ann. behav. med. (2020) 54:436–446
DOI: 10.1093/abm/kaz060

REGULAR ARTICLE

# The Effect of a Priest-Led Intervention on the Choice and Preference of Soda Beverages: A Cluster-Randomized Controlled Trial in Catholic Parishes

**J. Jaime Miranda, MD, MSc, PhD[1,2] • Alvaro Taype-Rondan, MD, MSc[1] • Janina Bazalar-Palacios, RN[3] • Antonio Bernabe-Ortiz, MD, MPH, PhD[1] • Dan Ariely, PhD[4]**

Published online: 18 December 2019


## Abstract

***Background*** Latin America ranks among the regions with the highest level of intake of sugary beverages in the world. Innovative strategies to reduce the consumption of sugary drinks are necessary.

***Purpose*** Evaluate the effect of a one-off priest-led intervention on the choice and preference of soda beverages.

***Methods*** We conducted a pragmatic cluster-randomized trial in Catholic parishes, paired by number of attendees, in Chimbote, Peru between March and June of 2017. The priest-led intervention, a short message about the importance of protecting one's health, was delivered during the mass. The primary outcome was the proportion of individuals that choose a bottle of soda instead of a bottle of water immediately after the service. Cluster-level estimates were used to compare primary and secondary outcomes between intervention and control groups utilizing nonparametric tests.

***Results*** Six parishes were allocated to control and six to the intervention group. The proportion of soda selection at baseline was ~60% in the intervention and control groups, and ranged from 56.3% to 63.8% in Week 1, and from 62.7% to 68.2% in Week 3. The proportion of mass attendees choosing water over soda was better in the priest-led intervention group: 8.2% higher at Week 1 (95% confidence interval 1.7%–14.6%, $p = .03$), and 6.2% higher at 3 weeks after baseline ($p = .15$).

***Conclusions*** This study supports the proof-of-concept that a brief priest-led intervention can decrease sugary drink choice.

***Clinical Trial information*** ISRCTN, ISRCTN24676734. Registered 25 April 2017, https://www.isrctn.com/ISRCTN24676734

**Keywords:** Behavioral economics • Carbonated beverages • Catholicism • Consumer behavior • Faith based organizations • Pragmatic clinical trials • Randomized controlled trials

✉ J. Jaime Miranda
Jaime.Miranda@upch.pe

1 CRONICAS Center of Excellence in Chronic Diseases, Universidad Peruana Cayetano Heredia, Av Armendariz 485, Miraflores, Lima, Peru

2 Department of Medicine, School of Medicine, Universidad Peruana Cayetano Heredia, Av Honorio Delgado 430, San Martin de Porras, Lima, Peru

3 Centro de Estudios de Población, Universidad Católica los Ángeles de Chimbote, Jirón Tumbes N 247, Casco Urbano, Chimbote, Peru

4 Center for Advanced Hindsight, Duke University, 334 Blackwell Street, Suite 320, Durham, NC 27701, USA

## Introduction

The elevated intake of sugar-sweetened beverages is associated with various conditions and chronic diseases [1]. Annually, 655,000 deaths have been attributed to the consumption of sugary drinks globally, due to diabetes, cardiovascular diseases, and different types of cancer [2]. Andean Latin America is one of the regions with the highest level of intake of sugary beverages in the world, with an average consumption per capita of 86.4 liters

per year [2]. In Peru, in 2008–2009, the average intake of sugary beverage per capita was 27.3 liters per year, and was higher in coastal areas of the country (30.6 liters) and urban areas (30 liters) [3]. Innovative and effective strategies to reduce the consumption of sugary drinks are necessary.

Interventions oriented to decrease the consumption of sugar-sweetened beverages have targeted taxation, community-level interventions, mass media campaigns, and schools [4–8]. While many of these interventions aim to address the issue from a wider societal perspective, faith-based interventions, defined as "[interventions] that are designed specifically for and often by individuals belonging to a certain faith [and] are designed to resonate with the deeply held beliefs and practices of that community," [9] could have a direct influence on the choices of individuals. Yet, studies examining the ability of faith-based organizations to decrease the consumption of sugar-sweetened beverages have not been conducted.

Some faith-based interventions have been found as a promising intervention for enhancing physical activity [10] and weight loss [11–13], but few of them have been conducted in Latin America [14]. A combination of faith-based strategies with low-intensity interventions to decrease the consumption of sugar-sweetened beverages would be worth pursuing. Low-intensity interventions, defined as those that consisted of 3 or less hours, could be as effective as longer interventions to improve health literacy [15]. Also, low-intensity trials, where contact with providers last 30 min or less, oriented to provide behavioral counseling to promote physical activity and a healthful diet could be effective to improve weight loss [16]. Proof-of-concept studies are therefore needed to inform the development of adequate interventions.

Catholicism is one of the key institutional actors in Latin American societies. As such, Catholic churches and associated services have the potential to serve as a vehicle to introduce and engage prevention-related strategies aimed at limiting or reducing the consumption of sugary drinks. The present study, a faith-based intervention, was carried out with the objective of evaluating the immediate and short-term impact of a one-off sermon given by priests on the choice and preference of soda beverages.

## Materials and Methods

### Trial Design

The CONSORT extension for cluster trials was followed [17]. This was a pragmatic, cluster-randomized trial conducted between March and June of 2017 (data were analyzed in July–August 2017) in Chimbote, a city in the Ancash region of Peru, in which Catholic parishes (clusters) were the randomized units. To minimize differences in the type of service and its attendees, for example, weddings or baptisms or masses during weekdays being different than masses from weekends, the first Sunday's morning service was chosen for all the assessments in this experiment. A total of four assessments were conducted in this study: formative, baseline, Week 1 after baseline, and Week 3 after baseline assessments. The priest's message intervention was delivered 1 week after the baseline assessment; thus, its immediate effect was evaluated in the same day. Lasting short-term effects of the experiment, without the priest's intervention, were evaluated 3 weeks after the baseline.

### Participants

There are 18 Catholic parishes in the city, all belonging to the Diocese of Chimbote. Of these, one offered mass services on Sunday evenings only, and another had, on average, ≤10 attendees at the first Sunday morning service, and four rejected to participate in the study. Therefore, the study included 12 parishes (clusters). The population comprised all attendees aged ≥18 years present at the first morning service on Sundays in the 12 parishes included in the study.

### Setting

Chimbote is a coastal city with a population of approximately 215,000 inhabitants [18]. According to the 2007 Peruvian census, 6% of the population is considered rural, 8% is illiterate, 66% have no health insurance, and 75% of the population ≥12 years old is self-described as Catholics [19]. A map of the location of these parishes is provided in Supplementary Figure S1.

### Formative Assessment

In the 12 parishes, a formative assessment was carried through a self-applied survey handled to all the mass' attendees at the end of the first Sunday morning service. This formative assessment was conducted 7 weeks before the study's baseline assessment, to characterize the profile of mass' attendees according to sex, age, education, self-reported consumption of soda in the last week, and various religious practices. It was decided that such characterization would occur before the intervention to avoid introducing suspicion and biases during the experiment [20]. The results of this formative assessment were also used to inform the amount of bottles and personnel needed at the baseline and intervention masses.

## Randomization

Restricted randomization [21] was used to allocate parishes to the intervention or control group. Acknowledging the differences in clusters, and using the information from the baseline assessment, a code in Python programming language (Stichting Mathematisch Centrum, Amsterdam, The Netherlands) was built to create all possible combination of pair of parishes based on two criteria: the number of attendees, and the proportion of individuals choosing a bottle of soda over water in the baseline assessment. It was expected that each pair of parishes would have a similar number of attendees (difference in cluster size ±75 individuals) and a similar proportion of individuals choosing a bottle of soda instead of a bottle of water after the baseline mass (±10% of difference). From all possible combinations without restriction ($n$ = 10,395), and using our criteria, we obtained 87 possible combinations of pair of churches and one combination were randomly selected. Then, within each pair, churches were randomly assigned to intervention or control group. Investigators who generated the random allocation were not part of the experiment's enrollment or fieldwork activities.

## Intervention

The intervention was targeted at the cluster level and is described using TIDieR guidance [22].

### *What?*

The intervention consisted in the delivery of a short message regarding the importance of protecting one's health. The following message, as per protocol, was delivered in Spanish by the priest, right after the sermon: "*Dear parishioners, before completing the homily, I would like to share a couple of thoughts with you. Family plays an important role in the Catholic community; the family must strive to achieve the health and well-being of all of its members. An ill society is the result of an ill family. Therefore, it is time to protect the family's health by starting to take action from today. What kind of food are we choosing? What is our family eating? The excessive consumption of sugary drinks, such as sodas and high-sugar juices, undermine our physical health. These beverages contain more sugar than what the body needs to be healthy. In my role as a priest, I want to invite you to change and improve the selection of our food. We can choose what is good for us. Let's choose health, let's choose water or sugar-free drinks*." The text of the intervention's message was built with the input of health communicators, psychologists, and anthropologists, and before the commencement of the experiment it was revised and approved by three priests and five attendees of parishes not taking part in the study.

### *Who?*

Priests from each parish delivered the intervention, hence there was no selection of priest based on expertise or background. During the week after the baseline assessment, one of the researchers visited each priest of the parishes allocated to the intervention group, explained the intervention message and gave them a printed paper with the text of the message. The priests were indicated to read the message right after the mass' sermon, which corresponds approximately to the middle of the mass. In addition, a group of trained personnel visited these priests an hour before the service, to remind them to give the message and to check if the priest had the text of the message.

### *How and where?*

The priests read the printed message to the entire mass' audience at the end of the sermon. No additional infrastructure or features were considered for the intervention.

### *When and how much?*

The intervention was provided only once, at Week 1 from baseline, within the mass' service.

### *Tailoring*

Priests were asked to read the message without adding or subtracting any information, so there was no tailoring in this intervention.

### *Modifications*

The baseline evaluation and subsequent assessments occurred simultaneously only in 11 of the 12 parishes. The disruption was due to an occasional celebration, scheduled at the same date of the beginning of the study in one of the participating churches. It was decided, for this specific church, to start the baseline and other procedures 2 weeks after the rest of parishes. This modification did not alter the prespecified analysis strategy. However, in addition, a sensitivity analysis excluding the delayed parish and its respective pair was conducted.

### *How well*

To evaluate fidelity [23, 24], the sermon and the distribution of drinks after the mass were video-recorded in all 12 parishes. These records were analyzed by the study investigators to ensure the intervention's message did not vary markedly between parishes.

## Other Procedures

All the assessments were performed immediately after the mass service, where people attending the mass were

provided with a choice of one bottle of 500 mL of soda or a bottle of 500 mL of water at no cost, a procedure that does not usually happen in regular mass services. Bottles were provided at the entrance door, outside of the church, by trained fieldworkers unaware of the experiment.

In addition, immediately after postintervention at Week 1, fieldworkers requested, on a voluntary basis, the name and telephone number of those individuals who chose a bottle. This information was used to contact individual participants, at Week 3 post baseline, to ask about their consumption of soda.

### Sample Size

Data collected during the formative research about the number of mass attendants and self-reported soda consumption during the last week were used for initial sample size calculations. At baseline, number of mass attendants as well as the objective choice of bottles of soda over water were also recorded, and these were used to confirm sample size calculations. Overall, in the 12 participating parishes at baseline, the average number of attendees was 128 (range 39–208) and, on average, 60% of participants chose soda (range: 49%–69%) while the rest chose water. With these data, a coefficient of variation of .07 was calculated using the formula proposed for experimental cluster-randomized studies [25].

The minimum number of clusters per group was calculated using the formula for cluster-randomized experimental studies [25]. Assuming a prevalence of choice of sweetened beverages of 60% in the control group and an immediate reduction postintervention to 40% in the intervention group, a minimum of 39 mass attendees per parish and a significant level of 5%, a minimum number of 5 clusters per study arm was required to reach a power of 90%. Based on this, it was decided to maintain all the 12 parishes in the study.

### Outcomes

The primary outcome was the proportion of individuals that choose a bottle of soda instead of a bottle of water immediately after the first service in the intervention compared to the control group. Fieldworkers recorded the selection of soda or water drinks on a form.

The secondary outcomes were the same proportion as in the primary outcome but 2 weeks after the first service, and the self-report of having bought one or more bottles of soda at least once during the previous week for personal and/or household consumption in the intervention compared to the control group.

### Analytical Methods

A double data entry process was performed in Microsoft Excel, and discrepancies were solved by reviewing the original documents where data were collected. Stata 14 for Windows (Stata Corp, College Station, TX) was used for analysis. Initially, continuous variables were summarized by means and standard deviations, and categorical variables by proportions.

Cluster-level estimates were used to compare primary and secondary outcomes between intervention and control groups utilizing a nonparametric test, that is, Wilcoxon rank-sum test, due to the number of clusters (six per arm) [21]. As one of the parishes was delayed in the initiation of fieldwork activities, a sensitivity analysis was conducted by excluding it and its pair, thus only including five church dyads.

For the sensitivity analysis, to assess the consistency of our results obtained with the nonparametric test, linear mixed models with random intercept (parish), restricted maximum likelihood and unstructured correlation matrix was used in accordance with a prespecified model:

$$\text{Outcome}_{ijk} = \beta_0 + \beta_1 * \text{Intervention} + \beta_2 * T_1 + \beta_3 * T_2 + \beta_4 * \text{Intervention} * T_1 + \beta_5 * \text{Intervention} * T_2 + v_{jk} + e_{ijk}$$

where the outcome was choosing soda in the person "$i$" at parish "$j$" and time "$k$," $\beta_0$ is the intercept, that is, the proportion of individuals choosing soda in the control groups at baseline; $\beta_1$ is the difference in the proportion of soda selection between intervention and control group at baseline; $\beta_2$ is the difference in the proportion of soda selection between Week 1 and baseline in the control group; $\beta_3$ is the difference in the proportion of soda selection between Week 3 and baseline in the control group; $\beta_4$ is the difference in the proportion of soda selection between the Week 1 and baseline in the intervention group and between Week 1 and baseline in the control group; $\beta_5$ is the difference in the proportion of soda selection between the Week 3 and baseline in the intervention group and between Week 3 and baseline in the control group; $v_{jk}$ is the random effect defined by the cluster; and $e$ is an indicator of the error of the model. Also, we estimated that $\beta_2 + \beta_4$ is the difference in the proportion of soda selection between Week 1 and baseline in the intervention group; $\beta_3 + \beta_5$ is the difference in the proportion of soda selection between Week 3 and baseline in the intervention group; $\beta_1 + \beta_4$ is the difference in the proportion of soda selection between intervention and control group at Week 1; and $\beta_1 + \beta_5$ is the difference in the proportion of soda selection between intervention and control group at Week 3.

### Ethical Aspects

The protocol of the present study was approved by the institutional review board of the Universidad Católica los Ángeles de Chimbote. Church priests signed an informed consent to participate in the study. Due to the nature of this study, a behavioral change experiment, it has been posed that "knowledge of the intervention, or of the existence of a trial could affect the outcome behaviour." [20] For this reason, a deception approach was used. Deception is a methodological alternative for low-risk studies that involves concealing the study objectives from participants during the experiment, and communicating them promptly upon completion of the study [26]. For this study, participants did not hear beforehand about the purpose of the study, and 4–5 weeks after completion of the last assessment, a debriefing session was conducted in each of the parishes. Fieldworkers were trained not to reveal the objective of the study. For the debriefing sessions, staff related to the study attended a similar Sunday morning service to reveal the purpose of the study to the audience and explain why this information was not provided earlier. In this manner, the debriefing session was made to the participating Catholic community in general.

## Results

### Characteristics of Participants

Twelve parishes accepted to participate and were included in this study, six parishes were allocated to control and six to the intervention group (Fig. 1). The number of those attendees who did not choose a drink, because they left the church or for other reasons, is shown in Supplementary Table S1. Results from the formative assessment, conducted 7 weeks before the baseline assessment, shows sociodemographic and religious commitment proxies between control and intervention groups. The profile of mass service attendants was predominantly female, 57 years old on average, and one third had higher education. The majority (90%) of mass attendees considers religion important in their lives, 75%–81% attend mass services at least weekly, and ~70% attended the same mass service a week earlier (Table 1).

### Choice of Drinks After the Mass Services

The proportion of soda selection at the baseline evaluation was ~60% and the overall difference in the proportion of soda selection between parishes assigned

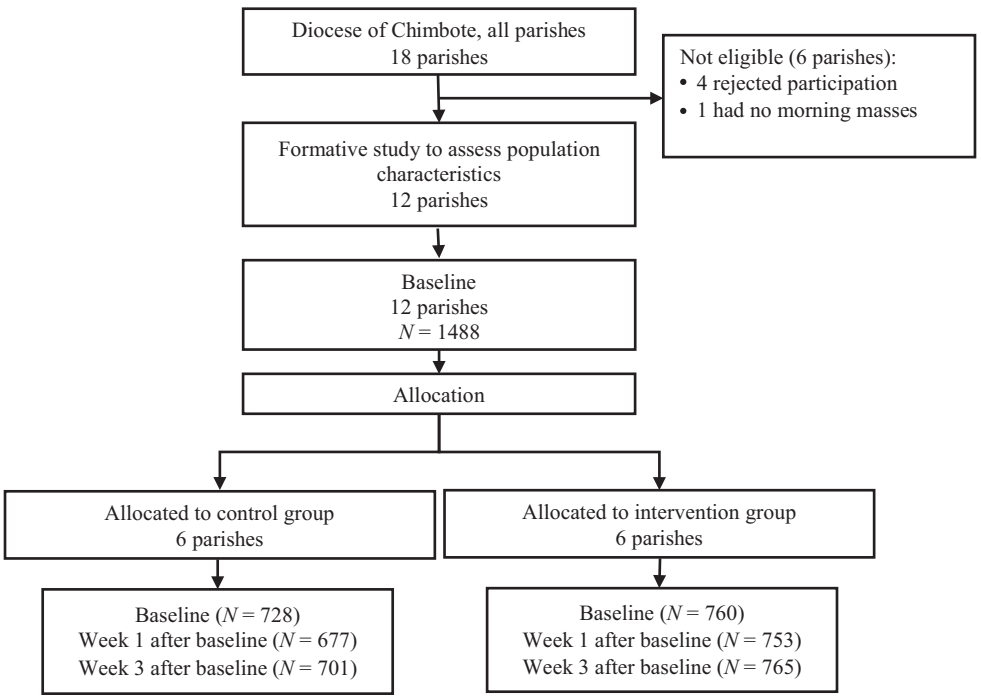


**Fig. 1.** Flowchart of parishes and participants in each step of the study. In the bottom cells are shown the total number of mass attendees who chose a bottle of drink (soda or water) in the different moments of the experiment. The number of nonparticipants, that is, attendees who did not choose a bottle of drink, are shown in Supplementary Table S1.

**Table 1** Characteristics of mass attendees in control and intervention groups during the formative assessment

| Formative assessment | Control group ($n$ = 728) | Intervention group ($n$ = 760) |
|---|---|---|
| | % | % |
| Females | 69.3% | 71.1% |
| Average age (years), mean (*SD*) | 56.3 (5.2) | 57.5 (2.7) |
| Higher education (≥12 years) | 38.7% | 36.8% |
| Consider religion very important in their lives | 89.5% | 89.8% |
| Self-report of daily pray | 63.0% | 70.8% |
| Attend church masses at least weekly | 81.1% | 74.7% |
| Attended to mass in the same parish last Sunday | 70.6% | 67.2% |

**Table 2** Balance in soda selection among parish's dyads[a] in the intervention and control group at baseline

| Control group | | | Intervention group | | | Difference[b] |
|---|---|---|---|---|---|---|
| Parish ID | Participants | Soda selection | Parish ID | Participants | Soda selection | |
| Parish 1 | 76 | 51.3% | Parish 9 | 123 | 56.1% | 4.8% |
| Parish 3 | 39 | 66.7% | Parish 2 | 56 | 66.1% | −0.6% |
| Parish 4 | 132 | 49.2% | Parish 11 | 137 | 58.4% | 9.2% |
| Parish 12[c] | 165 | 68.5% | Parish 5 | 116 | 51.7% | −16.8% |
| Parish 8 | 208 | 61.1% | Parish 6 | 192 | 60.9% | −0.1% |
| Parish 10 | 108 | 59.3% | Parish 7 | 136 | 66.9% | 7.7% |
| **Overall** | **728** | **59.6%** | **Overall** | **760** | **59.7%** | **0.1%** |

[a]Each row contains a pair of parishes after restricted randomization.

[b]Difference in proportion of soda selection (intervention − control) at baseline.

[c]All parishes, except parish ID12, initiated and continued in the study with assessments conducted on the same date. Parish ID 12 started the study 2 weeks later.

to intervention versus control was 0.1%, ranging from −16.8% to 9.2% (Table 2). The intracluster correlation coefficient of the outcome variable was .023.

The proportion of soda selection among participants in the intervention and control groups ranged from 56.3% to 63.8% in Week 1, and from 62.7% to 68.2% in Week 3 (Table 3). In terms of the immediate effects of the sermon, and accounting for baseline values, the proportion of mass attendees choosing soda was, on average, 8.2% lower in the intervention group compared to the control group ($p$ = .03). As we evaluated 1,488 participants, 8.2% would represent 122 fewer participants that chose soda. In terms of delayed effects, at 3 weeks after baseline, the difference between intervention and control group was 6.2% ($p$ = .15). Corresponding figures, calculated in the sensitivity analyses with 10 parishes only, showed evidence of a difference of 10.6% ($p$ = .01) and 8.7% ($p$ = .05) lower in the intervention groups at Week 1 and Week 3, respectively (Table 3).

## Patterns of Soda Consumption

There was no evidence of differences in the self-reported outcomes related to soda purchase for personal consumption or for familiar consumption. During the last week, and compared to any given week in the prior month, participants in the intervention and control group reported smaller volumes of soda purchases for personal consumption (−0.7 liters) and for household consumption (−2.6 and −2.2 liters), but there was no evidence of a difference between intervention and control groups (Table 3).

## Fidelity

The message, the actual intervention, was given by all priests with minimal changes, such as word substitutions, that did not alter its meaning. The fidelity of the intervention was high, and no major deviations from protocol during the delivery of the intervention were noted. Additional details are provided in Supplementary Table S2.

## Sensitivity Analyses

A sensitivity analysis exploring mass attendants rather than churches as the unit of analysis also confirmed our

**Table 3** Outcomes comparison between control and intervention groups

| Outcomes | All 12 parishes | | | | 10 parishes in which the experiment started at the same time (sensitive analysis)[a] | | | |
|---|---|---|---|---|---|---|---|---|
| | Control (6 parishes) | Intervention (6 parishes) | Difference (intervention minus control) | $p$[b] | Control (5 parishes) | Intervention (5 parishes) | Difference (intervention minus control) | $p$[b] |
| | % | % | % | | % | % | % | |
| **Main outcomes** | | | | | | | | |
| Difference in proportion of soda selection (Week 1 − baseline)[c] | 4.5% | −3.7% | −8.2% | **.03** | 5.2% | −5.4% | −10.6% | **.01** |
| Proportion of soda selection at Week 1 after baseline | 63.8% | 56.3% | −7.5% | .26 | 62.7% | 56.3% | −6.4% | .46 |
| **Secondary outcomes** | | | | | | | | |
| Difference in proportion of soda selection (Week 3 − baseline)[c] | 8.9% | 2.7% | −6.2% | .15 | 10.8% | 2.1% | −8.7% | **.05** |
| Proportion of soda selection at Week 3 after baseline | 68.2% | 62.7% | −5.6% | .26 | 68.4% | 63.8% | −4.6% | .46 |
| **Self-reported outcomes** | | | | | | | | |
| Difference in soda purchase for personal consumption (in liters)[d] | −0.7 | −0.7 | 0.1 | .75 | −0.8 | −0.8 | 0.0 | .92 |
| Difference in soda purchase for familiar consumption (in liters)[d] | −2.6 | −2.2 | 0.5 | .63 | −2.8 | −2.5 | 0.3 | .92 |

[a]Sensitivity analysis including only those dyads that participated in the experiment simultaneously.

[b]Wilcoxon rank-sum test. Bold estimates are significant ($p < .05$).

[c]Differences correspond to difference-in-difference approaches, that is, [observation at week × minus baseline in the intervention group] minus [observation at week × minus baseline in the control group].

[d]Purchasing behaviors were asked immediately after the Week 3 mass service and represent the difference between the self-reported median values (in liters) of soda purchased during the last week compared to a usual week in the previous month.

**Table 4** Proportion of soda selection: linear mixed model effects

| Difference in the proportion of soda selection | Unit of analysis: parishes | | Unit of analysis: mass attendants | |
|---|---|---|---|---|
| | Unadjusted | Adjusted[a] | Unadjusted | Adjusted[a] |
| Proportion of soda selection in the control group at baseline | 59.3 (53.4; 65.2) | 87.4 (28.5; 146.3) | 58.7 (52.8; 64.6) | 77.8 (37.4; 118.2) |
| Between intervention and control group, at baseline | 0.7 (−7.7; 9.0) | 1.2 (−5.5; 7.9) | 1.0 (−7.3; 9.3) | −3.7 (−13.6; 6.1) |
| Between Week 1 and baseline, in the control group | 4.5 (−0.1; 9.0) | 4.5 (−0.1; 9.0) | **5.2 (0.1; 10.2)** | **5.2 (0.1; 10.2)** |
| Between Week 3 and baseline, in the control group | **8.9 (4.3; 13.5)** | **8.9 (4.3; 13.5)** | **10.1 (5.1; 15.1)** | **10.2 (5.2; 15.2)** |
| Between Week 1 and baseline, in the intervention group | −3.7 (−8.3; 0.8) | −3.7 (−8.3; 0.8) | −3.7 (−8.5; 1.2) | −3.7 (−8.5; 1.2) |
| Between Week 3 and baseline, in the intervention group | 2.7 (−1.9; 7.2) | 2.7 (−1.9; 7.2) | 3.3 (−1.6; 8.1) | 3.2 (−1.6; 8.1) |
| Between intervention and control group, at Week 1 | −7.5 (−15.9; 0.8) | **−7.0 (−13.7; −0.2)** | −7.8 (−16.2; 0.6) | **−12.6 (−22.5; −2.7)** |
| Between intervention and control group, at Week 3 | −5.6 (−13.9; 2.8) | −5.0 (−11.7; 1.7) | −5.9 (−14.2; 2.5) | **−10.7 (−20.6; −0.8)** |
| (Week 1 minus baseline, in the intervention group) minus (Week 1 minus baseline, in the control group) | **−8.2 (−14.6; −1.7)** | **−8.2 (−14.6; −1.7)** | **−8.8 (−15.8; −1.8)** | **−8.9 (−15.9; −1.9)** |
| (Week 3 minus baseline, in the intervention group) minus (Week 3 minus baseline, in the control group) | −6.2 (−12.7; 0.2) | −6.2 (−12.7; 0.2) | −6.9 (−13.8; 0.1) | **−6.9 (−13.9; 0.0)** |

Bold estimates are statistically significant ($p < .05$).

[a]Adjusted for the frequency of weekly attendance to mass and the frequency of daily pray in the parish (variables collected at the formative evaluation).

results (Table 4). Consistency analyses using crude and multivariable regressions confirm the direction and effect size of the primary and secondary outcomes of choice of drinks at Week 1 and Week 3, including significant reductions in the proportion of participants choosing soda in the intervention group at Week 1 and significant increases at Week 3 in the control group.

## Discussion

Using a minimally intensive intervention of short duration inserted within the sermon of a Catholic mass, we were able to see immediate effects in the preferences and choices of attendees' selection of water over soda drinks. Soda selection was 8%–11% lower in the intervention than in control groups, accounting for baseline patterns a week earlier. Two weeks after the priest's intervention, results remained in the same direction but attenuated by a magnitude of 2%, remaining significant only in the sensitivity analyses. Further analyses by regressions confirmed the direction of the results. Taken together, these results show an immediate effect of a simple, short message delivered by priests on choices of drinks and open a promising route to expand initiatives that will complement obesity prevention, inviting more consistent collaborations between public health professionals and priests.

The rise of obesity introduces many challenges globally, with solutions needed at the individual, societal, and governmental level. From a policy point of view, most of the attention of strategies to reduce consumption of sweetened beverages has been placed on taxation [4]. In Mexico, a 6%–10% decrease in the consumption of sweetened beverages, 2 years after the introduction of taxation, has been documented [27]. In Berkeley, California, taxes have been linked with shifting consumers to purchase healthier beverages without causing undue economic hardship [28]. These taxation initiatives have been projected to have major gains in terms of preventing obesity and cardiovascular diseases [29–31].

Regarding health behavior, there is evidence that people face self-control problems and knowledge constraints, which may lead them to make suboptimal decisions [32]. In this study, we offer a pragmatic approach showing modest effect sizes which could translate to health benefits if done regularly, or if soda is no longer consumed at all by even a few people, the health benefit

would also be greater. If further developed and tested, similar interventions could contribute to improve the arsenal of behavioral interventions directly changing and altering health-related behaviors, in this case by altering preferences of sweetened beverages.

Two recent systematic reviews have explored in detail interventions aimed at reducing the intake of sugar-sweetened drinks across a diversity of age groups [33, 34]. The evidence synthesis exercise found no effects of the retrieved interventions on the adult group [33]. Also, none of these systematic reviews retrieved faith-based interventions, emphasizing the novelty of our work. The evidence-base of faith-based interventions to improve physical activity and reduce obesity is limited: there is a heterogeneity of studies [10, 35], improvements are needed in clearly describing the intervention's context [13], and theories of behavior change to anticipate choices of water over sweetened beverages [36]. As a growing field, the majority of faith-based studies still require more robust study designs and larger sample sizes [10, 13, 35, 37]. Our study design overcame such hurdles, in a pragmatic manner, by using a cluster-randomized design across 12 churches, and by securing high fidelity in the implementation of the protocol.

While long-term change in objective indicators is important, pragmatic short-term alternatives altering choices, as the ones tested in this study, are also needed to inform the development of further interventions as well as to engage with nonhealth sectors on prevention efforts [38]. Given the long-standing presence of Catholicism in Latin American societies, this study signals the potential that such institutions can deliver and sustain strategies for health-promoting behaviors and thus contribute to improve health outcomes. For example, Catholic institutions reach millions of individuals at all stages of life, from childhood and adolescence into late adulthood, a coverage and an interaction that is far wider and frequent than with health services. As such, this opens alternative opportunities to develop and tailor interventions with a variety of age groups, moments, for example, baptism and confirmation, through a diversity of combinations of dose, frequency, types of messages, and delivery channels. While this study was conducted in Catholic churches, there is potential to expand this type of faith-based approach to other religions. Some religions sustain a higher frequency of contact during the week with their congregants which could enhance the effects observed in this study.

Some limitations are worth noting. Our study was powered to test effects in 10 parishes, and while we decided to conduct the study with all 12 parishes, all but one of them started the experiment 2 weeks later. Analysis including all parishes shows smaller effects, by a magnitude of 2%, than the sensitivity analyses including only 10 parishes. Potential explanations are not necessarily related to contamination, as we chose the first morning service on Sunday, possibly the one that congregates the most regular attendees to any given parish. However, the difference in baseline soda selection among parishes in the intervention and control group was disproportionately higher among the pair of parishes excluded for the sensitivity analysis, an expected finding since the baseline information of the delayed church was not available when the randomization was conducted. Also, from baseline to Week 1, the frequence of soda choice in the control group increased (+4.5%) while the intervention group decreased (−3.7%). We doubt they could alter the interpretation of our results, mainly because the direction of these observations is in line with the expected direction of the effect of our intervention. The increase in soda choice in the control group could be explained because the participants could feel more at ease and with higher confidence in choosing soda given the repeated exposure to the drinks offered in our study.

Our study had no effect in terms of self-reported soda purchasing patterns after the intervention, and while this type of data is amenable to biases, it suggests that interventions affecting immediate preferences and choices within the church need to be further and adequately explored to be able to translate into changes in terms of purchasing and consumption patterns, preferably exploring long-lasting effects. Sunday mass attendants may not be representative of the general population, however they do represent adults with decision and purchase power that will likely influence other household members about consumption of soda beverages. Lastly, it is unknown if parishioners will habituate to the health messages from their priests, and if so, when such saturation would occur. This experiment serves as a proof-of-concept to inform the design of future more complex interventions, and the role of priests should receive further consideration.

## Conclusion

A pragmatic single low-intensity short-duration one-off sermon given by a priest during a church mass service has an immediate effect in reducing the choice of soda beverages over water. Our study, a cluster-randomized controlled trial, improves upon the methodological weaknesses of previous faith-based studies, particularly in terms of study design, sample size, and a clear description of the intervention. By introducing strategies for behavioral change related to the consumption of sugary drinks using Catholic venues we offer pragmatic opportunities to further develop this area, and move the field beyond research produced only in high-income settings [8]. In so doing, this enhances the importance of conducting research in this topic in low- and middle-income

countries, and thus contributes toward closing a major research gap in the field.

## Supplementary Material

Supplementary material is available at *Annals of Behavioral Medicine* online.

**Acknowledgments** To the Diócesis de Chimbote, priests and churches who kindly granted permission to participate in the study, and various colleagues at Universidad Católica los Ángeles de Chimbote for their support in making this study possible, particularly Padre Jaume Benaloy. Our special gratitude to various colleagues and collaborators who provided their time and inputs at various stages. Special thanks to Vilarmina Ponce and María K. Cárdenas for their inputs in developing the intervention's message; to Diego Azañedo, Julio Cjuno and Giulianna Gamero, for their active support during the fieldwork activities of the study; to Elizabeth Zavaleta and Wendy Arhuis for data entry; and to David Beran, Pablo Cazzulino, Liam Smeeth, and David Peiris for comments and editorial support to earlier versions of this work.

**Funding** The study was supported by the Center for Advanced Hindsight, Duke University and Universidad Católica los Ángeles de Chimbote. J.J. Miranda acknowledges having received support from the Alliance for Health Policy and Systems Research (HQHSR1206660), DFID/MRC/Wellcome Global Health Trials (MR/M007405/1), Fogarty International Center (R21TW009982, D71TW010877), Grand Challenges Canada (0335-04), International Development Research Center Canada (IDRC 106887, 108167), Inter-American Institute for Global Change Research (IAI CRN3036), Medical Research Council (MR/P008984/1, MR/P024408/1, MR/P02386X/1), National Cancer Institute (1P20CA217231), National Heart, Lung and Blood Institute (HHSN268200900033C, 5U01HL114180, 1UM1HL134590), National Institute of Mental Health (1U19MH098780), Swiss National Science Foundation (40P740-160366), Wellcome Trust (074833/Z/04/Z, 093541/Z/10/Z, 107435/Z/15/Z, 103994/Z/14/Z, 205177/Z/16/Z, 214185/Z/18/Z), and the World Diabetes Foundation (WDF15-1224). A. Taype-Rondan received support as trainee from the Inter-American Institute for Global Change Research (IAI CRN3036). A. Bernabe-Ortiz is supported by Wellcome Trust (103994/Z/14/Z). D. Ariely is supported by the Center for Advanced Hindsight, Duke University.

### Compliance with Ethical Standards

**Authors' Statement of Conflict of Interest and Adherence to Ethical Standards** J. Jaime Miranda, Alvaro Taype-Rondan, Janina Bazalar-Palacios, Antonio Bernabe-Ortiz, and Dan Ariely declare that they have no conflict of interest. The protocol of the study was approved by the Institutional Review Board at Universidad Católica Los Ángeles de Chimbote (003-2017-CIEI-ULADECH-Católica).

**Primary Data:** The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

**Authors' Contributions** JJM and DA conceived the idea and study design for this study. JJM, ATR, JBP, and ABO designed and supervised the overall study. ATR and ABO led the statistical analysis. ATR and JBP contributed to the revision of the literature and drafted the first version of the manuscript. All authors participated in the critical revision, provided important intellectual content, and gave their final approval of the version submitted for publication.

**Ethical Approval:** The protocol of the study was approved by the Institutional Review Board at Universidad Católica Los Ángeles de Chimbote (003-2017-CIEI-ULADECH-Católica).

**Informed Consent:** Not applicable.

## References

1. World Health Organization. *Reducing Consumption of Sugar-Sweetened Beverages to Reduce the Risk of Childhood Overweight and Obesity*. 2017. Available http://www.who.int/elena/titles/ssbs_childhood_obesity/en/. Accessibility verified December 4, 2019.
2. Singh GM, Micha R, Khatibzadeh S, et al.; Global Burden of Diseases Nutrition and Chronic Diseases Expert Group (NutriCoDE). Global, regional, and national consumption of sugar-sweetened beverages, fruit juices, and milk: a systematic assessment of beverage intake in 187 countries. *PLoS ONE*. 2015;10:e0124845.
3. Instituto Nacional de Estadística e Informática. *Consumo per cápita de los principales alimentos, 2008–2009*. Lima, Peru: INEI; 2012.
4. Brownell KD, Farley T, Willett WC, et al. The public health and economic benefits of taxing sugar-sweetened beverages. *N Engl J Med.* 2009;361:1599–1605.
5. Schwartz MB, Schneider GE, Choi YY, et al. Association of a community campaign for better beverage choices with beverage purchases from supermarkets. *JAMA Intern Med.* 2017;177:666–674.
6. Farley TA, Halper HS, Carlin AM, Emmerson KM, Foster KN, Fertig AR. Mass media campaign to reduce consumption of sugar-sweetened beverages in a rural area of the United States. *Am J Public Health.* 2017;107:989–995.
7. Avery A, Bostock L, McCullough F. A systematic review investigating interventions that can help reduce consumption of sugar-sweetened beverages in children leading to changes in body fatness. *J Hum Nutr Diet.* 2015;28(suppl 1):52–64.
8. Popkin BM, Hawkes C. Sweetening of the global diet, particularly beverages: patterns, trends, and policy responses. *Lancet Diabetes Endocrinol.* 2016;4:174–186.
9. Stewart JM. Faith-based interventions: pathways to health promotion. *West J Nurs Res.* 2016;38:787–789.
10. Bopp M, Peterson JA, Webb BL. A comprehensive review of faith-based physical activity interventions. *Am J Lifestyle Med.* 2012;6:460–478.
11. Kim KH, Linnan L, Campbell MK, Brooks C, Koenig HG, Wiesen C. The WORD (wholeness, oneness, righteousness, deliverance): a faith-based weight-loss program utilizing a community-based participatory research approach. *Health Educ Behav.* 2008;35:634–650.
12. Lancaster KJ, Carter-Edwards L, Grilo S, Shen C, Schoenthaler AM. Obesity interventions in African American faith-based organizations: a systematic review. *Obes Rev.* 2014;15(suppl 4):159–176.
13. Timmons SM. Review and evaluation of faith-based weight management interventions that target African American women. *J Relig Health.* 2015;54:798–809.

14. Gamero-Vega G, Cjuno J, Bazalar J, Azañedo D, Taype-Rondan Á, Miranda J. [Research on faith-based interventions and faith-placed health interventions: current situation and perspectives in Latin America]. *Gac Sanit.* 2018;32:315–317.
15. Taggart J, Williams A, Dennis S, et al. A systematic review of interventions in primary care to improve health literacy for chronic disease behavioral risk factors. *BMC Fam Pract.* 2012;13:49.
16. Lin JS, O'Connor E, Whitlock EP, et al. *Behavioral Counseling to Promote Physical Activity and a Healthful Diet to Prevent Cardiovascular Disease in Adults: Update of the Evidence for the U.S. Preventive Services Task Force*. Rockville, MD, USA: Agency for Healthcare Research and Quality; 2011.
17. Campbell MK, Piaggio G, Elbourne DR, Altman DG; CONSORT Group. Consort 2010 statement: extension to cluster randomised trials. *BMJ.* 2012;345:e5661.
18. Instituto Nacional de Estadística e Informática. *Población 2000 al 2015*. Available at http://proyectos.inei.gob.pe/web/poblacion/. Accessibility verified December 4, 2019.
19. Instituto Nacional de Estadística e Informática. *Censos Nacionales 2007: XI de Población y VI de Vivienda—Base de Datos REDATAM*. Available at http://censos.inei.gob.pe/Censos2007/redatam/. Accessibility verified December 4, 2019.
20. Hutton JL, Eccles MP, Grimshaw JM. Ethical issues in implementation research: a discussion of the problems in achieving informed consent. *Implement Sci.* 2008;3:52.
21. Hayes RJ, Moulton LH. *Cluster Randomised Trials*. 2nd ed. New York, NY: CRC Press; 2017.
22. Hoffmann TC, Glasziou PP, Boutron I, et al. Better reporting of interventions: template for intervention description and replication (TIDieR) checklist and guide. *BMJ.* 2014;348:g1687.
23. Breitenstein SM, Gross D, Garvey CA, Hill C, Fogg L, Resnick B. Implementation fidelity in community-based interventions. *Res Nurs Health.* 2010;33:164–173.
24. Carroll C, Patterson M, Wood S, Booth A, Rick J, Balain S. A conceptual framework for implementation fidelity. *Implement Sci.* 2007;2:40.
25. Hayes RJ, Bennett S. Simple sample size calculation for cluster-randomized trials. *Int J Epidemiol.* 1999;28:319–326.
26. Gelinas L, Wertheimer A, Miller FG. When and why is research without consent permissible? *Hastings Cent Rep.* 2016;46:35–43.
27. Colchero MA, Rivera-Dommarco J, Popkin BM, Ng SW. In Mexico, evidence of sustained consumer response two years after implementing a sugar-sweetened beverage tax. *Health Aff (Millwood).* 2017;36:564–571.
28. 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:e1002283.
29. Barrientos-Gutierrez T, Zepeda-Tello R, Rodrigues ER, et al. Expected population weight and diabetes impact of the 1-peso-per-litre tax to sugar sweetened beverages in Mexico. *PLoS ONE.* 2017;12:e0176336.
30. Cobiac LJ, Tam K, Veerman L, Blakely T. Taxes and subsidies for improving diet and population health in Australia: a cost-effectiveness modelling study. *PLoS Med.* 2017;14:e1002232.
31. Basu S, Vellakkal S, Agrawal S, Stuckler D, Popkin B, Ebrahim S. Averting obesity and type 2 diabetes in India through sugar-sweetened beverage taxation: an economic-epidemiologic modeling study. *PLoS Med.* 2014;11:e1001582.
32. Luoto J, Carman KG. *Behavioral Economics Guidelines with Applications for Health Interventions*. Washington, DC: Inter-American Development Bank; 2014. Available at https://publications.iadb.org/handle/11319/6503
33. 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;18:1350–1363.
34. Abdel Rahman A, Jomaa L, Kahale LA, Adair P, Pine C. Effectiveness of behavioral interventions to reduce the intake of sugar-sweetened beverages in children and adolescents: a systematic review and meta-analysis. *Nutr Rev.* 2018;76:88–107.
35. Lancaster KJ, Carter-Edwards L, Grilo S, Shen C, Schoenthaler AM. Obesity interventions in African American faith-based organizations: a systematic review. *Obes Rev.* 2014;15(suppl 4):159–176.
36. Sharma M, Catalano HP, Nahar VK, Lingam VC, Johnson P, Ford MA. Applying Multi-Theory Model (MTM) of health behavior change to predict water consumption instead of sugar-sweetened beverages. *J Res Health Sci.* 2017;17:e00370.
37. Campbell MK, Hudson MA, Resnicow K, Blakeney N, Paxton A, Baskin M. Church-based health promotion interventions: evidence and lessons learned. *Annu Rev Public Health.* 2007;28:213–234.
38. He M, Wilmoth S, Bustos D, Jones T, Leeds J, Yin Z. Latino church leaders' perspectives on childhood obesity prevention. *Am J Prev Med.* 2013;44:S232–S239.