQ: parent-reported child intake	Identification and prevention of Dietary- and lifestyle-induced health EFfects In Children and infantS (IDEFCS) Community Children ages 2 to 9 years	Research staff	12+

TABLE 1 Studies identified in systematic review of drinking-water access and consumption among children 0-to 5- years old

	Intervention			Results				Quality
Author, Year	Intensity	Water Behaviour Target	Water and/or SSB Strategy	Outcomes	I	C	Effect	
Anand, 2007	Provided two 18-L containers of filtered water and 24 bottles of water to each household per week	↑ intake	Water + SSB: train caregivers	Change in consumption of water servings per day, I vs C at 6 months	+0.3 servings (SD = 1.3)	−0.1 servings (SD = 0.9)	$P < 0.04$*	D&B: 18 (fair)
Beets, 2017	Daily throughout school year	↑ provision	Water + SSB: train caregivers	Odds of observing water served at snack on more than or equal to 1-day observed, I vs C at 1 year	NA	NA	OR = 4.17 (95% CI, 0.91-19.17), P = NS	D&B: 19 (fair)
Bell, 2014	Ongoing	↑ provision	Water: train providers	Percent of services providing only water or plain milk to children Percent of services serving water with every eating occasion	Baseline: 68% Follow-up: 95% $P < 0.0001$* Baseline: 11% Follow-up: 20% $P = 0.38$	Baseline: 58% Follow-up: 82% $P < 0.0001$* Baseline: 16% Follow-up: 23% $P = 0.62$	Time* Treatment: $P = 0.018$* Time* Treatment: $P = 1.00$	NOS: 5 (moderate)
Colchero, 2017	Ongoing	↑ purchases	SSB policy to change relative pricing (SSB tax)	Absolute change in per capita Liter/week purchases versus projected Relative % change in per capita Liter/week purchases	3.39 ± 0.012 L (114.63 ± 0.41 oz) per capita/week NA	2.92 ± 0.010 L (98.74 ± 0.34 oz) per capita/week projected NA	+0.50 L (16.91 oz) (SD = 0.003 L) (0.10 oz) $P < 0.001$* +16.2% (SD = 0.036), $P < 0.001$*	NOS: 5 (moderate)
De Bourdeaudhuij, 2015	NR	↑ intake	Water: policy/practice (access); promotion	Change in frequency of water intake (times) per week from baseline to follow-up at 24 months	Boys: M (SE): Baseline: 21.74 times (1.76) Follow-up: 22.00 times (1.77) Girls: M (SE): Baseline: 21.37 times (1.64) Follow-up: 21.72 times (1.64)	Boys: M (SE): Baseline: 21.34 times (1.76) Follow-up: 21.55 times (1.77) Girls: M (SE): Baseline: 20.84 times (1.64) Follow-up: 20.76 times (1.64)	Time* Treatment: $F = 0.03$, $P = 0.866$ Time* Treatment: $F = 1.51$, $P = 0.220$	NOS: 6 (moderate)

TABLE 1 (Continued)

Author, Year	Study Design and Country	Age Range (years)	% Female or Male		Sample Size and Notable Characteristics	Water Definition (Access or Consumption)	Assessment	Intervention		
			I	C				Name, Setting, and Target	Delivered by	Length (months)
de Silva-Sangiorski, 2010	Quasi-experimental controlled trial Australia	0-5	2-year-olds: 48% 3.5-year-olds: 49.5%	2-year-olds: 48.1% 3.5-year-olds: 48.8%	2-year-olds: I: 1587, C: 17 732 3.5-year-olds: I: 1191, C: 14 647 Low-income	Consumption: Amount Servings (250 mL) per previous day	Proxy-report: 24 recall: parent report of child water intake	Romp & Chomp Community 12 000 children in Geelong, Australia	Health service providers, local and state government, universities, education, and leisure partners	12+
Foster, 2014	RCT: matched pairs created within strata US	All ages	NR	NR	Eight supermarkets Stores were located in urban, high-minority, low-income neighbourhoods, in areas of below-average supermarket density, or in areas having a supermarket customer base with >50% living in a low-income census tract.	Access: Physical access: sales of bottled water Ounce per week: sales of in-aisle bottled water in ounce per week; sales of water units from checkout coolers	Weekly sales records reported by supermarkets	NR Retail: supermarkets Consumers at supermarkets	Supermarket staff	6 to 12
Franks, 2017	Randomized, factorial controlled trial Poland	3-6	Info: 48% Info + water: 51%	50%	334 at randomization Info: 136 Info + water: 137 C: 61	Consumption: Amount: plain water (tap water, bottled still, and carbonated water) mL per day	Proxy-report: 7-day dietary record of child fluid intake	NR Home Households with children (age 3-6) that were infrequent water consumers	Research staff	6 to 12
Giles, 2012	Cluster-RCT US	5-12	M: Mean (SD): 48.5% (0.7)	M: Mean (SD): 51.1% (10.8)	20 ASPs Low-income, minority	Access: At selection: water served to children at snack time Ounce: average daily ounce of water served to child	Visual estimation	The Out-of-School Nutrition and Physical Activity Initiative (OSNAP) Afterschool Children in ASPs	Research staff and primary snack provider	6 to 12
Haroun, 2010	Quasi-experiment: natural experiment, no control UK: England	3-12	F: n = 3341		Pre-intervention (2005), 151 schools, 7166 students, Post-intervention (2009), 136 schools, 6696 students	Access: At selection: water provided to children at lunch Servings: water served as a % of all types of food/drinks provided Consumption: Opportunity: water (still or carbonated, unsweetened, unflavored) taken by student during lunchtime Water observed on lunch tray or in lunchbox	Visual estimation Visual estimation	NR School children in primary school	Department for education	12+ (after schools were required to comply with regulations)

TABLE 1 (Continued)

	Intervention			Results				Quality
Author, Year	Intensity	Water Behaviour Target	Water and/or SSB Strategy	Outcomes	I	C	Effect	
de Silva-Sangiorski, 2010	NR	↑ intake	Water + SSB: campaign, policy/ practice in early childhood services Water: access (reusable water bottles)	Change in servings of water intake on previous day, I vs C from baseline to follow-up at 3 years	NA	NA	Coefficient (95% CI): +0.02 servings (−0.08, 0.11), $P = 0.74$	NOS: 6 (moderate)
Foster, 2014	1 day a month for 2 to 3 hours	↑ purchases (population or potential caregivers)	Water: promotion in supermarket and key placement	Change of sales of targeted products: In-aisle water (Aquafina) in total ounce per week Checkout cooler water in total units per week I vs C	NA	NA	1690.0 oz (SE = 6649.8), $P = 0.0109$* 18.5 units (SE = 6.0), $P = 0.0002$*	D&B: 18 (fair)
Franks, 2017	Over 3 weeks: Info: six online sessions; social: online forum; water: 63 bottles of 330 mL per person	↑ intake	Water: train caregivers; access (water delivered to household)	Change in plain water intake (mL) at follow-up point by treatment arm at 1 year	Info: 221.9 mL (7.5 oz), $P = 0.0001$* Info + social: 198.4 mL (6.7 oz), $P = 0.0001$* Info + water: 157.9 mL (5.3 oz), $P = 0.0001$* Info + water + social: 216.3 mL (7.3 oz), $P = 0.0001$*	117.7 mL (4.0 oz), $P = 0.0001$*	Intake not significantly different among treatment arms at baseline. No test of significance for changes I vs C group presented.	D&B: 20 (good)
Giles, 2012	Three learning sessions for providers; daily serving of water to children	↑ access and intake	Water: policy/ practice (menu change); train providers; access (water jugs/ coolers)	Changes in average servings of beverages provided in ounce per child per day, I vs C at 6 months Number of times per day water served, I vs C at 6 months	NA	NA	+3.6 oz (95% CI, 1.3-5.9), $P = 0.01$* +0.6 times (95% CI, 0.2-1.0), $P = 0.01$*	D&B: 18 (fair)

TABLE 1 (Continued)

Author, Year	Study Design and Country	Age Range (years)	% Female or Male		Sample Size and Notable Characteristics	Water Definition (Access or Consumption)	Assessment	Intervention		
			I	C				Name, Setting, and Target	Delivered by	Length (months)
Hornsby, 2017	Quasi-experiment, no control US	0-6	NR	NR	2014: 603 children 2015: 600 children	Consumption: Opportunity: tap or bottled water % of parents reporting child drinks tap water daily; % of parents reporting child drinks bottled water daily	FFQ: telephone survey of parents	Cavities Get Around Community: media campaign Media targeted low-income mothers age 18 to 34 in Colorado; broad target was low-income families with children age 0 to 6 years	Research staff, Colorado Public Health and Environment; Delta Dental of Colorado Foundation	12+
Kaufman-Shriqui, 2016	Cluster-RCT Israel	4-7	NR	NR	I: seven schools, 165 children C: four schools, 66 children Low-income, significant differences in BMI *z* score, BMI, and sedentary hours between I and C	Consumption: Opportunity: habitual water drinking % of children who habitually drink water	Proxy-report: FFQ: completed by parent about child	NR School, children and mothers of children age 4 to 7 years	Teacher, psychologist, nurse, dietitian, economist	3 to 6
Kenney, 2015	Cluster-RCT US	4-18 (grades PK to 12)	M: Mean (SD): 49.3% (5.5)	M: Mean (SD): 45.4% (9.2)	I: 90 lunch periods at baseline, 87 lunch periods at follow-up C: 89 lunch periods at baseline, 88 lunch periods at follow-up	Consumption: Opportunity: student selection of free water during lunch period % of students taking water Consumption: Amount: water intake during lunch period Ounce: per student per lunch period	Visual estimation	Grab a Cup, Fill it Up! School Students and school staff with an existing source of water in cafeteria	Researchers, trained food and nutrition services personnel, custodial staff	<1
Lahlou, 2015	Randomized, factorial controlled trial Poland	3-6	NR	NR	439 households (fluid consumption reported for 334 children and caregivers)	Consumption: Amount: plain water (tap water, bottled still, and carbonated water) mL per day	Proxy-report: 7-day dietary record of child fluid intake	NR Home Households with children between 3 to 6 years old that were infrequent water consumers	Research staff, some information relayed by parents, online discussion forum	6 to 12
Lee, 2014	Cluster-RCT US	5-12	F: ~50%		I: 10 ASPs with 639 person days observed among 188 children C: 10 ASPs with 738 person days observed among 212 children Low-income, minority	Consumption: Amount: water intake at snack Ounce: consumed per child per snack time	Visual estimation	The Out of School Nutrition and Physical Activity Initiative (OSNAP) Afterschool Children attending ASPs in Boston, MA	ASP staff, researchers, food service provider	6 to 12
McGarvey, 2004	Quasi-experiment with control US	2-4	NR	NR	I: 121 parents, C: 65 parents Low-income, minority; parents enrolled in WIC	Access: At selection: parent offering water to child instead of SSB	Parent survey of frequency of offering water behaviours	Fit WIC Social Service Agency: WIC Clinic WIC parents with 2- to 4-year-old children	WIC nutritionists or nutrition assistants	12+

(Continues)

TABLE 1 (Continued)

	Intervention			Results				Quality
Author, Year	Intensity	Water Behaviour Target	Water and/or SSB Strategy	Outcomes	I	C	Effect	
Haroun, 2010	Daily during school year	↑ intake and ↓ other beverage provision	Water + SSB: policy (school meal standards)	Water served at school during lunchtime as a % of all foods/ drinks provided from pre-standard to post-standard (2005-2009)	NA	NA	+0.7%, $P = 0.001$*	NOS: 6 (moderate)
				Percent of students taking water at lunchtime from pre-standard to post-standard (2005-2009)			+21.8%, $P < 0.001$*	
Hornsby, 2017	30 second TV and radio advertisements to decrease sugar intake, other details not reported	↑ intake	Water + SSB: train caregivers; promotion and campaign	Percent of children who drink tap water daily from baseline (2014) to follow-up (2015) at 18 months	NA	NA	2014: 41% vs 2015: 63%, $P < 0.01$*	NOS: 3 (moderate)
				Percent of children who drink bottled water from baseline (2014) to follow-up (2015)			2014: 57% vs 2015: 56%, P = NS	
Kaufman-Shriqui, 2016	10, 45-minute lessons for children, three meetings for mothers, and teacher training	↑ intake	W + SSB: train caregivers Water: promotion	Percent increase in children who habitually drink water from baseline to 3 months	49.1%	25.9%	$P = 0.003$*	D&B: 21 (Good)
				Percent increase in children who habitually drink water from baseline to months	43.7%	30.1%	$P = 0.02$*	
Kenney, 2015	Daily during schooldays	↑ selection and intake	Water: access (cups and dispensers); promotion	Difference in change in % of students that selected water during lunch period	NA	NA	+9.4% (95% CI, 4.4-14.4), $P < 0.001$*	D&B: 22 (good)
				Difference in change in water consumption (ounce) I vs C from baseline to follow-up			+0.58 oz (95% CI, 0.27-0.90), $P < 0.001$*	

TABLE 1 (Continued)

Author, Year	Study Design and Country	Age Range (years)	% Female or Male		Sample Size and Notable Characteristics	Water Definition (Access or Consumption)	Assessment	Intervention		
			I	C				Name, Setting, and Target	Delivered by	Length (months)
						Times water offered per day (1 = *none* to 6 = *5 or more times per day*)				
McGowan, 2013	Cluster-RCT UK	2-6	M: 50%	M: 50%	I: 58 parents C: 68 parents Low-income	Access: At selection: parent serving/offering (water or milk) to child Automaticity of feeding behaviour index Consumption: Opportunity: water intake Occasions per day from 7-point scale (*never/rarely* to *3 or more times daily*)	Parent survey (self-report habit index) FFQ: parent report of child's usual frequency of water consumption	NR Home Parents of children age 2 to 6 years	Research staff	1 to 3
Mozaffarian, 2010	Quasi-experiment, no control US	5-14	NR	NR	848 snack days, seven YMCA programmes YMCA programmes	Access: At selection: water served to children at snack Average servings per week of water served at snack eating occasion	Menu document review	YMCA Learning Collaborative Afterschool YMCA staff and leadership	Research staff	12+
Norton, 2015	Randomized, factorial controlled trial US	Preschoolers (3+)	F: class 1: 41.7%, F: class 2: 57.1%		26 children at randomization (class 1: 14, class 2: 16) None	Consumption: Water intake during snack time Grams of beverage consumed per snack occasion	Weighing	NR Child-care Preschoolers attending child-care	Researchers	1 to 3
Pinket, 2016	Cluster-RCT Belgium, Bulgaria, Germany, Greece, Poland, Spain	3.5-5.5	M: 51.5%		4964 preschoolers None	Consumption: Amount: total water intake (from all beverages consumed); plain water intake mL per day	FFQ: caregiver-reported FFQ (12 months)	The ToyBox-intervention School and child-care Preschoolers and their parents	Teachers trained by researchers	6 to 12
Ritchie, 2015a	Quasi-experiment: natural experiment, no control US	2-5.5	NR	NR	429 child-care centres "pre" policy change (2008); 435 child-care centres "post" policy change (2012) CACFP child-care centres	Access: Physical access: water available to children at meals or snacks and for self-serve indoors and outdoors Made available or unavailable to children on the past day	Self-report: FFQ completed by child-care provider	California Healthy Beverages in Child-Care Law of 2010; Child Nutrition Reauthorization Act of 2010 Child-care Licensed child-care facilities in California	Federal and state legislation	12+

TABLE 1 (Continued)

	Intervention			Results				Quality
Author, Year	Intensity	Water Behaviour Target	Water and/or SSB Strategy	Outcomes	I	C	Effect	
Lahlou, 2015	Over 3 weeks: info: six online sessions; social: online forum; water: 63 bottles of 330 mL per person	↑ intake	Water: train caregivers; access (water delivered to household)	Change in child water consumption (mL/day) within condition from baseline to year 1	Info only: mean change = 221.9 mL (7.5 oz); $P = 0.00$* Info + social: mean change = 198.4 mL (6.7 oz), $P = 0.00$* Info + water: mean change = 157.9 mL (5.3 oz), $P = 0.00$* Info + water + social: mean change = 216.3 mL (7.3 oz), $P = 0.00$*	Control: mean change = 117.7 mL (4.0 oz), $P = 0.00$*	NA	D&B: 14 (poor)
Lee, 2014	Three learning sessions for providers; daily serving of water to children	↑ access and intake	Water: policy/ practice (menu change); train providers; access (water jugs)	Change in water consumption ounce at snack, I vs C from baseline to follow-up at 6 months	NA	NA	Main effect (95% CI); 1.49 oz (1.21-1.78), $P < 0.0001$*	D&B: 17 (fair)
McGarvey, 2004	Six educational group sessions, two individual sessions	↑ provision	Water + SSB: train caregivers	Mean change in frequency (times) per day of serving water in place of a sweetened drink, I and C change from baseline to follow-up within condition (I and C) at 12 months	Mean (95% CI) 0.64 times (0.19–1.09)	Mean (95% CI): 0.16 times (−0.16–0.49)	Interaction time* treatment $F_{(1,145)} = 8$, $P = 0.005$*	NOS: 5 (moderate)
McGowan, 2013	4, 1-hour home visits over 8 weeks	↑ intake	Water + SSB: train caregivers	Post-intervention autonomy score points of parent habit of serving/ offering healthy drinks (water or milk) controlling for baseline, I, and C	+1.4 points (SD = 2.1)	+0.1 points (SD = 2.1)	Wald's $F = 150.04$, $P < 0.001$*	D&B: 19 (fair)
				Post-intervention mean of water occasions (times) per day controlling for baseline, I, and C	+0.6 times (SD = 1.0)	+0.1 times (SD = 0.9)	Wald's $F = 8.67$, $P = 0.032$*	

TABLE 1 (Continued)

Author, Year	Study Design and Country	Age Range (years)	% Female or Male		Sample Size and Notable Characteristics	Water Definition (Access or Consumption)	Assessment	Intervention		
			I	C				Name, Setting, and Target	Delivered by	Length (months)
Ritchie, 2015b	Quasi-experiment: natural experiment, no control US	2-5	NR	NR	"Pre" policy change (2008): 429 child-care centres; "post" policy change (2012): 435 child-care centres Child-care centres participating in CACFP	Access: Physical access: water made available to children at meals or snacks and for self-serve indoors and outdoors Available/ unavailable	Survey completed by child-care provider	California Healthy Beverages in Child-Care Law of 2010; Child Nutrition Reauthorization Act of 2010 Child-care Licensed child-care facilities in California	Federal and state legislation	12+
Silver, 2017	Quasi-experiment: natural experiment, with control	NR	NR	NR	10152 store-day records	Access: Physical access: purchases of bottled water Absolute difference, % change in volume of plain water purchased (ounces) per transaction compared with expected sales with no tax	Point-of-sale electronic scanner data	NR Community Berkeley, CA population	Government	12+
Verbastel, 2013	Cluster-RCT Belgium	9-24 months	M: 53.2%	M: 56.2%	106 for water-specific analyses None	Consumption: Amount: total daily water intake mL per day	FFQ: caregiver-reported FFQ	NR Child-care Caregivers of children attending child-care centres	Researchers developed materials that were provided to parents by child-care providers	12+
Waters, 2018	Cluster-RCT Australia	5-12	NR	NR	2806 children at randomization Low-income	Access: At selection: water in lunchbox or canteen order Included or excluded in lunchbox or canteen order Consumption: Amount: glasses of water consumed per day Consuming two or more glasses of water per day	Visual estimation Parent-reported survey	*Fun 'n Healthy in Moreland!* School Children from economically disadvantaged area	Researchers, community development workers	12+

TABLE 1 (Continued)

	Intervention			Results				Quality
Author, Year	Intensity	Water Behaviour Target	Water and/or SSB Strategy	Outcomes	I	C	Effect	
Mozaffarian, 2010	2- to 3- day training sessions on three occasions	↑ frequency of serving	Water + SSB: train caregivers; policy/practice	Mean change in average water servings per week at snack eating occasion baseline to follow-up	NA	NA	(+2.1 servings/wk) (P = 0.08); sites served water daily at snack at follow-up	NOS: 3 (moderate)
Norton, 2015	Snack time with change in beverage/portion condition occurring weekly	↑ intake	Water: portion size (6 and 12 oz)	Water consumed (grams /occasion) when provided in 12-oz. serving size cups vs 6-oz. serving size cups	NA	NA	173.9 ± 101.7 g (5.9 ± 3.4 oz) / occasion vs 121.3 ± 59.9 g (4.1 ± 2.0 oz)/ occasion, P < 0.01* $F_{(1,23)}$ = 8.568, P < 0.01*	D&B: 19 (fair)
Pinket, 2016	NR	↑ intake	Water: train caregivers; access (water stations in classrooms); promotion (teacher led)	Change in total water intake (mL) per day from water content of all beverages, I vs C, from baseline to follow-up Change in water intake (mL) per day, I vs C, from baseline to follow-up	NA	NA	−26.7 mL (−0.9 oz), P = NS +11 mL (0.4 oz), P = NS	D&B: 17 (fair)
Ritchie, 2015a	Daily during weekdays	↑ provision	Water + SSB: policy (child-care licensing)	Odds of water always being served at the table with meals or snacks in 2008 vs 2012 Odds of water being easily and visibly available for self-serve indoors in 2008 vs 2012 Odds of water being easily and visibly available for self-serve outdoors in 2008 vs 2012	NA	NA	OR = 2.36 (95% CI, 1.75-3.13), P = 0.001* OR = 1.47 (95% CI, 1.08-1.98), P = 0.02* OR = 1.59 (95% CI, 1.17-2.17), P = 0.03*	NOS: 4 (moderate)
Ritchie, 2015b	Daily during weekdays	↑ provision	Water + SSB: policy (child-care licensing)	Percent of sites always serving water at all meals or snacks in 2008 vs 2012 Percent of sites making water available for self-serve indoors between in 2008 vs 2012	NA	NA	28.0% vs 46.7%, P = 0.008* 69.0% vs 76.5%, P = 0.001*	NOS: 5 (moderate)

(Continues)

TABLE 1 (Continued)

Author, Year	Intervention			Results				Quality
	Intensity	Water Behaviour Target	Water and/or SSB Strategy	Outcomes	I	C	Effect	
Ritchie, 2015b				Percent of sites making water available for self-serve outdoors in 2008 vs 2012			68.8% vs 77.5%, $P < 0.001$*	
Silver, 2017	Ongoing	↑ purchases	SSB policy to change relative pricing (SSB tax)	Percent change in plain water purchased (ounces/transaction) compared with expected sales	+15.6% relative to baseline, $P < 0.05$	−4.4% relative to baseline $P < 0.05$	NA	NOS: 8 (high)
				Absolute difference in plain water purchased (ounces/transaction) compared with expected sales with no tax	Absolute difference = 1.21 oz/transaction (95% CI, 1.09-1.34, $P < 0.01$)	Absolute difference = −0.56 oz/transaction (95% CI, −0.63, −0.49, $P < 0.01$)		
Verbastel, 2013	NR	↑ intake	Water + SSB: train caregivers	Change in mL water intake per day, I vs C, from baseline to follow-up	Baseline: mean = 196.06 mL (6.63 oz), SD = 137.42 mL (4.65 oz) Follow-up: mean = 311.08 mL (10.52 oz), SD = 139.64 mL (4.72 oz)	Baseline: mean = 207.97 mL (7.03 oz), SD = 153.63 mL (5.19 oz) Follow-up: mean = 293.79 mL (9.93 oz) SD = 155.75 mL, (5.27 oz)	Time* treatment: $F = 0.05$, P = NS	D&B: 19 (fair)
Waters, 2018	NR	↑ intake	Water: policy/practice (access); promotion	Odds of children including plain water in lunchbox, I vs C at follow-up	NA	NA	OR = 1.71 (95% CI, 1.05-2.78), $P = 0.03$*	D&B: 22 (good)
				Odds of children consuming 2+ glasses of water per day, I vs C at follow-up			OR = 1.33 (95% CI, 0.78-2.30), $P = 0.3$	

Abbreviations: 95% CI, 95% confidence interval; AOR, adjusted odds ratio; ASP, afterschool programme; BMI, body mass index; C, control or comparison group; CACFP, Child and Adult Care Food Program; D&B, Downs and Black checklist; FFQ, food frequency questionnaire; I, intervention; M (SE), mean (standard error); NOS, Newcastle-Ottawa scale; NS, not significant; OR, odds ratio; RCT, randomized controlled trial; SD, standard deviation; SSB, sugar-sweetened beverage; UK, United Kingdom; US, United States; WIC, Special Supplemental Nutrition Program for Woman, Infants, and Children. Water access was classified in two domains, physical environmental access and physical access at selection. Water consumption was classified in two domains, measurement of consumption without assessing the amount consumed or measurement of the amount of water that is consumed. Where applicable, all water volume-specific outcomes are presented in ounces in addition to the units presented in original study. When original volume unit was not ounces, the authors used the following conversion factors: 1 mL = 0.033814 oz; 1 g = 0.033814 oz; 1 L = 33.814 oz. These converted units are presented in parenthesis.

categories by strategy level (ie, policy, organizational, setting specific) (Table 2). Intervention strategies are described in further detail for each study in Appendix B. In some cases, multiple intervention strategies were used simultaneously in a study. The most frequently used strategies were policy and practice changes, increasing water access and convenience, and providing education, training, or social support for caregivers.

Three studies solely focussed on interventions to increase water access or consumption. Eleven focussed on interventions to impact nutrition-related outcomes more broadly. Six studies included intervention strategies related to water in addition to other nutrition and physical activity behaviours and measured successful changes in water access or consumption (Table 2). Of the 25 included studies, 13 included one or more outcomes measuring aspects of water access. Of these, 11 (85%) documented significant increases in the measure of water access used. Fifteen studies included one or more outcomes of water consumption. Of these, 10 (67%) documented increased water intake. Three studies measured both water access and consumption. Two were effective for both outcomes.

Overall, 12 studies were conducted in settings or among populations that were lower income, eight studies were composed of a majority of racial or ethnic minority members, and two studies included populations who drank less than recommended water intake. Studies were conducted in an array of educational settings and in homes and community environments. Few assessed health outcomes, cost of the intervention, or used objective measures of access or intake. No study addressed water quality.

3.2 | Risk of bias, design, and outcome measurement

Studies were of fair methodological quality (average score: 18.8 of 26) for randomized studies and of moderate quality (5.1 of 9) for non-randomized studies. Fourteen of the 25 studies assessed used a strong research study design with random assignment to intervention and control status at either the group or individual level (Table 1). Of these, seven also used objectively measured outcomes for water access or water consumption; the remaining used only proxy- or self-reported outcomes. Six of the seven studies with a strong research design and objectively measured outcomes demonstrated measurable impact on water-related outcomes. Researchers did not identify any noted conflicts of interest because of funding source or other factors. Below, each study is briefly summarized by study setting and outcome including water access, water consumption, or a combination of these.

3.3 | Studies to increase water access

3.3.1 | Child-care

In two studies conducted using repeated statewide surveys of providers that examined the impact of two state and federal policy changes regarding beverages that should be served to children in child-care settings, Ritchie et al documented that a greater percentage of child-care sites served water with meals/snacks (47% vs 28%, OR = 2.36; 95% CI, 1.75-3.13; *P* value = 0.001) and made self-serve water available indoors (77% vs 69%, OR = 1.47; 95% CI, 1.08-1.98; *P* value = 0.02) and outdoors (78% vs 69%, OR = 1.59; 95% CI, 1.17-2.17; *P* value = 0.03) from before to after the policy changes.[24,31]

Bell et al conducted a quasi-experimental controlled trial of infants and children age 6 weeks to 6 years in child-care centres in a predominately indigenous area of Australia.[33] The study examined how providing technical assistance (staff training, resources, incentives, follow-up support, performance monitoring, and feedback) to child-care providers in support of healthy eating policies and practices (including water provision at every eating occasion) impacted policy and practice implementation. From pre- to post-intervention, there was a significantly greater increase in the proportion of child-care centres in the intervention region that reported providing only water or plain milk than those in the comparison region (27% vs 24%; *P* value = 0.018).

3.3.2 | Social service agency

In a non-randomized controlled trial in Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) clinics, McGarvey et al provided targeted educational messaging focussed on encouraging parents to substitute SSBs with water during a series of two individual and six group educational sessions.[35] Participants in both intervention and control groups reported increased frequency of offering the child water in place of a sweetened drink over time, and the increase was significantly greater (*P* value = 0.005) for participants at the intervention sites +0.64 times/day (95% CI, 0.19-1.09) than in control sites +0.16 times/day (95% CI, −0.16-0.49).

3.3.3 | Community

Colchero et al conducted a natural experimental study (no control group) of reported purchases among 85118 households in Mexico to examine how an excise tax on SSBs affected beverage purchases.[37] The authors found a significant increase in observed versus expected bottled-water purchases from pre-implementation to post-implementation of the SSB tax (0.50 L/wk, SD = 0.003; *P* value < 0.001) with a relative increase of 16.2% (SD = 0.036; *P* value < 0.001).

Foster et al implemented a randomized controlled trial of a 6-month-long placement and promotion intervention to increase sales of healthier products (milk, ready-to-eat cereal, frozen meals, water, and diet drinks) in supermarkets in urban, low-income neighbourhoods in Philadelphia.[38] Water-related strategies included placing bottled water in dead spaces and end caps, in checkout coolers on the top shelf, and at eye level in aisles. Water was promoted in aisles with call-out signage. Water placement and promotion strategies resulted in a significant increase in recorded sales of in-aisle Aquafina brand water (1690.0 units/wk, SE = 6649.8; *P* value = 0.0109) and checkout cooler water (18.5 units/wk, SE = 6.0; *P* value = 0.0002) in intervention markets as compared with controls.

Silver et al examined evidence for change in bottled-water sales 1 year after a tax on SSBs was instituted in Berkeley, CA.[32] In a quasi-experimental study (with control), store-provided point-of-sale scanner data from Berkeley and adjacent community stores without the tax demonstrated that sales of untaxed water rose in Berkeley

TABLE 2 General characteristics, strategies, and outcomes of studies to promote water access and intake among 0- to 5-year olds

General Characteristics					Strategy[a]: Policy Level/Community Wide			Strategy: Organization Systems/Operation	Strategy: Setting-Specific Marketing/Promotion and Environmental Availability		Outcomes					
Author	Study Design	Focus[b]	Level[b]	Setting[b]	Policy (P) Practice (*p*)	Price	Campaign	Education/ Training/ Social Support	Site Promotion	Beverage Access/ Convenience	Water Access	Water Intake	SSB Intake	Juice Intake	Milk Intake[e]	Wt/ BMI
Anand (2007)[e]	Cluster-RCT	M	Indiv	Home				W + SSB		W; delivery		↑	↓	↓	↔	↔
Beets (2017)	Cluster-RCT	S-N	Indiv	After school				W + SSB			↔[c]					
Bell (2014)[e]	Quasi-experiment controlled trial	S-N	Indiv	Child-care				W + SSB			↑ (combined with milk)					
Colchero[e] (2017)	Quasi-experiment: natural experiment, no control	S-N	Pop	Community	SSB P	SSB tax						↑[d]				
De Bourdeau-dhuij (2015)	Quasi-experiment: controlled trial	M	Indiv	Community	W P/*p*				W	W		↔	↔	↔		
de Sliva-Sangiorski (2010)	Quasi-experiment controlled trial	M	Pop	Community	W + SSB P/*p*		W + SSB	W + SSB	W + SSB	W; reusable water bottles		↔	↓	↓	↔ plain/ flavor	↓
Foster (2014)[e]	RCT: matched pairs in strata	S-N	Indiv	Retail					W	W; water placement	↑[d]					
Franks (2017)[e]	Randomized factorial controlled trial	S-W	Indiv	Home				W		W; water delivery		↑	↓		↔	
Giles (2012)[e]	Cluster-RCT	M	Indiv	After school	W P/*p*			W		W; water jugs/coolers	↑					
Haroun (2018)[e]	Quasi-experiment: natural experiment, no control	S-N	Pop	School	W + SSB P						↑	↑				
Hornsby (2017)[e]	Quasi-experiment, no control	S-N	Pop	Community			W + SSB; campaign	W + SSB				↑	↔	↓	↓ white milk; ↑ flavor milk	
Kaufman-Shriqui (2016)[e]	Cluster-RCT	M	Indiv	School				W + SSB				↑	↓			↓

(Continues)

TABLE 2 (Continued)

General Characteristics					Strategy[a]: Policy Level/Community Wide			Strategy: Organization Systems/Operation	Strategy: Setting-Specific Marketing/Promotion and Environmental Availability		Outcomes					
Author	Study Design	Focus[b]	Level[b]	Setting[b]	Policy (P) Practice (*p*)	Price	Campaign	Education/ Training/ Social Support	Site Promotion	Beverage Access/ Convenience	Water Access	Water Intake	SSB Intake	Juice Intake	Milk Intake[e]	Wt/ BMI
Kenney (2015)[e]	Cluster-RCT	S-W	Indiv	School					W	W; cups		↑	↓	↓	↔	
Lahlou (2015)[e]	Randomized factorial controlled trial	S-W	Indiv	Home				W		W; water delivery		↑				
Lee (2014)[e]	Cluster-RCT	M	Indiv	Afterschool	W P/*p*			W + SSB		W; H20 jugs/ coolers		↑				
McGarvey (2004)[e]	Quasi-experiment with control	M	Indiv	Social Service Agency (WIC)				W + SSB			↑ water in lieu of SSBs					
McGowan (2013)[e]	Cluster-RCT	S-N	Indiv	Home				W + SSB			↑	↑	↓			
Mozaffarian (2010)	Quasi-experiment, no control	M	Pop	After school	W + SSB P/*p*			W + SSB			↔					
Norton (2015)[e]	Randomized factorial controlled trial	S-N	Indiv	Child-care						W; cup portion size		↑				
Pinket (2016)	Cluster-RCT	M	Indiv	School, child-care				childcare W	W	W; water stations		↔	↔	↓	↔	
Ritchie (JAND)[e]	Quasi-experiment: natural experiment, no control	S-N	Pop	Child-care	W + SSB P						↑					
Ritchie (PCD)[e]	Quasi-experiment: natural experiment, no control	S-N	Pop	Child-care	W + SSB P						↑					
Silver (2017)[e]	Quasi-experiment: natural experiment with control	S-N	Pop	Community	SSB P	SSB tax					↑					
Verbastel (2014)	Cluster-RCT	M	Indiv	Child-care				W + SSB				↔	↔		↔	↓
Waters (2017)[e]	Cluster-RCT	M	Indiv	School	W P/*p*			W	W	W; taps, reusable	↑	↔	↔	↔		↔

(Continues)

TABLE 2 (Continued)

	General Characteristics				Strategy[a]: Policy Level/Community Wide			Strategy: Organization Systems/Operation	Strategy: Setting-Specific Marketing/Promotion and Environmental Availability		Outcomes					
Author	Study Design	Focus[b]	Level[b]	Setting[b]	Policy (P) Practice (p)	Price	Campaign	Education/ Training/ Social Support	Site Promotion	Beverage Access/ Convenience	Water Access	Water Intake	SSB Intake	Juice Intake	Milk Intake[e]	Wt/ BMI
										water bottles						

Abbreviations: P, policy; *p*, practice; SSB, focus on reducing sugar-sweetened beverage access/intake; TA, technical assistance; W, focus on increasing water access/intake; W + SSB, focus on increasing water access/intake and decreasing SSB access/intake

[a]Policy-level/community-wide strategies include community-level policies or practices that increase accessibility of water or reduce accessibility of SSBs, community-wide media campaigns focussed on increasing intake of water or decreasing intake of SSBs, and strategies to increase the price of SSBs or decrease the price of water. Organization systems and operations strategies include training/education or social supports/networks at the organization/system level to increase intake of water or reduce intake of SSBs. Setting-specific strategies include efforts at the site level to increase accessibility of water, decrease accessibility of SSBs, or promotion to increase intake of water, or reduce intake of SSBs

[b]S-N, single nutrition focus; S-W, single water focus; M, multiple focus on nutrition and physical activity; Pop, population-level intervention; Indiv, individual-level intervention

[c]↑, significant increase; ↓, significant decrease; ↔, no change

[d]Assesses sales of beverages which is a proxy for household access

[e]Combined dairy intake rather than milk.

by 15.6% (+1.21 oz/transaction; 95% CI, 1.09-1.34; P value < 0.01) but declined by 4.4% in the comparison community compared with expected projected sales volumes.

3.3.4 | Afterschool

Mozaffarian et al used pre-post menu data from programmes participating in training sessions focussed on improving the nutritional quality of foods and beverages served to afterschool programme participants to document changes in water offerings.[34] At follow-up, sites served water daily at snack (5.0 servings/wk), though the increased difference from baseline within sites (2.1 servings/wk) was not statistically significant.

Beets et al conducted a cluster-randomized controlled trial of the development and implementation of healthy eating standards (including snack water offerings at the table in cups/bottles and accessibility to water at all times) in 20 afterschool programmes serving 1700 children in South Carolina.[36] In contrast to the comparison programmes, the odds of water being observed as a beverage on one or more days in intervention afterschool programmes at 1-year post-intervention were not statistically significant.

In a cluster-randomized controlled trial, Giles et al examined the impact of an intervention to promote water as the beverage of choice in 20 Boston afterschool programmes participating in a learning collaborative.[39] The collaborative focussed on policy and environmental changes to promote healthy eating and drinking and physical activity. In comparison with controls, programmes receiving the 6-month water intervention (ie, policy changes to replace juice with water on the menu, provider trainings to increase water offerings at snack, and increased access to water via insulated jugs and pitchers) were observed to serve more water to participants (+3.6 oz/child daily; 95% CI, 1.3-5.9; P value = 0.01) and to increase the frequency at which water was served (0.6 times/day; 95% CI, 0.2-1.0; P value = 0.01).

3.4 | Studies to increase water consumption

3.4.1 | Child-care

Through direct measurement of children's water consumption in child-care settings, Norton et al found increased water consumption at snack when water was provided in 12- versus 6-oz-serving size cups (173.9 g/occasion, SD = 101.7 vs 121.3 g/occasion, SD = 59.9; P value < 0.01), respectively.[40]

Verbestel et al provided a poster and tailored feedback to parents of preschool students on key obesity-related behaviours including replacing SSBs with water.[41] Using parent proxy-reported questionnaire data, researchers found no significant increase in water consumption (mL/day) from baseline to follow-up among students in intervention sites when compared with controls.

In six countries, Pinket et al implemented teacher and student education and water promotion sessions, installed water stations, and provided educational materials to parents of students in preschool classes.[42] Using proxy reports of children's usual beverage habits of the prior 12 months, researchers did not find a statistically significant

difference in water intake among intervention students when compared with control students post-intervention.

3.4.2 | Home

Anand et al employed a cluster-randomized controlled trial of a multi-component nutrition and physical activity promotion intervention among 51 households in a Canadian Aboriginal community.[43] The water-related intervention component consisted of home visits by health counselors and weekly water deliveries to participants' homes. Counselors helped families establish health goals around reducing SSB intake and increasing water consumption. Weekly water deliveries included two 18-L containers of filtered spring water and 24 bottles of spring water. When compared with households that received no intervention, intervention household members reported consuming significantly more servings of bottled or distilled water per day, respectively (−0.1 servings/day, SD = 0.9 vs +0.3 servings/day, SD = 1.3; *P* value < 0.04).

Franks et al and Lahlou et al completed a series of studies with 3- to 6-year-olds and their caregivers in Poland.[44,45] They examined the effect of multiple strategies to promote water intake among children not meeting minimum water intake recommendations. The intervention consisted of different combinations of the following conditions: (1) information (about water), (2) information and water delivered to the home, (3) information and a social forum, or (4) information, water delivery, and a social forum. Information included online coaching sessions about the health benefits of drinking water. Water included deliveries of water to the household (63 bottles of 330 mL per participant). Social forums consisted of online discussion opportunities. Beverage diary data were used to observe intake within all groups. Over time, significant increases in plain water intake were reported for the following groups: control (117.7 mL over 7 days; *P* value = 0.0001); information (221.9 mL over 7 days; *P* value = 0.0001); information and social forum (198.4 mL over 7 days; *P* value = 0.0001); information and water delivery (157.9 mL over 7 days; *P* value = 0.0001); and information, water delivery, and social forum (216.3 mL over 7 days; *P* value = 0.0001).

3.4.3 | Community

In a cluster non-randomized controlled trial involving 2- to 10-year-olds and their families at community sites and schools in eight European countries, De Bourdeaudhuij et al examined the impact of a multi-component intervention.[46] Components included policies and practices, environmental changes, education, and campaigns focussed on increasing consumption of drinking water. While there were some intervention impacts observed for individual countries, pooled data demonstrated no significant intervention effects on water intake.

De Silva-Sangiorski et al utilized a quasi-experimental study design to examine the impact of policy, sociocultural, and environmental changes focussed on several outcomes in Australian preschool children.[47] Outcome measures included physical activity, water consumption, fruit and vegetable intake, SSB intake, and screen time. Compared with the control group, no statistically significant difference was found in the change in daily servings of water consumed by study participants from pre- to post-intervention.

Hornsby et al conducted a quasi-experimental study (no control) to examine how a multimedia campaign (multimedia promotion, outreach by *promotores*, family education) to reduce juice consumption and promote tap water consumption affects beverage intake among low-income families in Colorado.[25] From pre-campaign to mid-campaign, there was a statistically significant increase in the proportion of families reporting that their children were drinking tap water daily (41% pre vs 63% post; *P* value < 0.01). There was no significant change in the proportion of families reporting that their children were drinking bottled water daily.

3.4.4 | Schools with early education programmes

Kenney et al conducted a randomized controlled trial of a water access and promotion intervention in US elementary schools.[12] The intervention consisted of water promotion posters and placement of cups adjacent to existing drinking-water sources. On the basis of direct observation, compared with control schools, there was a statistically significant increase in the proportion of students in intervention schools who took drinking water (+9.4%; 95% CI, 4.4-14.4%; *P* < 0.001) and drank water (+0.58 oz; 95% CI, 0.27-0.90; *P* < 0.001) during the lunch period.

Kaufman-Shriqui et al conducted a randomized controlled trial of 4- to 7-year-olds in Israeli schools to understand the impact of nutrition and physical activity-focussed classes (including drinking-water-related curricula focussed on the importance of drinking water instead of SSBs) on children's dietary habits and weight status.[26] Compared with parents in control sites, there was a statistically significant increase in the proportion of intervention-site parents who reported habitual water drinking among children (43.7% vs 30.1%; *P* value = 0.02).

3.4.5 | Afterschool

Lee et al conducted a multi-component cluster-radomized controlled trial in afterschool programmes.[27] Intervention components included a quality improvement approach to training programme staff and adopting policy and environmental strategies to increase water access during snack and to support healthy eating among students. This approach led to greater increases in observed student water consumption during snack in intervention programmes (1.49 oz; 95% CI, 1.21-1.78; *P* value < 0.0001) as compared with controls.

3.5 | Studies focussed on both water access and consumption outcomes

3.5.1 | Home

McGowan et al conducted a randomized controlled trial of a home-visiting programme in the United Kingdom that trains parents to more regularly serve water instead of SSBs to their children.[28] Controlling for baseline levels of reported consumption frequency, compared with controls, there was a statistically significant increase in intervention parent report of greater automaticity (habitual repetition) for providing

healthy drinks to their children ($P < 0.001$) and the number of occasions their children consumed water (+0.6 times/day vs +0.1 times / day; $P = 0.032$) at follow-up.

3.5.2 | School

In a quasi-experimental study (no control), Haroun et al directly observed changes in the provision of foods and beverages before and after implementation of nutrition standards (eg, provision of drinking water and restriction of SSBs) in a representative sample of primary schools in England.[29] Compared with pre-standard schools, post-standard schools provided significantly more water at lunchtime as a percentage of all food/drinks provided (+0.7%; P value = 0.001). Post-standard schools also had greater proportions of students who took water during school lunch (21.8%; P value < 0.001).

Waters et al studied the impact of a multifaceted approach to making improvements in school environments, policies, and practices focussed on dietary and physical activity behaviours among students.[30] This randomized controlled trial found no significant differences, from baseline to follow-up, in the likelihood of parents reporting their student had two or more glasses of water per day. However, compared with controls, observed intervention students had a a greater odds of having water with their lunch (OR = 1.71; 95% CI, 1.05-2.78; $P = 0.03$).

4 | DISCUSSION

To date, little research has systematically summarized the evidence on strategies that may influence water access and consumption among young children aged 0 to 5 years old. Among population-level studies, such as studies of interventions that operate at a state or whole community level, policy-level strategies including pricing strategies and policies related to improved water access were hallmarks of successful interventions. In individual-level studies, improving water access and increasing water convenience strategies were frequently used in effective or promising studies. Of note, while intervention study effect sizes indicate small total daily volume increases (eg, 0.5-3.5 oz), for young children, depending on age, this volume increase could represent a doubling of the current per capita total daily plain water intake among US children aged 0 to 2 years[48] and could replace a significant portion of the volume of SSBs currently consumed among children 0 to 5 years.[49]

Research design and outcome measurement play an important role in assessing the success of strategies. Most of the studies identified (14 of 25)[12,26-28,30,36,38-45] were randomized or cluster-randomized controlled trials, and seven of these studies[12,27,30,36,38-40] used objectively derived measures of water access or consumption outcomes (Table 1). These studies were conducted in afterschool programmes,[27,36,39] schools and early child-care settings,[12,30,40] and in a community retail environment.[38] Overall, these 14 studies were rated of "fair" quality using the standardized summary assessment for risk of bias.

This review demonstrated a range of interventions across diverse settings, but strategies to promote water intake in clinical settings were lacking. Given the high frequency of clinical visits for infants and young children, particularly in the first 2 years of life, a focus on clinical settings including oral healthcare sites may be warranted. Moreover, as many low-income families, who are most at risk for high rates of SSB consumption and associated health conditions, also participate in WIC and home-visiting programmes, these contexts provide other possible settings for intervention. However, to inform water-related interventions and policies for infants and toddlers, it will be important to develop plain water requirements for optimal growth and development.

Five studies in this review included weight-related outcomes.[26,30,41,43,47] As each of these studies employed strategies to promote nutrition and physical activity more broadly, the contribution of water promotion strategies in obesity prevention is unclear. Given that singular water access and promotion interventions in primary and secondary schools show promise in obesity prevention,[50] it would also be desirable to understand whether water promotion efforts in child-care could have similar impacts. As drinking fluoridated water can help prevent dental caries[3] and adequate hydration is related to improved cognitive function,[51] it is also essential to investigate how efforts to promote water access and intake impact these other nonweight-related health measures.

Given the age of the study population, accurate water consumption outcome measurement tools that are sensitive to small changes in intake are critical to evaluate change.[52] Proxy-reported questionnaires to measure water consumption are useful for documenting overall daily water consumption, particularly in large samples. However, semi-quantitative frequency questionnaires may not be sensitive to small differences in intake. Objective measures such as weighing or observed intake could be better measurement strategies, though objective measures occurring at the point of intake do not provide a measure of overall daily intake. Children may compensate for increased water consumption in one context by decreasing water consumption at other times of the day. The use of a proxy-reported consumption measure may be a concern in an intervention setting where the proxy-reporter cannot directly observe child behaviour (eg, parents reporting on water intake of their child in child-care). Future studies may benefit from using a combination of objective and proxy-reported measures of outcomes for water access and consumption.

This review highlights some research gaps related to interventions to promote water access and intake among children 0 to 5 years in studies published between 2000 and 2018. First, only three studies (including two that are from a single study group) examined strategies to promote water access or intake in isolation from other nutrition or physical activity-related strategies.[26,45,46] Several studies show promise in increasing water intake or reducing SSB or fruit-juice intake with no significant impacts on milk consumption.[12,42-44,47] To help guide policies and practices in this area, studies could examine whether water promotion strategies alone, SSB reduction strategies alone, or both strategies in combination are superior in increasing water intake, reducing SSB consumption, and impacting health. It is possible that studies published prior to 2000 may have addressed some of these considerations.

Lastly, future studies should document information regarding the safety and quality of drinking water provided to children. In this review, no studies provided information about the quality of water

provided to children or families. Conveying information about water quality in a simple, easy to understand format may provide yet another strategy to promote consumption of drinking water in young children. Furthermore, documenting the cost and cost-effectiveness of water access and promotion intervention efforts is equally essential; only one study[12] assessed intervention cost.

5 | CONCLUSIONS

Water access and water convenience strategies were frequently used in effective or promising studies. Limited data are available on the cost of intervention strategies, the role of water quality assessment, and health outcomes associated with increased water consumption. It will be essential to identify ways to translate successful strategies or combinations of strategies to unexplored settings and to study their impact. Future research will benefit from more objectively assessed measures of water consumption and access appropriate for the strategy and setting.

ACKNOWLEDGEMENTS

This work was funded by Healthy Eating Research, a national program of the Robert Wood Johnson Foundation, as part of a larger effort to develop a national research agenda on healthy beverage consumption among children aged 0 to 5 years. The authors would like to thank Mary Story and the Healthy Eating Research Staff and the Project Advisory Committee for their important feedback and guidance.

CONFLICTS OF INTEREST

No conflict of interest was declared.

ORCID

Angie L. Cradock https://orcid.org/0000-0002-2951-9514
Mary Kathryn Poole https://orcid.org/0000-0003-3466-8650
Kaylan E. Agnew https://orcid.org/0000-0002-8762-8292
Chasmine Flax https://orcid.org/0000-0001-7210-4771
Nicole Capdarest-Arest https://orcid.org/0000-0002-0174-5587
Anisha I. Patel https://orcid.org/0000-0001-9198-7936

REFERENCES

1. Bleich SN, Vercammen KA. The negative impact of sugar-sweetened beverages on children's health: an update of the literature. *BMC Obes*. 2018;5(1):6.
2. Lieberman HR. Hydration and cognition: a critical review and recommendations for future research. *J Am Coll Nutr*. 2007;26(5 Suppl):555S-561S.
3. Iheozor-Ejiofor Z, Worthington HV, Walsh T, et al. Water fluoridation for the prevention of dental caries. *Cochrane Database Syst Rev*. 2015;(6). Cd010856. https://doi.org/10.1002/14651858.CD010856.pub2
4. Beckerman JP, Alike Q, Lovin E, Tamez M, Mattei J. The development and public health implications of food preferences in children. *Front Nutr*. 2017;4:66.
5. Wang YC, Hsiao A, Orleans CT, Gortmaker SL. The caloric calculator: average caloric impact of childhood obesity interventions. *Am J Prev Med*. 2013;45(2):e3-e13.
6. Lidsky TI, Schneider JS. Adverse effects of childhood lead poisoning: the clinical neuropsychological perspective. *Environ Res*. 2006;100(2):284-293.
7. Kenney EL, Long MW, Cradock AL, Gortmaker SL. Prevalence of inadequate hydration among US children and disparities by gender and race/ethnicity: National Health and Nutrition Examination Survey, 2009-2012. *Am J Public Health*. 2015;105(8):E113-E118.
8. Patel AI, Shapiro DJ, Wang YC, Cabana MD. Sociodemographic characteristics and beverage intake of children who drink tap water. *Am J Prev Med*. 2013;45(1):75-82.
9. Kenney EL, Gortmaker SL, Cohen JFW, Rimm EB, Cradock AL. Limited school drinking water access for youth. *J Adolesc Health*. 2016;59(1):24-29.
10. Patel AI, Grummon AH, Hampton KE, Oliva A, McCulloch CE, Brindis CD. A trial of the efficacy and cost of water delivery systems in San Francisco Bay Area middle schools, 2013. *Prev Chronic Dis*. 2016;13. https://doi.org/10.5888/pcd13.160108
11. Patel AI, Hecht K, Hampton KE, Grumbach JM, Braff-Guajardo E, Brindis CD. Tapping into water: key considerations for achieving excellence in school drinking water access. *Am J Public Health*. 2014;104(7):1314-1319.
12. Kenney EL, Gortmaker SL, Carter JE, Howe MCW, Reiner JF, Cradock AL. Grab a cup, fill it up! An intervention to promote the convenience of drinking water and increase student water consumption during school lunch. *Am J Public Health*. 2015;105(9):1777-1783.
13. Hanna-Attisha M, LaChance J, Sadler RC, Schnepp AC. Elevated blood lead levels in children associated with the Flint drinking water crisis: a spatial analysis of risk and public health response. *Am J Public Health*. 2016;106(2):283-290.
14. Balazs C, Morello-Frosch R, Hubbard A, Ray I. Social disparities in nitrate-contaminated drinking water in California's San Joaquin Valley. *Environ Health Perspect*. 2011;119(9):1272-1278.
15. Stillo F, Gibson JM. Exposure to contaminated drinking water and health disparities in North Carolina. *Am J Public Health*. 2017;107(1):180-185.
16. Daniels MC, Popkin BM. Impact of water intake on energy intake and weight status: a systematic review. *Nutr Rev*. 2010;68(9):505-521.
17. Vargas-Garcia EJ, Evans CEL, Prestwich A, Sykes-Muskett BJ, Hooson J, Cade JE. Interventions to reduce consumption of sugar-sweetened beverages or increase water intake: evidence from a systematic review and meta-analysis. *Obes Rev*. 2017;18(11):1350-1363.
18. Vercammen KA, Frelier JM, Lowery CM, McGlone ME, Ebbeling CB, Bleich SN. A systematic review of strategies to reduce sugar-sweetened beverage consumption among 0-year to 5-year olds. *Obes Rev*. 2018;19(11):1504-1524.
19. PRISMA. PRISMA: transparent reporting of systematic reviews and meta-analyses. http://www.prisma-statement.org. Accessed April 11, 2018.
20. Covidence. Covidence. https://www.covidence.org/. Accessed April 11, 2018.
21. Downs SH, Black N. The feasibility of creating a checklist for the assessment of the methodological quality both of randomised and non-randomised studies of health care interventions. *J Epidemiol*. 1998;52(6):377-384.
22. Stang A. Critical evaluation of the Newcastle-Ottawa scale for the assessment of the quality of nonrandomized studies in meta-analyses. *Eur J Epidemiol*. 2010;25(9):603-605.
23. Semega J, Fontenot K, Kollar M. U.S. Census Bureau, current population reports, P60-259, Income and Poverty in the United States: 2016 Washington, DC 2017.

24. Ritchie LD, Sharma S, Gildengorin G, Yoshida S, Braff-Guajardo E, Crawford P. Policy improves what beverages are served to young children in child-care. *J Acad Nutr Diet*. 2015;115(5):724-730.
25. Hornsby WC, Bailey W, Braun PA, Weiss K, Heichelbech J. Busting the baby teeth myth and increasing children's consumption of tap water: building public will for children's oral health in Colorado. *Front Public Health*. 2017;5:238.
26. Kaufman-Shriqui V, Fraser D, Friger M, et al. Effect of a school-based intervention on nutritional knowledge and habits of low-socioeconomic school children in Israel: a cluster-randomized controlled trial. *Nutrients*. 2016;8(4):234.
27. Lee RM, Okechukwu C, Emmons KM, Gortmaker SL. Impact of implementation factors on children's water consumption in the out-of-school nutrition and physical activity group-randomized trial. *New Dir Youth Dev*. 2014;2014(143):79-101.
28. McGowan L, Cooke LJ, Gardner B, Beeken RJ, Croker H, Wardle J. Healthy feeding habits: efficacy results from a cluster-randomized, controlled exploratory trial of a novel, habit-based intervention with parents. *Am J Clin Nutr*. 2013;98(3):769-777.
29. Haroun D, Harper C, Wood L, Nelson M. The impact of the food-based and nutrient-based standards on lunchtime food and drink provision and consumption in primary schools in England. *Public Health Nutr*. 2018;14(2):209-218.
30. Waters E, Gibbs L, Tadic M, et al. Cluster randomised trial of a school-community child health promotion and obesity prevention intervention: findings from the evaluation of fun 'n healthy in Moreland. *BMC Public Health*. 2017;18(1):92.
31. Ritchie LD, Yoshida S, Sharma S, Patel A, Vitale EH, Hecht K. Drinking water in California child-care sites before and after 2011-2012 beverage policy. *Prev Chronic Dis*. 2015;12:E89.
32. Silver LD, Ng SW, Ryan-Ibarra S, et al. Changes in prices, sales, consumer spending, and beverage consumption one year after a tax on sugar-sweetened beverages in Berkeley, California, US: a before-and-after study. *PLoS Med*. 2017;14(4):e1002283.
33. Bell AC, Davis L, Finch M, et al. An implementation intervention to encourage healthy eating in centre-based child-care services: impact of the Good for Kids Good for Life programme. *Public Health Nutr*. 2014;18(9):1610-1619.
34. Mozaffarian RS, Wiecha JL, Roth BA, Nelson TF, Lee RM, Gortmaker SL. Impact of an organizational intervention designed to improve snack and beverage quality in YMCA after-school programs. *Am J Public Health*. 2010;100(5):925-932.
35. McGarvey E, Keller A, Forrester M, Williams E, Seward D, Suttle DE. Feasibility and benefits of a parent-focused preschool child obesity intervention. *Am J Public Health*. 2004;94(9):1490-1495.
36. Beets MW, Weaver RG, Turner-McGrievy G, et al. Two-year healthy eating outcomes: an RCT in afterschool programs. *Am J Prev Med*. 2017;53(3):316-326.
37. Colchero MA, Molina M, Guerrero-Lopez CM. After Mexico implemented a tax, purchases of sugar-sweetened beverages decreased and water increased: difference by place of residence, household composition, and income level. *J Nutr*. 2017;147(8):1552-1557.
38. Foster GD, Karpyn A, Wojtanowski AC, et al. Placement and promotion strategies to increase sales of healthier products in supermarkets in low-income, ethnically diverse neighborhoods: a randomized controlled trial. *Am J Clin Nutr*. 2014;99(6):1359-1368.
39. Giles CM, Kenney EL, Gortmaker SL, et al. Increasing water availability during afterschool snack: evidence, strategies, and partnerships from a group randomized trial. *Am J Prev Med*. 2012;43(3 Suppl 2):S136-S142.
40. Norton EM, Poole SA, Raynor HA. Impact of fruit juice and beverage portion size on snack intake in preschoolers. *Appetite*. 2015;95:334-340.
41. Verbestel V, De Coen V, Van Winckel M, Huybrechts I, Maes L, De Bourdeaudhuij I. Prevention of overweight in children younger than 2 years old: a pilot cluster-randomized controlled trial. *Public Health Nutr*. 2014;17(6):1384-1392.
42. Pinket AS, Van Lippevelde W, De Bourdeaudhuij I, et al. Effect and process evaluation of a cluster randomized control trial on water intake and beverage consumption in preschoolers from six European countries: the ToyBox-study. *PLoS One*. 2016;11(4):e0152928.
43. Anand SS, Davis AD, Ahmed R, et al. A family-based intervention to promote healthy lifestyles in an aboriginal community in Canada. *Can J Public Health*. 2007;98(6):447-452.
44. Franks B, Lahlou S, Bottin JH, Guelinckx I, Boesen-Mariani S. Increasing water intake in pre-school children with unhealthy drinking habits: a year-long controlled longitudinal field experiment assessing the impact of information, water affordance, and social regulation. *Appetite*. 2017;116:205-214.
45. Lahlou S, Boesen-Mariani S, Franks B, Guelinckx I. Increasing water intake of children and parents in the family setting: a randomized, controlled intervention using installation theory. *Ann Nutr Metab*. 2015;66(Suppl 3):26-30.
46. De Bourdeaudhuij I, Verbestel V, De Henauw S, et al. Behavioural effects of a community-oriented setting-based intervention for prevention of childhood obesity in eight European countries. Main results from the IDEFICS study. *Obes Rev*. 2015;16(Suppl 2):30-40.
47. de Silva-Sanigorski AM, Bell AC, Kremer P, et al. Reducing obesity in early childhood: results from Romp & Chomp, an Australian community-wide intervention program. *Am J Clin Nutr*. 2010;91(4):831-840.
48. Grimes C, Szymlek-Gay E, Nicklas T. Beverage consumption among U. S. children aged 0–24 months: National Health and Nutrition Examination Survey (NHANES). *Nutrients*. 2017;9(3):264.
49. Demmer E, Cifelli CJ, Houchins JA, Fulgoni V. Ethnic disparities of beverage consumption in infants and children 0–5 years of age; National Health and Nutrition Examination Survey 2011 to 2014. *Nutr J*. 2018;17(78):78.
50. Schwartz AE, Leardo M, Aneja S, Elbel B. Effect of a school-based water intervention on child body mass index and obesity. *JAMA Pediatr*. 2016;170(3):220-226.
51. Adan A. Cognitive performance and dehydration. *J Am Coll Nutr*. 2012;31(2):71-78.
52. Grummon AH, Sokol RL, Hecht CA, Patel AI. Measuring beverage consumption in US children and adolescents: a systematic review. *Obes Rev*. 2018;19(8):1017-1027.

How to cite this article: Cradock AL, Poole MK, Agnew KE, et al. A systematic review of strategies to increase drinking-water access and consumption among 0- to 5-year-olds. *Obesity Reviews*. 2019;20:1262–1286. https://doi.org/10.1111/obr.12833

APPENDIX A

LITERATURE SEARCH STRATEGY

The following databases were searched:

- MEDLINE/PubMed
- ERIC
- Cumulative Index of Nursing and Allied Health (CINAHL)
- Embase

- Web of Science
- Cochrane Register of Controlled Clinical Trials

Limits applied included the following:

- Published after January 1, 2000
- English language

Date searches were run on January 12, 2018.
The search strategy was to combine searches of the following:

- Beverage and water-supply-related terms
- Young child-related terms

Beverage and water supply related terms.
Drinking water*
Water suppl*
Water*
Beverage*
Drink*
Consum*
Intake
Access*
Availab*
Dispenser*
Bottle*
Cooler*
Fountain*
Tap
Serv*
Young child related terms
Child*
Infan*
Neonat*
Newborn*
Baby
Babies
Toddler*
Preschool*
Girl*
Boy*
Full strategies:
MEDLINE/PubMed
((“Drinking Water*”[Mesh] OR “water supply*”[mesh] OR “water*”[mesh] OR water[tw]) AND (“Beverages”[Mesh] OR beverage*[tw] OR “drinking*”[mesh] OR drink*[tw] OR consum*[ti] OR intake[ti] OR access*[ti] OR availab*[ti])) AND (dispenser*[tw] OR bottle*[tw] OR cooler*[tw] OR fountain*[tw] OR tap[tw] OR serv*[tw]) AND (“Child, Preschool”[Mesh] OR “Infant”[Mesh] OR “child”[mesh] OR child*[tw] OR infan*[tw] OR neonat*[tw] OR newborn*[tw] OR baby[tw] OR babies[tw] OR toddler*[tw] OR preschool*[tw] OR girl*[tw] OR boy*[tw]) AND (“2000/01/01”[PDat]: “3000/12/31”[PDat]) AND English[lang]
ERIC
((MAINSUBJECT.EXACT(“Water”) OR water) AND (MAINSUBJECT.EXACT(“Health Behavior”) OR beverage* OR drink* OR consum* OR intake OR access* OR availab*)) AND (dispenser* OR bottle* OR cooler* OR fountain* OR tap OR serv*) AND (MAINSUBJECT.EXACT(“Young Children”) OR MAINSUBJECT.EXACT(“Infants”) OR MAINSUBJECT.EXACT(“Neonates”) OR preschool* OR child* OR infan* OR neonat* OR newborn* OR baby OR babies OR toddler* OR girl* OR boy*)
Additional limits: After January 1, 2000
Language: English
CINAHL
((MH “water” OR MH “water supply” OR water) AND (MH “beverages” OR beverage* OR drink* OR consum* OR intake* OR access* OR availab*)) AND (dispenser* OR bottle* OR cooler* OR fountain* OR tap OR serv*) AND (MH “Child, Preschool” OR MH “Infant+” OR MH “Infant, Newborn+” OR MH “child” OR child* OR infan* OR neonat* OR newborn* OR baby OR babies OR toddler* OR preschool* OR girl* OR boy*)
Limiters - Published Date: 20000101-; English Language.
Embase
((‘drinking water’:ti,ab,kw OR ‘water supply’:ti,ab,kw OR ‘water’:ti,ab,kw) AND (‘beverage’:ti,ab,kw OR ‘drinking’:ti,ab,kw OR ‘drink*’:ti,ab,kw OR ‘consum*’:ti,ab,kw OR ‘intake*’:ti,ab,kw OR ‘access*’:ti,ab,kw OR ‘availab*’:ti,ab,kw)) AND (‘dispenser*’:ti,ab,kw OR ‘bottle*’:ti,ab,kw OR ‘cooler*’:ti,ab,kw OR ‘fountain*’:ti,ab,kw OR ‘tap*’:ti,ab,kw OR ‘serv*’:ti,ab,kw) AND (‘preschool child’:ti,ab,kw OR ‘infant’:ti,ab,kw OR ‘child’:ti,ab,kw OR ‘newborn’:ti,ab,kw OR ‘neonat*’:ti,ab,kw OR ‘baby’:ti,ab,kw OR ‘babies’:ti,ab,kw OR ‘toddler*’:ti,ab,kw OR ‘preschool*’:ti,ab,kw OR ‘girl*’:ti,ab,kw OR ‘boy*’:ti,ab,kw) AND [english]/lim AND (2000:py OR 2001:py OR 2002:py OR 2003:py OR 2004:py OR 2005:py OR 2006:py OR 2007:py OR 2008:py OR 2009:py OR 2010:py OR 2011:py OR 2012:py OR 2013:py OR 2014:py OR 2015:py OR 2016:py OR 2017:py OR 2018:py)
Web of Science
(((TS = “drinking water” OR TS = “water supply” OR TS = water) AND (TS = beverage* OR TS = drink* OR TI = consum* OR TI = intake OR TI = access* OR TI = availab*)) AND (TS = dispenser* OR TS = bottle* OR TS = cooler* OR TS = fountain* OR TS = tap OR TS = serv*) AND (TS = child* OR TS = preschool* OR TS = infan* OR TS = newborn* OR TS = neonat* OR TS = baby OR TS = babies OR TS = toddler* OR TS = girl* OR TS = boy*)) AND LANGUAGE:(English)
Time span: 2000-2018
Cochrane Register of Controlled Clinical Trials
#1 MeSH descriptor: [Drinking Water] explode all trees
#2 MeSH descriptor: [Water Supply] explode all trees
#3 MeSH descriptor: [Water] explode all trees
#4 water
#5 #1 or #2 or #3 or #4
#6 MeSH descriptor: [Beverages] explode all trees
#7 MeSH descriptor: [Drinking] explode all trees
#8 #6 or #7 or beverage* or drink* or consum* or intake or access* or availab*
#9 #5 and #
#10 dispenser* or bottle* or cooler* or fountain* or tap or serv*
#11 #5 and #8 and #10

#12 MeSH descriptor: [Child] explode all trees

#13 child* or infan* or neonat* or newborn* or baby or babies or toddler* or preschool* or girl* or boy*

#14 #12 or #13

#15 #11 and #14

Publication Year from 2000

APPENDIX B

DETAILS OF INTERVENTION STRATEGIES

APPENDIX B. Details of intervention strategies

Author, year	Strategy (Water and/or Sugar-Sweetened Beverages [SSBs])
Anand, 2007	Train/teach/educate caregivers to increase water; train/teach/educate caregivers to decrease SSBs; increase water availability/convenience at point of selection/consumption intake: water delivered to household
Beets, 2017	Train/teach/educate caregivers to increase water provision/access/availability and decrease SSB provision/access/availability
Bell, 2014	Train providers to increase water provision/access/availability: practice change and capacity building with incentives, resources and support at 12+ months
Colchero, 2017	Policy and pricing interventions to alter the relative price of water and SSBs: 2014 implementation of SSB excise tax
De Bourdeaudhuij, 2015	Policy/practice change that focus on water access: increase physical water availability/convenience at point of selection/consumption for children: increase water promotion/encouragement: target environmental and personal factors
de Silva-Sangiorski, 2010	Water promotion/encouragement campaign: Smiles 4 Miles, oral health campaign; policy/practice change for water and SSB provision: Go For Your Life, award programme for healthy practices in early childhood services; beverage access/convenience: reusable water bottles
Foster, 2014	Increase physical water availability/convenience (caregivers or children) at point of purchase: marketing product, placement and promotion; water placed in dead spaces/end caps and in checkout coolers on the top shelf. Water and diet drinks were placed in aisles and at eye level. Aisle signage used to promote water.
Franks, 2017	Train/teach/educate caregivers to increase water provision/access/availability: info: online sessions about child water intake; social: social forum; increase physical water availability/convenience at point of selection/consumption: water: delivered to household
Giles, 2012	Policy/practice change for water provision/access/availability: policy/practice change to replace juice with water on snack menu; train/teach/educate providers to increase water provision/access/availability: offer water at snack; increase physical water availability/convenience at point of selection/consumption: tap water in insulated jugs and pitchers filled with bottled water from large coolers
Haroun, 2010	Policy change for SSB provision/access/availability; policy change for water provision/access/availability: 2008 food and nutrient-based standards for school lunches
Hornsby, 2017	Train/teach/educate caregivers to decrease SSB provision/access/availability; train/teach/educate caregivers to increase water provision/access/availability; train/teach/educate caregivers to substitute water for SSBs; water promotion/encouragement campaign; campaign to replace SSBs with water; increase water promotion/encouragement: TV (English and Spanish outlets), radio, digital/online, billboards, and social media to increase water, decrease SSBs and protect baby teeth
Kaufman-Shriqui, 2016	Train/teach/educate caregivers to decrease SSB provision/access/availability; train/teach/educate caregivers to increase water provision/access/availability; train/teach/educate caregivers to substitute water for SSBs: educational lessons promoted decrease SSBs and drinking water instead; increase water promotion/encouragement: nutrition programme using traditional ethnically accepted diverse recommendations
Kenney, 2015	Increase physical water access/convenience at point of selection/consumption: cup dispensers placed near fountains with cups; increase water promotion/encouragement: posters to promote water intake posted by water fountains
Lahlou, 2015	Train/teach/educate caregivers to increase water provision/access/availability: kid-size water bottles delivered at home; caregivers educational resources; online support forum
Lee, 2014	Policy/practice change for water provision/access/availability: policy/practice change to replace juice with water on snack menu; train/teach/educate providers to increase water provision/access/availability: offer water at snack; increase physical water availability/convenience at point of selection/consumption: tap water in insulated jugs and pitchers filled with bottled water from large coolers
McGarvey, 2004	Train/teach/educate caregivers to substitute water for SSBs: instructions for parents to replace SSBs with water and reinforcement by staff and community organizations
McGowan, 2013	Train/teach/educate caregivers to decrease SSB provision/access/availability; train/teach/educate caregivers to increase water provision/access/availability; train/teach/educate caregivers to substitute water for SSBs: parent education resources
Mozaffarian, 2010	Train/teach/educate caregivers to decrease SSB provision/access/availability; train/teach/educate caregivers to increase water provision/access/availability; policy/practice change
Norton, 2015	Increase water access at point of selection: increase the size of vessel/amount of water served to children to increase consumption; 6- and 12-oz portion of water served to children at snack
Pinket, 2016	Train/teach/educate caregivers to increase water provision/access/availability: how to ensure student water consumption throughout the day; parent education on water; increase physical water availability/convenience at point of selection/consumption: water stations installed in classrooms; increase water promotion and encouragement: teacher-led activities to promote water stories, sensory perception games, experiments, and excursions

APPENDIX B (Continued)

Author, year	Strategy (Water and/or Sugar-Sweetened Beverages [SSBs])
Ritchie, 2015a	Policy change for SSB provision/access/availability; policy change for water provision/access/availability: state policy for licensed child-care to serve water at meals, indoors/outdoors. Federal policy requiring Child and Adult Care Food Program—participating child-care to provide water throughout the day and at meals
Ritchie, 2015b	Policy change for SSB provision/access/availability; policy change for water provision/access/availability: state policy for licensed child-care to serve water at meals, indoors/outdoors. Federal policy requiring Child and Adult Care Food Program—participating child-care to provide water throughout the day and at meals
Silver, 2017	Policy and pricing to alter the relative price of water and SSBs: 2015 implementation of SSB excise tax of $0.01/oz

APPENDIX B (Continued)

Author, year	Strategy (Water and/or Sugar-Sweetened Beverages [SSBs])
Verbastel, 2013	Train/teach/educate caregivers to increase water provision/access/availability and replace SSBs with water: provided poster for parents with tips for water consumption and tailored feedback reports on child-specific behaviours reported by parent
Waters, 2018	Policy/practice change for water provision/access/availability; train/teach/educate caregivers to increase water provision/access/availability; increase physical water availability/convenience at point of selection/consumption for children; increase water promotion and education: various water access and consumption strategies including policy, environmental availability, and education