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Challenges in Reducing Sugar-Sweetened Beverage Consumption through the Promotion of Water Intake: The *Drink Smart* in Schools Non-Randomised Pilot Trial

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Abstract

Background: Consumption of Sugar-Sweetened Beverages (SSB) in Mexican children remains high with soft drinks accounting for 10% of energy intake. Greater intakes of SSB are associated with higher risks of weight gain, type 2 diabetes and the Metabolic Syndrome (MS).

Objective: A 12-week educational programme was developed to target environmental resources including school water fountains and determine its effectiveness on water and SSB consumption.

Methods: Sixteen classes in four schools in Mexico were recruited and non-randomly allocated to the intervention (N= 2 schools, 8 classes) or control group (N= 2 schools, 8 classes) in September 2015. The sample included 337 children aged 7-12 years (222 in intervention and 115 in controls). SSB and water intakes were measured through a beverage questionnaire at baseline and post-intervention.

Results: Mean baseline intakes of all beverages combined, including water, were 2133 mL (SD= 892mL) for the intervention group and 2250 mL (SD= 896 mL) for controls. At the end of the study, intervention and control groups achieved reductions in daily intake of SSB by -61 mL/day and -132mL/day, respectively, with a non-significant mean difference between groups of 71 mL/day (95% CI: -94 to 236; p= 0.4). Similarly, consumption of water throughout the day decreased in both the intervention and control groups by -169 mL/day and -62 mL/day respectively with a mean difference between groups of 67 mL/day (95% CI: -108 to 242 mL/day, p= 0.5).

Conclusion: The programme was insufficient to achieve behaviour change in children. Effectiveness may require more intensive approaches with parental involvement and further changes to the built environment.

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Introduction

Decreasing consumption of free-sugars particularly in the form of Sugar-Sweetened Beverages (SSBs) remains a global health priority considering the higher risk of adiposity-related chronic diseases from higher intakes [1,2]. Results from experimental and longitudinal studies demonstrate increases in risks of weight gain, [3] the metabolic syndrome and type 2 diabetes [1,4,5] for every additional serving portion per day of SSB or for consumers within the highest ranges of consumption (typically more than 6 servings per week). Furthermore, the direct implication of SSB -as vehicles of highly fermentable carbohydrates for oral bacteria- on dental caries [6] has been key to reinforcing global guidelines on limiting intake of free sugars in children and adults to no more than 10% of total energy per day [7] and ideally to no more than 5% -as enforced in countries like the UK [8]. Typically, an 8-ounce serving of SBB provides between 23 to 30 grams of free sugars [6] or 5% of total energy intake.

Whilst intakes of SSB are higher than recommended in many countries, [9] analyses on regional and national burdens of disease linked to SSB consumption on type 2 diabetes, cardiovascular disease and cancer have estimated that amongst the 20 most populated countries, Mexico has the largest absolute (405 deaths/million adults) and proportional (12.1%) deaths derived from SSBs [9]. Childhood obesity remains high in Mexico at approximately 33.2% [10] and contributing factors such as consumption of SSB, exceeds 10% of total energy intake [11]. Results from a survey in 2008 across 6335 obese 6 to 15 year- olds living in the state of Guanajuato had evidenced a prevalence of the metabolic syndrome in approximately 14% of this population [11]. As clinical progression of the metabolic syndrome into type 2 diabetes and cardiovascular disease prior to adulthood has been documented, [13] addressing dietary modifications in this age group can have long-lasting health and economic effects.

Policies introduced by the Mexican executive include modifications to the school environment to engage children into healthier dietary practices. For instance, the reinforcement of the National Agreement for Healthy Nutrition produced in 2010 restricted sales of SSB in school cafeterias [14] and potable water supply at schools has been fostered since the Health Sectorial Programme in 2013 [15]. Evidence of their effectiveness, has slowly emerged highlighting the feasibility of nudging young populations into drinking more water using the school as a setting for intervention.

Successful behavioural changes are still warranted at the school level, as goals for SSB intakes in children have not been met. Results from a pilot study in 2014 highlighted that only 34% of Mexican scholars were bringing plain water with their lunch boxes, whereas 50% still brought sweetened beverages– which contributed to 21% of the energy they consumed coming from items brought from home. Furthermore, only one third (33%) of the primary schools surveyed had access to free drinking water (water fountains) [16].

Decreasing SSB consumption in children remains an achievable target as indicated by a systematic review and meta-analysis which portrayed decreases of around 20% in SSB intake and increases in water intake by 70 mL per day across child-based interventions [17]. Moreover, schools are recognised as valuable settings to influence dietary behaviours in children as their universality offers a channel to reach children from different cultural backgrounds and economic strata [18]. Considering the current health context for children in Mexico, we have evaluated the effectiveness of the *Drink Smart in schools'* project, a water campaign across four Mexican primary schools, aimed at reducing consumption of SSB through the promotion of water intake.

Methods

School characteristics

A non-randomised controlled pilot study was conducted in 7 to 12-year-old children attending four public elementary schools in the city of Leon, Mexico from September to December 2015 (12 weeks in total). Assuming a two sided test, α= 0.05 and power of 80%, 231 children were needed per group to detect a difference in water intake of one serving size (240 mL) between intervention and control groups in approximately 4 schools. Considering the study's design and that differences at the school level were not taken into account as well as an estimated dropout rate of 10–15%, a final sample size between 231 and 250 subjects per group (2 schools from intervention and 2 schools from control) was planned.

The department of Nutrition at the Ministry of Education in Leon and staff from the University of Guanajuato discussed the viability of conducting the study. For administrative convenience, the Nutrition department provided a list of potential schools from three different educational districts in Leon that had been contacted - 6 months before the start date of this project - to receive a one week nutritional course on healthy eating and that also fulfilled the following criteria: children from 3rd to 6th grade enrolled, a minimum of 150 students and located in the urban area of Leon. Schools with and without water fountains were required.

Characteristics of each school can be seen in supplemental table 1. The institutional review board at the Hospital of High Speciality in Guanajuato and the Ethics Review committee within the faculty of Mathematics and Engineering Sciences at the University of Leeds approved the study protocol (MEEC 15-002).

Activities

Intervention condition

The methods and intervention components of the *Drink Smart* in school´s project were informed by intervention mapping and systematically reviewing the literature surrounding the topic [17]. The range of potential interventions was categorised using the proposed framework "*Promise table"* from Swinburn *et al* [19]. The study comprised the promotion of the water fountain through banners placed around the school, the provision of a 500 mL reusable water bottle, the introduction of a daily "water break" during class time, a urine colour chart placed at toilets and the provision of nutritional information through board games to promote drinking plain water and discourage SSB intake, which could take from 15 to 30 minutes of classroom time.

Control condition

Control schools were asked to keep to their usual curriculum and a leaflet with information on consequences of too much SSB intake and benefits of water intake was provided to children and teachers. At the end of the study, schools were given the same classroom materials as the intervention groups.

Outcome measures

The primary outcomes were the change in consumption of water and SSB in millilitres per day. Intakes were assessed before the start of the intervention and directly at the end of the intervention (on week 13th) through a piloted beverage questionnaire (supplemental figure 1). The questionnaire collected information on intakes throughout five periods within a day (before, during and after school). Beverages assessed were: Carbonated drinks, sports drinks, sweetened flavoured milk products, fruit drinks (bottled) and frappes (made from syrups), fresh fruit drinks (100% fruit juice, fruited- sweetened water) and plain water. This tool was based on the Child and Diet Evaluation Tool (CADET) [20] and another validated beverage questionnaire [21].

A process evaluation was undertaken six weeks after the start of the intervention and four weeks after the end through a semi-structured questionnaire to heads of schools and teachers in the intervention group to explore perceived changes in children's attitudes and the school's ethos.

No anthropometric measurements were collected and were not available at the Ministry of Education.

Statistical analysis

Multilevel analysis was used to assess the effects of the intervention in order to take account of the nested nature of the data. Levels were defined as: 1) individual student 2) school. A random-effects linear regression model was implemented since it is generally recommended for combining continuous outcomes (such as volume of intakes) as it considers the correlation between intakes of beverages of children from the same school (within-school variation) [22].

Participants with beverage intakes of more than 4 L were excluded as these were deemed to have completed the forms incorrectly. A change score approach was followed, calculated by subtracting baseline intakes from follow up intakes rather than adjusting for baseline measurements, in order to meet regression assumptions [23]. A negative score therefore indicated a reduction in SSB intake at follow up.

Subgroup analyses were carried out to identify any variations in the primary outcome (e.g., differences in consumption at home and school times and between different types of sugary drinks). Intraclass Correlation Coefficients (ICC) were produced for each beverage category to determine variation at the cluster level and sensitivity analyses were pre-specified to identify differences in effect size according to different strata: gender, SES and parental education. Confidence intervals and p-values took into account the number of school clusters as well as the number of children. Analyses were conducted in Stata IC version 14.1 following the intention-to treat-principle, thus no data imputation was performed. It should be noted that although this intervention was a pilot trial, it focused on testing the components and processes of a prospective main trial with the intention of also providing an estimate of effect size [24].

School and participant flow during the study has been summarised in figure 1. Written parental consent was obtained for 485 of the 545 children attending schools (89%). From the 479 children screened at baseline, 429 children had complete data for analysis (90%), but only 337 (70%) were considered to have suitable data for final analyses: Those with beverage intakes not exceeding 4,000 mL/day.

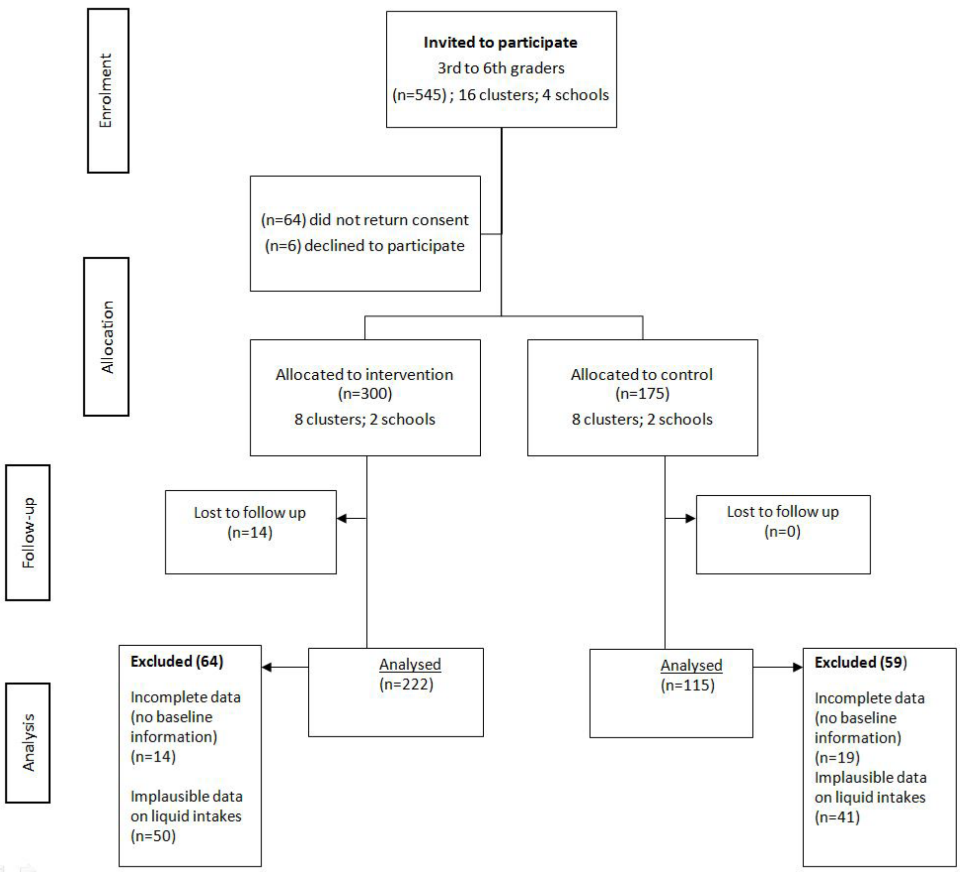

Figure 1: *Study flow chart:* screening, allocation and analysis of schools and study participants.

An adapted version of the Mexican National questionnaire [25] to measure socioeconomic status (based on housing and employment characteristics) was sent to parents and response was very low (25-30%). At baseline, the control and intervention groups were not different in characteristics related to gender, age or socioeconomic characteristics (supplemental table 2). However, control groups had statistically higher intakes of carbonated and fruit drinks in comparison to intervention groups at baseline.

Changes in water and SSB throughout the day

At the end of the study consumption of water throughout the day had decreased in both the intervention and control groups by -169 mL/day and -62 mL/day respectively with a non-significant mean difference between groups of 67 mL/day (95% CI: -108 to 242 mL/day, p=0.5) (Table 1). Intraclass correlation coefficients (ICC) revealed that less than 1% of the variation for changes in water intake were at the school level, thus 99% of variation were due to student's individual characteristics.

The change scores across all SSB combined did not significantly differ across intervention and control groups (IG-CG) with both conditions achieving reductions of -61 mL/day and -132 mL/day, respectively. The difference between groups, adjusted for clustering indicated a greater albeit non-significant change for the control group on all SSBs of 71 mL/day (95% CI: -94 to 236, p= 0.4). The larger reduction of fruit drinks in the control group (82 mL/day [95% CI: 1 to 163; p= 0.049]) was significant. There were no associations highlighting effects of gender, SES or parental education level on intakes of SSB or water. Thus, no further sensitivity analyses were conducted.

Changes at school time (8 am - 12.30 pm)

Water intake decreased within groups, with reductions in controls being more pronounced (intervention: -54 mL/day vs control: -135 mL/day), yet the difference in the change score between groups was not statistically significant (81 mL/day; 95% CI: -16 to 178; p=0.1). Also, the difference between groups in the change from baseline to follow-up in consumption of SSBs was not significantly different between groups (-47 mL/day; 95% CI: -115 to 22; p= 0.2).

Changes at home-time/out-of-school hours.

Changes in water intake out of school hours did not differ between groups (IG-CG) after adjustment for clustering (9 mL/day; 95% CI: -164 to 146; p= 0.9). Conversely, changes in all SSBs differed significantly between groups indicating greater increases for the intervention group (149 mL/day; 95% CI: 26 to 273; p= 0.02) out of school hours. Greater reductions were seen in controls for processed fruit drinks in comparison to the intervention group (164 mL, 95% CI: 45 to 283 p= 0.01). ICC for all SSB combined highlighted that only 1% of the variation in this outcome was at the school (group) level.

Table 1: Intervention effect on changes in water and SSB throughout the day.

Beverages (ml/day)	Unadjusted data Mean (SD)		Change from Baseline Mean [95% CI]	Adjusted difference ‡ [95% CI]	P value
	Baseline	Post-intervention			
All beverages combined (except water)					
IG	1116 (689.7)	1072(655.05)	-61 [-162 to 40]	71 [-94 to 236]	0.4
CG	1204(780.5)	1055 (680.9)	-132 [-256 to 8]		
Water					
IG	1017(684.1)	848 (692.0)	-169 [-275 to -62]	67 [-108 to 242]	0.5
CG	1046(764.5)	811 (647.8)	-235 [-369 to -102]		
Total intakes					
IG	2133(892)	1903 (792.6)	-230 [-364 to -96]	138 [-86 to 361]	0.2
CG	2250 (896)	1883 (734.1)	-367 [-544.8 to -189]		

‡ Adjusted for clustering.

Process evaluation

Five weeks after the intervention started, records of implementation of the water break by teachers were reviewed. Five out of eight teachers in the 2 intervention schools implemented the water break. Reasons for lack of implementation were: being a new teacher (n=1), not understanding how to record the activity (n=1) and not knowing where the recording sheet was kept (n=1). In relation to the conservation of water bottles, half of the classes had already lost them or started to bring different containers. Teachers were also asked about exposing children to the board games; three teachers declined exposure due to insufficient materials to rotate amongst children, being a new teacher, lack of time and badly-behaved children (games were seen as a reward for achievement of expected classroom goals). However, participant engagement with activities were found to be high throughout the study as seen by formative assessments of children.

At the end of the study, seven teachers and one head of intervention schools suggested an increased children's awareness on the favourable effects of drinking more water and on the consequences of drinking too many SSBs. The water break was documented by 5 teachers around 7 weeks after the intervention had started, with no execution towards the end of the study (around week 10) in both sites. Further barriers seen by school´s staff for children not drinking healthier beverages were the lack of parental engagement, excessive availability and marketing strategies of SSBs.

Discussion

This feasibility study, whilst targeting an important obesity risk factor, was insufficient to modify behaviour in children as consumption of water throughout the day decreased, albeit non-significantly, from baseline to post intervention with higher reductions seen in control groups. Intake of SSBs during the day was minimally reduced from baseline to post-intervention in both groups. We found, however, that there was a greater statistically significant reduction in SSB intake in control groups (in contrast to intervention) during out-of-school hours.

Few Mexican studies have assessed the effectiveness of educational and environmental manoeuvres in schools as a way to promote water intake and diminish consumption of SSBs in children, and these existing studies have reported some improvements in this area [26-28]. For instance, Elder *et al.*, [27] conducted a controlled study in two schools in Mexico city and one in San Diego, USA involving the distribution of a water bottle, modifying choice at the school's cafeteria and using urine colour charts as proxies of hydration [27]. After 12 weeks, an increase in water intake was documented at all experimental sites; however, direct observational measures of the child were used to evaluate liquid intake only at school (with no assessment on water intake or other beverages throughout the day). Furthermore, promotion of water intake was done through placement of 20 L water containers in each class, which were financed by parents, as many schools in Mexico still lack water fountains [29]. Yet, this strategy could not be scalable to all populations, including the one in our study.

A cluster-RCT involving 271 Mexican school-aged children found that when water fountains were used with the above mentioned components, water intake could increase significantly by 170 mL in experimental groups during school hours [28]. Coupled with nudges in the school's environment highlighting consumption of water over SSB, a reduction in SSB intake was reported for intervention groups over the whole day in subgroup analyses. This intervention, though with a similar curriculum as the Drink Smart project was more intensive and had higher contact with children and staff. However, children from control groups tended to be heavier than those in intervention arms at baseline and SSB definition did not include many sugary drinks [28].

A pioneer intervention for Mexican policy was a cluster-RCT which allocated 27-Mexican schools under three different conditions ranging in intensity of activities [26]. This intervention reduced the opportunities for children to eat/drink higher-in sugar products (including SSB) in school hours and documented an 18.5% decrease in consumption of these products in experimental groups. This study was more highly powered with 886 students enrolled and was more comprehensive than our intervention as it involved working closely with school cafeterias, setting rules for eating times at school and ensuring water availability through containers. Data, nevertheless, were measured through direct observation of children's intake and were supported by purchasing information from the school's cafeterias. This intervention was also more cost and time intensive [26].

An alternative explanation for differences in water intake at the end of this study in comparison to the aforementioned trials was the change in seasonality; September to December temperature usually falls from 30C to 20C [30] - which could have made children drink less water. We also observed a higher reduction of SSB intake in control groups that could have been due to the lack of randomisation, which resulted in imbalances at baseline (with higher consumption of certain drinks in controls).

Based on the available experience in Mexican schools what seems to work most effectively is limiting availability of SSB and guaranteeing highly accessible palatable water instead. Assessment of such initiatives should, ideally, incorporate randomised methods to diminish bias including seasonal influences. Fiscal resources have focussed on water promotion in Mexican schools through fountains, yet as learnt from this study, this may not be the most engaging resource for children.

Achieving change in children's beverage intake clearly remains challenging [8,17,20]. In Mexico, whilst policy documents targeting nutrition strategies in schools are available, [31] a programme's dose and fidelity widely depend on the willingness of all school staff for its implementation. For instance, our process evaluation identified that uptake of educational components started to decline after 6 weeks of implementation, with some of the activities (such as the water break) not being implemented by the end of the study. Teachers' busy agenda [32] as well as their self-perception and influential role towards modifying health behaviours in children (often parent blaming) may stand as barriers for not delivering activities as planned [33].

Promotion of water intake through school water fountains faces the negative views and resistance by children to drink water when fountains are broken, dirty or produce unpalatable water [34]. Indeed, the latest WASH report has shown that 87% of the schools in Mexico have limited sanitation and hygiene infrastructure (WASH). Future work should prioritise limiting availability of SSBs around schools, whilst keeping school policies and resources to ensure health promotion activities. Parental involvement is important, as recent qualitative evidence in Mexican adolescents [35] has emphasised that consuming SSB at home is a habitual, deeply-rooted behaviour where parents are usually responsible for purchasing SSBs [36].

Strengths and limitations

Although a pilot study, this was the first intervention in the region to assess whether nutritional efforts in combination with environmental nudges could positively affect children's beverage intake throughout the day. Information collected is highly valuable for decision makers, since resources are limited to conduct programme evaluation of nutrition schemes across schools.

This study had several limitations. First, it targeted a population independent of weight status, thus intervention effects on children with different BMI was not possible, yet it could have been a source of variation in beverage intake [37]. Also, habitual energy intake, diet quality and compensations in other sugary products were not assessed. Though randomisation was intended, assignment of participants was hindered by educational authorities who may have provided highly motivated schools, therefore, findings cannot be generalised to all populations. Whilst data was collected for a single day, the beverage questionnaire was comprehensive on selection of portion sizes by means of selecting a glass, a can, a small or large bottle together with images to assist children in portion estimation; its application was easy, fast and non-burdensome. Nevertheless, measuring beverage intake remains challenging despite improvements in assessment tools; harmonisation of definitions and a better estimation of portion sizes should be tackled to increase accuracy in results [38]. Developments in mobile and web-based tools, for example, could allow for better collection and analysis of beverage data [39,40]. Whilst a short intervention could benefit from "booster" sessions and longer time to engage participants in the desired behaviours, children's interest in activities was found to be high throughout the study. Parental involvement, on the other hand was minimal, even though it is an element that could bring success to school-based health promotion frameworks [33].

Conclusion

This school-based intervention combining an educational and environmental approach had little impact on children's SSB and water intakes. The dose and length of the programme were insufficient to bring about behaviour change in children and mainly raised awareness on the importance of drinking more water throughout the day. Future research should contemplate engaging parents and addressing barriers outside the school to encourage children to have healthier choices.

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Conflict of interest

The authors declare that they have no conflict of interest

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Ethical approval

"All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional review board at the Hospital of High Speciality in Guanajuato (**CNBCEI 11 0001 2009.05.01; CEI 19-15**)and the Ethics Review committee within the faculty of Mathematics and Engineering Sciences at the University of Leeds approved the study protocol **(MEEC FREC; MEEC 15-002)** and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards."

Informed consent

"Informed consent was obtained from all individual participants included in the study."

Contributors

EJVG, CELE and JEC all contributed to the original idea and planning of the study. EJVG has led the implementation of the activities and data collection; EJVG and CELE led the development and execution of the statistical analysis, CELE and EJVG have shared responsibility in drafting the manuscript. JEC has provided essential guidance at all stages of the study and assisted in all drafts of the manuscript. All authors have read and approved the final manuscript.

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