Dissemination and Implementation of a Community Wide Campaign Model to Improve Fruit & Vegetable Intake and Physical Activity Among Mexican Americans in the Texas-Mexico Border Region

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Abstract

Background

Evidence-based programs are slow to disseminate to create public health impact. Mexican Americans have low uptake of the modifiable healthy behaviors of fruit and vegetable (FV) consumption and physical activity (PA). This study analyzed the dissemination and implementation of an evidence-based community-wide campaign (CWC), *Tu Salud ¡Si Cuenta!* (TSSC), in augmenting these behaviors among Mexican Americans living along the U.S.-Mexico Border.

Methods

We examined reach, effectiveness, adoption, implementation, and maintenance (RE-AIM) of the program. For effectiveness, participants were classified into "low exposure" and "high exposure" groups based on home visits by a community health worker (CHW). A dietary questionnaire and the Godin-Shepherd Exercise Questionnaire were used to quantify mean FV consumption and weekly PA level, respectively. Mean differences in change from baseline to follow-up was compared between the groups based on multivariable linear regression analysis, adjusting for age, gender, insurance and poverty status, and program components received. Odds of newly meeting FV and PA guidelines at follow-up were estimated with multivariable logistic regression analysis. All analyses were repeated for each location separately.

Results

Low-income Mexican-Americans (N = 8225) across twelve locations along the U.S.-Mexico border were analyzed. The program reached 2.2% of the total population of the lower Rio Grande Valley region (Cameron and Hidalgo Counties, Texas). The high exposure group had significantly greater FV intake (adjusted mean difference = + 0.65 FV servings, 95% CI: 0.53−0.77) and PA (adjusted mean difference = + 185.6 MET-minutes, 95% CI: 105.9-265.4) than the low exposure group. The high exposure group was significantly more likely to meet FV guidelines (adjusted odds ratio (AOR) = 2.03, 95% CI: 1.65−2.47) and PA guidelines (AOR = 1.36, 95% CI: 1.10−1.68) at follow-up. In location-specific analysis, the association of increasing program exposure to degree of improvement in FV consumption and PA was replicated. 92.3% (12/13) of locations offered the program adopted it. 58.3% (7/12) of program locations implemented with fidelity, and 91.7% (11/12) maintained the program.

Conclusions

The results indicate this CWC intervention shows promise for improving health outcomes among low-income Mexican Americans in a scaled-up implementation effort. The adoption and maintenance of the program was strong, but staff capacity and turnover adversely impacted implementation fidelity.

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Contributions To The Literature

- The national priority of preventing chronic diseases among underserved populations requires broad implementation of evidence-based programs responsive to the complexities of lifestyle change in such populations.
- Dissemination and implementation research related to Latino health helps to promote health equity. Few systematic studies of a scaled-up community-wide campaign for low-income populations are available.
- This study reports factors influencing dissemination/implementation of the community-wide campaign in twelve low-income U.S.-Mexico border communities. Community health worker delivery and funding for implementation positively influenced reach, effectiveness, adoption, and maintenance, while lack of qualified community health workers and turnover negatively impacted the fidelity of implementation.

Background

Latinos, specifically Mexican Americans living on the U.S.-Mexico border in Texas have higher incidence and mortality rates of noncommunicable diseases (NCDs) paralleling those seen in developing, middle-income countries [1]. Individual-level lack of self-efficacy [2] and community-level built environment factors such as the lack of healthy food availability and physical activity infrastructure [3] precludes the uptake of modifiable health behaviors in Latinos, who thus are disproportionately not meeting the guidelines of consuming five servings of fruits and vegetables (FV) daily [4] nor achieving at least 150 minutes of moderate and vigorous physical activity (PA) weekly [5]. Consequently, this results in increased susceptibility to NCDs including Type 2 Diabetes Mellitus [6], hypertension [7,8], and cardiovascular disease [9,10], which culminate in increased all-cause mortality [11,12,13].

In the U.S., a higher proportion of Latinos meet the recommended intake of fruits [14], and consume more FV servings than whites [15]; however, Latino mean FV intake is only 60% of the recommended guidelines [11,16]. Moreover, Latinos along the Texas-Mexico border are less likely to meet FV guidelines than the general American Latino population [1]. For Latinos living on the U.S.-Mexico Border, 80% of cardiovascular, diabetes, and stroke cases could be prevented by modifying health behaviors of FV consumption and PA engagement [17].

Latinos in the U.S. are less physically active than whites [3,6,18], with a higher proportion not meeting the aforementioned PA guidelines [19]. Physical inactivity rates are highest for those with less education [3], in poverty [19,20], or Latinas [21]. Additionally, Latinos living on the Texas-Mexico border were significantly less likely to meet PA guidelines compared to Latinos in the U.S. [1].

Community-Wide Campaigns

Community-wide campaigns (CWC) represent an evidence-based approach to improving FV consumption and PA engagement [22]. CWCs employ multicomponent, community-based interventions including media messages, social support, health education, risk factor screening, environmental infrastructure, and policy improvements in a cost-effective manner [22,23]. Some CWC interventions use theory such as the Transtheoretical Model [24,25,26], and Social Cognitive Theory [27,28,29] to tailor strategies to individuals [30], while also targeting other levels of influence from the socio-ecological model [31,32]. CWCs have shown improvement in PA in Koreans [26], Canadians [29], and Native Americans [33]. However, few CWCs targeting PAs have been published [34], and fewer have been based on behavioral theory [33]. CWC studies rarely focus on Southern/Eastern Europeans, Southern/Southeastern Asians, and American minorities that generally face more socioeconomic and community-level barriers that exacerbate health disparities [1,30]. One notable exemption is the Tu Salud ¡Si Cuenta! (*Your Health Matters*!) (TSSC) program designed to increase FV intake and intentional PA engagement in Mexican Americans living along the Texas-Mexico border [2,23,35,36]. The TSSC program demonstrated increased odds of meeting PA guidelines among Latino study participants compared to Latinos in a different border city without the program [23]. Also, exposure to the TSSC program was associated with meeting PA guidelines [35].

While CWCs are effective in improving outcomes, like many other evidence-based programs, the adoption and scale up of these programs at the population level takes far too long, even decades [37]. Program dissemination and implementation research seeks to enhance the spread of evidence-based interventions to priority populations by using planned strategies in response to the enormous gap between knowledge of what can maximize healthy outcomes and what is currently being delivered in community settings [38,39]. A critical research gap exists in the *real-world implementation of* CWC programs [30], with a particular lack of studies focused on vulnerable Latino populations. To date, with the exception of the North Karelia study which was later nationally disseminated [40,41], there has not been a study specifically examining the broad dissemination of a CWC program [42]. This study evaluates the dissemination of the evidence-based TSSC program to 12 municipalities on the Texas-Mexico border.

RE-AIM Framework

We used the RE-AIM (Reach, Effectiveness, Adoption, Implementation, and Maintenance) analytical framework [43] to evaluate the public health impact of the TSSC program between January 2014 – November 2019. The CWC model was originally developed and tested internationally and in the U.S. [2,23,36], and then adapted for Latinos in one city on the Texas-Mexico Border [35]. This study examines the dissemination of this program to 12 municipalities/precincts over two adjacent border counties. Our research questions include: 1) Reach - what percent of the population was reached by home visits conducted by TSSC community health workers (CHWs) and were participants low-income Latinos?; 2) Effectiveness - is the TSSC program significantly associated with improvements in FV and PA levels among participants across and by location?; 3) Adoption - what percent of communities offered the TSSC program adopted it?; 4) Implementation- what percent of locations implemented the program with fidelity?; and 5) Maintenance- what percent of locations maintained the program until the end of the study period?

Methods

Study Context and Study Population

All municipal and precinct locations involved in this study are located along the U.S.-Mexico border with Texas. The region is young (mean age of 45 years) [44] and rapidly growing [45], with a 2010 population of over 1.3 million, of which over 93% are Latino [1,45]. This area has over one third of the population living in poverty [46,47], with its per capita income half the American average [45], and low education levels [45].

As is common in persistent poverty regions, health disparities abound [47]. Over 28% of adults in the region have diabetes, and over 84% of adults are obese or overweight [48]. Additionally, nearly 67% of the adult population lacks health insurance [44].

Implementing Locations

The TSSC program has been disseminated and implemented in 12 locations. There were two county precincts with a population of 190,000 each, and ten municipalities included two major urban areas with a population of over 75,000 each ("City"), two small towns that ranged in population from 5,000 to 70,000 ("Town"), and six rural areas with populations of less than 5,000 ("Rural") [49].

Program Description and Implementation Over Time

The Tu Salud ¡Si Cuenta! (*Your Health Matters*!) was initially designed for Latinos living in one border city to increase FV consumption and PA engagement [2,50] and targeted psychosocial and environmental constructs that influence FV consumption and PA [2,51,52], including self-efficacy and cognitive and behavioral processes of change [2,35]. Social support and risk factor screening were provided during CHW home visits that included brief Motivational Interviewing strategies [53], which is an important component in behavior change [51,52]. TSSC used a community-engaged research approach to adapt the model to the cultural values of Mexican Americans on the Border [35]. Beginning in 2014, the TSSC program was expanded to other municipalities in the region using the core CWC model components (Table 1).

Measures and Study Design

The overall sample comprised of participants from across the twelve locations that were brought into the study between 2014 – 2019 (Figure 1).

Reach

Reach was measured as the percent of the total population living in the municipalities and precincts that agreed to have program CHW follow-up visits to address risk factors. This measure of reach is conservative but accurate. The total population of the municipalities/precincts ("locations") was based on the 2018 American Community Survey [49] in the 12 locations as the denominator and the total unique TSSC program participants who received CHW home visits during the study timeframe as the numerator. We also examined reach by assessing the ethnicity and poverty status of participants.

Socio-demographic characteristics

Sociodemographic characteristics collected from the sample included: sex (male/female), age (respondent's date of birth), Latino (yes/no), health insurance (insured with government or private health insurance or uninsured), and income (above or below the federal poverty level [54]). Income level was based on two questions regarding household size and yearly household income. These variables were used to describe the reach of the program and in multivariable regression models of effectiveness.

Effectiveness

We assessed the effectiveness of the TSSC program by examining exposure to program elements and change in self-reported measurements of daily FV consumption and weekly PA. We classified the participants into two groups of "low exposure" (2-3 CHW visits) vs. "high exposure" (4-5 CHW visits) to define their exposure to the program.

Fruit and Vegetable (FV) Consumption

The validated Two-item Dietary Questionnaire for adults was used to assess FV consumption among participants, asking "How many portions of fruit, of any sort, do you eat on a typical day?" and "How many portions of vegetables, excluding potatoes do you eat on a typical day?" [55], with pictures of locally consumed fruits and vegetables to reflect recommended portion sizes [35]. The threshold for meeting current U.S. dietary recommendations was set at 5 FV servings (3 cups of vegetables, 2 cups of fruits) daily [4].

Physical Activity (PA)

A modified version of the Godin-Shepherd Leisure-Time Exercise Questionnaire instrument [56,57] was used to measure the intensity, frequency, and duration of intentional PA. Weekly frequency of moderate or strenuous PA was multiplied by the minutes spent on each moderate or strenuous activity to calculate each participants' weekly metabolic equivalent adjusted minutes (MET-minutes). The metric for being "physically active" was quantified as meeting the U.S. PA recommendations of ≥600 MET-minutes weekly [58], in tandem with prior exercise interventions [1,23,35,36,51,52].

Participant Assignment to Locations

Participants were classified by the geographic location they received TSSC program services. Almost exclusively, participants were seen within the jurisdictional boundaries of the CHW paid by that municipality or precinct. Three CHWs were hired by the university to deliver services across multiple locations; their participants were grouped by the participant's primary residence.

Adoption

Census data [49] were used to identify the total number of municipalities/precincts in the two-county region. We examined historical records of meetings and contracts for the number of municipalities/precincts offered the TSSC program and the number that implemented the program between January 2014 - November 2019.

Implementation

Fidelity was based on evidence of reaching at least 35 participants with documented CHW home visits in the "high exposure" and "low exposure" categories to be included in the location-specific analysis. The programmatic electronic database that captured participant-level data by location was used to determine sufficient numbers of participants by site.

Maintenance

This was defined as the number of locations that adopted the program and had an active program including an employed CHW until November 2019.

Statistical Analysis

Guided by the RE-AIM Framework [43], the following approach to analysis was taken:

Reach: The percent of people who received CHW home visits over the total population of the 12 locations and the percent of the total participants who reported being low-income and Latino.

Effectiveness: We compared baseline characteristics of participants between two study groups ("low exposure" vs. "high exposure") using Student's t-test or its non-parametric equivalent (i.e. Wilcoxon rank sum test) for continuous variables and Chi-square test for categorical variables. To evaluate the program

effects on increases in the amount of FV consumption or MET-minutes of PA, we calculated the changes in each outcome variable from baseline to the last CHW visit per participant. The changes from baseline to the last visit were compared between low and high exposure groups using multivariable linear regression models to examine the associations of program exposure with FV consumption or PA separately.

We also performed analysis for the subset of data from those who did not meet daily FV consumption recommendations or weekly PA guidelines at baseline, using logistic regression models to assess whether program exposure is associated with newly complying with FV or PA guidelines by the time of the last CHW visit. We further assessed the program effects by each location. While we conducted all aforementioned statistical analyses for each outcome variable, potential confounding effects such as participants' demographic characteristics were evaluated and adjusted accordingly in multivariable models. To account for heterogeneity among participants in their baseline measurement and duration of total follow-up, we adjusted for these variables in our analysis models. We also tested for effect modification to assess whether the program effects on behavior changes were modified by other variables. Underlying assumptions of linear regression and logistic regression were evaluated while developing final multivariable models. SAS software (SAS Institute Inc., version 9.4, Cary NC) was used to perform all statistical analyses with statistical significance level of 0.05.

Adoption: The percent of total municipalities/precincts in the two-county region that were offered the intervention and adopted it.

Implementation: The percent of locations where CHWs delivered the program reaching at least 35 participants in the high and low exposure categories.

Maintenance: The percent of locations that adopted the program and had active programming until November 2019.

Results

Reach

The TSSC program was implemented across 12 locations with a cumulative population of 718,647 [49]. Between January 2014 and November 2019, a total of 15,870 participants agreed to a follow-up visit by a CHW, or about 2.21% of the total population. Among participants who provided ethnicity data, 12,304 (93.25%) identified as Latino, which aligns with the 12 locations' cumulative 91.3% Latino population [45,49]. Among participants who provided both household size and income information, 8823 (81.18%) were below the Federal Poverty Line [54], which is much higher than the 30.9% poverty rate in the study's twelve locations [49]. Finally, 8225 participants (81.91%) who provided both ethnicity and income data were aligned with our priority population of Latinos with low income [54], which is much higher than the 12 locations' cumulative 32.9% Latino-**specific** poverty rate [49].

Effectiveness Baseline Characteristics

Among 15870 TSSC participants, those who had only one CHW visit (n=9778, 61.1%) were excluded from the analysis as no comparison follow-up measurement of FV consumption and PA from baseline could be examined. Non-Latinos (n=335, 5.5%) and those who did not disclose their ethnicity (n=71, 1.2%) were excluded from the analysis. A total of 5686 (36.0%) participants were included in our analysis and were classified into "low exposure" (n=4639) and "high exposure" (n=1047) groups for analytical comparisons.

Baseline characteristics by exposure group are presented (Table 2). Median length of follow-up was 2.3 months (IQR= [1.1,5.1]) for the low exposure group, and 6.6 months (IQR= [4.9,9.3]) for the high exposure group. Participants in the high exposure group, compared to the low exposure group, did not differ significantly by age or sex (Table 2). The high exposure group was significantly more likely to have health insurance (49.0% vs. 40.1%, p=0.0008) and be under the federal poverty level (FPL) (76.6% vs. 84.2%, p<0.0001). In addition, at baseline, the high exposure group had significantly higher mean MET-minutes (306.3 vs. 166.4 MET-minutes, p<0.0001), mean FV consumption (3.4 vs. 3.2 servings, p<0.0001), and more people who met the PA guidelines (44.0% vs. 37.9%, p=0.0004), and the FV consumption guidelines (27.5% vs. 20.6%, p<0.0001) (Table 2).

Effectiveness Across Municipalities on Fruit and Vegetable Consumption

The unadjusted and adjusted mean change in FV consumption from baseline to the last CHW visit were compared by low and high exposure group (Table 3). There was an increase in FV consumption from baseline to the last CHW visit in both exposure groups. We found that FV consumption increase from baseline to the last CHW visit in the high exposure group (+1.38 FV servings) was significantly higher than low exposure group (+0.73 FV servings) (adjusted mean difference= +0.65 FV servings, 95% CI: 0.53-0.77; p<0.0001) based on a multivariable adjusted model including confounders of participants' age, sex, insurance and poverty status, and the number of program components received (e.g. newsletter, exercise classes, newspaper, etc.) (Table 3). Additionally, participants with health insurance had significantly more FV consumption increase from baseline compared to those without insurance (adjusted mean difference= +0.39 FV servings, 95% CI: 0.29-0.49; p<0.0001) (Table 3). There were no statistically significant associations found with age, gender, or poverty status of participants.

Out of 4411 individuals who did not meet FV guidelines at baseline, 946 (21.6%) met the recommended FV guidelines by their last CHW visit (Table 4). The high exposure group had significantly higher odds of meeting FV consumption guidelines by the last CHW visit compared to the low exposure group (adjusted odds ratio [AOR]= 2.02, 95% CI: 1.65-2.47; p<0.0001) based on the multivariable logistic regression model, after controlling for aforementioned potential confounding effects (Table 4). Higher number of program strategies received (AOR 1.30, 95% CI: 1.22-1.39; p<0.0001), and having health insurance (AOR 1.24, 95% CI: 1.04-1.48; p=0.0151) were significantly associated with a significant increased odds of complying with FV guidelines at the last CHW visit (Table 4). There were no statistically significant associations found with age, sex, or poverty status of study participants (Table 4).

Effectiveness Across Municipalities on Physical Activity Guidelines

The mean change from baseline to the last CHW visit for PA (in MET-minutes per week) were compared between the low and high exposure group based on univariable (unadjusted) and multivariable (adjusted) linear regression models across all twelve locations (Table 3). There was an increase in MET-minutes PA from baseline to the last CHW visit in both exposure groups. The PA increase from baseline to the last CHW visit in the high exposure group (+396.3 MET-minutes) was significantly higher than the low exposure group (+210.7 MET-minutes) (adjusted mean difference= +185.6 MET-minutes, 95% CI: 105.9-265.4; p<0.0001) based on multivariable models after controlling for potential confounders (Table 3). Higher number of program strategies received (+147.8 MET-minutes per additional program component, 95% CI: 120.8-174.7; p<0.0001), younger age (-9.3 MET-minutes per year of age increase, 95% CI: -11.3 to -7.3; p<0.0001), and having health insurance (+161.7 MET-minutes, 95% CI: 95.1-288.3; p<0.0001) were significantly associated with greater increase in PA level from baseline. No statistically significant associations were found with sex and poverty status (Table 3).

Among 3429 participants who did not meet PA guidelines at baseline, 1133 (33.3% of the group) met PA guidelines by their last CHW visit (Table 4). The high exposure group had significantly higher odds of meeting PA guidelines by the last CHW visit compared to the low exposure group (AOR= 1.36, 95% CI: 1.10-1.68; p=0.0046),based on the multivariable logistic regression model after controlling for potential confounding effects (Table 4). Higher number of program strategies received (AOR 1.18, 95% CI: 1.10-1.26; p<0.0001), female sex (AOR 1.35, 95% CI: 1.12-1.61; p=0.0014), and having health insurance (AOR 1.36, 95% CI: 1.15-1.63; p=0.0004) were significantly associated with increased odds of complying with PA guidelines. Older age and being in poverty (AOR 0.73, 95% CI: 0.59-0.91; p=0.0005) had significantly lower odds of complying with PA guidelines (Table 4).

Effectiveness by Location on FV and PA

As this is a study examining the dissemination of a model program to locations in a region, we examined the program effect by location where the sample size was greater than n>35 in either the high or low exposure group based on multivariable analysis (Table 5). One city (City B), two county precincts, and two rural municipalities (Rural E and Rural F) did not have enough sample size (n>35) in the high exposure group to be included in the location-level program effectiveness analysis. Therefore, the adjusted mean changes in FV consumption and PA levels from baseline to the last CHW visit were compared between the low and high exposure group across seven different locations- one major urban area (City A), two towns (Town A, B), and four rural municipalities (Rural A, B, C, and D). The proportion of their sample that fell in the high exposure group varied greatly across locations and was documented as 27.7% of n=1251 (City A); 7.4% of n=457 (Town A); 11.0% of n=747 (Town B); 56.7% of n=702 (Rural A); 15.4% of n=540 (Rural B); 7.7% of n=467 (Rural C); 6.6% of n=587 (Rural D).

For FV consumption, in each of the municipalities there was an increase in FV consumption in both exposure groups at follow-up, and the high exposure group had significantly more increase in FV consumption compared to the low exposure group based on the adjusted model; for example, in Town A, the high exposure group had significantly higher increase in FV consumption compared to the low exposure group (adjusted mean difference= +1.45 FV servings, 95% CI: 0.71-2.19; p<0.0001) (Table 5). The high exposure group had higher odds of meeting FV consumption guidelines compared to the low exposure group in six of seven locations, with five locations meeting statistical significance (Table 5).

The mean changes from baseline to the last CHW visit for PA (in MET-minutes per week) were compared between the low and high exposure group in each location (Table 5). We found that the high exposure group had more increase in PA compared to the low exposure group in five of seven municipalities, including Town A which had an adjusted mean difference in change of +897.62 MET-minutes (95% CI: 541.05-1254.19; p<0.0001). On the other hand, the high exposure group had a lower mean change of PA compared to the low exposure group in two locations: Town B (adjusted mean difference in change: -171.11 MET-minutes) and Rural B (adjusted mean difference in change: -147.53 MET-minutes), but these findings were not statistically significant (Table 5). We also found that the high exposure group had significantly higher odds of meeting PA guidelines by the last CHW visit compared to the low exposure group in six of seven municipalities, with three meeting statistical significance; in Rural C, the high exposure group had significantly higher odds of meeting PA guidelines compared to the low exposure group (AOR 5.41, 95% CI: 1.62-18.08; p=0.0061) (Table 5).

Program Adoption

During the first half of the study period (January 2014- December 2017), nine locations were offered the program and all nine adopted it in one county (100% adoption rate). A total of 18 municipalities were in this county. Beginning August 2017, more locations were approached. One municipality (Rural F) was approached and adopted in the initial county. Three out of four precincts in a second county were contacted, and two implemented the program. The county precinct that did not agree to participate did not differ on sociodemographic variables such as racial composition or poverty rate as compared to the adopting precincts [49]. The overall adoption rate in both counties (adopted/approached) was 92.3%

Program Implementation

Of the 12 locations that adopted, seven implemented with fidelity (58.3%) by meeting the criteria to be included in the location-specific effectiveness analysis. The five locations that did not implement with fidelity included two locations with personnel issue (Rural E and City B), and the three locations that adopted in the second half of the study period. For example, one location (Rural F) did not begin participant enrollment until January 2019.

Program Maintenance

All but one location maintained the program (91.7%) by having active programming until November 2019. Rural E discontinued the program due to personnel issues where qualified staff were not consistently available.

Discussion

In the literature, CWCs have been successfully adapted to promote health behaviors such as FV consumption [35,59] and physical activity engagement [60,61] for the long-term management of chronic disease burden in communities, including among Latinos [2,23,35]. Indeed, the real-world implementation of

evidence-based programs has the potential to improve public health. This study contributes to the literature by using the RE-AIM Framework [43] to examine the Reach, Effectiveness, Adoption, Implementation, and Maintenance of a CWC program implemented across multiple locations for a health disparate population of low-income Mexican Americans along the U.S.-Mexico border.

Reach

The "reach" of community-based interventions in the form of program enrollment of the priority population in need is not routinely reported [62,63], which limits the external validity and applicability of the findings of community interventions to other health disparate communities. Prior community-based health promotion interventions have found that minorities are less likely to meet eligibility criteria for enrollment and have differential attrition rates, thus culminating in participants of community-based interventions being wealthier, higher educated, and older than the target population of the intervention [62,63]. Within this study's five-year time frame, approximately 2.2% (over 15,000) of the total population in the participating region was reached with the program component that required enrollment and personalized CHW visits [64,65,66]. Unlike prior studies [62,63], this intervention effectively enrolled the priority population for which programming services were designed. The goal of the TSSC program was to reach low-income Latinos and this was achieved with nearly 82% of the participants (n=8225) fitting this criteria, which is far greater than our 12 locations' general 33% rate of low-income Latinos [49].

A noticeable issue with the reach and ultimately its effectiveness was that more than half of those reached by the program did not receive a follow-up CHW home visit. As the program retools implementation in the various locations, an emphasis on follow-up visits should be done. Overall, the reach results indicate that a CWC model appears to enroll low-income Latinos, which expands past literature showing CWC-based research being focused on primarily white, wealthier populations [1,30,33].

Effectiveness

As evidence-based programs are implemented in real-world settings across varied locations, they need to remain effective at improving outcomes. We found significant improvement in FV consumption and PA aggregately across locations with those in the high exposure group having generally greater increases in FV consumption and PA MET-minutes than the low exposure group, but with both groups demonstrating improvement from baseline. Our study population was predominantly low income, uninsured, middle-aged Latinas and therefore our findings provide insight into improving nutrition and physical activity behaviors in this specific population. Additionally, our study parallels existing literature which suggests that CWC interventions in the Latino community that incorporate CHW outreach leads to improved behavioral outcomes and uptake [2,35].

Other CWC-based interventions globally also found improvement in nutritional choices including decreasing high-fat dairy [67,68], saturated fat [69,70], and red meat [71] in both developed and developing nations. We found some differential impacts based on sociodemographic factors. In particular, health insurance (government and private) was associated with significantly greater mean increases in FV consumption and PA MET-minutes and an increased odds of meeting FV and PA guidelines, after controlling for other confounders (e.g., age, sex, poverty status). The ability to afford or qualify for this type of coverage likely signifies more stable employment, higher socioeconomic status, and legal residency/citizenship status which enhances the ability to engage in this longitudinal program. Additionally, having insurance likely equates to individuals having more routine access to healthcare and thus exposure to healthcare providers and auxiliary staff who may also provide supplemental encouragement- beyond the scope of the program- for the participant to engage in healthier eating and PA behaviors. In general, our finding parallels past research among Latinos where having insurance has been associated with increased PA levels [3,72].

Overall, our aggregate findings of effectiveness indicate that the program was disseminated and implemented in a manner that the two primary outcomes were achieved when individuals were exposed through CHW follow-up visits. Past research suggests that successful implementation of the CWC model appears to be related to implementation in communities with high needs [73]; our study results corroborate this finding.

We examined outcomes by location to further investigate effectiveness. Those participants who received high exposure to the program, across all locations, were significantly more likely to report improved mean change in FV consumption over baseline. Furthermore, in most locations, among those who did not meet the FV guidelines at baseline, their odds of meeting guidelines by last follow-up was robustly associated with having high program exposure versus low program exposure, regardless of setting. These findings suggest that programmatic engagement is associated with improvements to participants' FV consumption, thus highlighting the need to increase high levels of exposure to the program for more low-income Mexican Americans.

The results were more mixed in the location analysis for PA. Most locations (five of seven) demonstrated that high exposure was associated with increased MET-minutes of PA compared to the low exposure group, but only two of seven locations had statistically significant results. Overall, the difference in effect size by location is wide, differs by outcome, and is partially explained by individual and organizational capacity factors. The CHWs differed individually in their professional backgrounds and approach to follow-up visits. The implementing organizations differed in their approach to supervision and municipality priorities. As the CHWs balanced these factors, their time and emphasis on follow-up visits and programmatic content may have differed. Future research should examine these and other factors associated with the Implementation and Maintenance dimensions of the RE-AIM framework [43] more fully to particularly understand the variability in PA outcomes by location.

Adoption

The TSSC program was adopted by 92.3% of locations (12/13) to which it was promoted. Our study reflects interest and motivation to adopt the program in a high need region. Enthusiasm for adoption was likely influenced by the presence of grant funding to cover annual program costs. Over time the local municipalities were able to leverage this core funding into additional programming and infrastructure improvements, which built enthusiasm. This then is the issue with public health funding for low resource regions; the need and willingness is there, but without funding the adoption of evidence based programs is curtailed. Generally, past research has indicated that community-based interventions are not adopted because health issues are not perceived by key

stakeholders and municipal decision-makers as relevant [74,75,76]. Notably, the TSSC program builds upon prior local adoption of this program [2,23,35], and leverage those successes to create relevance, and handle perceived barriers and challenges to facilitate collaboration and program adoption.

Implementation

This scaled-up version of the TSSC program was implemented with fidelity in 58.3% of locations (7/12). The program attempted to localize the CWC to each implementing location by tailoring to demographic profile, cultural values, and health issues. Discrepancies with implementation rests with personnel challenges that varied for each community. Locations that adopted the TSSC program with fidelity generally quickly identified CHWs with experience or capacity to implement program components; accordingly, these locations began their programming early in the study period. According to Knudsen et al. (2020), implementation fidelity can be enhanced personnel training, as well as routine (monthly) monitoring of the dosage of program components delivered, and adherence to program component protocols at each location [77]. With this iteration of the program, monthly CHW training sessions were conducted to enhance programming consistency, along with location-specific annual implementation evaluations. Future iterations of the TSSC program should further explore additional factors influencing implementation fidelity.

Maintenance

The program was ultimately maintained by 91.7% of locations (11/12) during the nearly five-year time frame. Indeed, maintenance was high, but like adoption, influenced by the presence of ongoing grant funding to support the intervention staff and activities. As the program is still currently active in the locations with future expansion planned, more knowledge about maintenance will come over time, as has been the case in the extensively studied original CWC program implementation in Finland which has been faithfully maintained in many communities for over 40 years [40,41].

Limitations

The limitations to our study include a lack of control communities, which had this been an efficacy study would be a substantial flaw. However, several previous studies with control groups on the TSSC program have shown evidence of efficacy [23, 35, 36], and this study focused on the real-world, scaled up dissemination and implementation of the program across an entire health disparate region. The results do advance the literature on CWC models to address FV consumption and PA in twelve locations advancing the knowledge of the reach, effectiveness, adoption, implementation, and maintenance of this model in real-world scenarios.

Another limitation is the difference in the sample size between the low and high exposure groups when examining program effectiveness. The high exposure group was smaller and the unequal sample size between these groups may have weakened the statistical power and did result in five of the twelve implementing locations being excluded from the analysis. As the programs develop and realize more participants in the high exposure group, and more participants who are followed for a longer timeframe, further analysis should be done to examine maintenance of the program using longitudinal analysis. Finally, as with many population studies, the outcome variables were measured through self-reported measures. These measures are subject to desirability bias and objective measures tend to be too costly for large populations [52]. Future research could consider a subsample cohort drawn that is followed with more complete measures such as the Automated Self-Assessment (ASA) for dietary intake information [78] or Accelerometers for physical activity assessment [52].

Conclusions

This study used the RE-AIM Framework [43] to evaluate a scaled-up CWC across twelve locations along the U.S.-Mexico border and uniquely contributes to the literature. Overall, this study demonstrates that the TSSC program reached its intended low-income Mexican American population who at baseline have low uptake of health behaviors including FV consumption and PA engagement [1, 17], which consequently culminates in a disproportionate burden of NCDs in this community [6–13]. The study showed effectiveness in its dose-dependent relationship between increased program exposure and degree of statistically significant increases in FV consumption and PA. The study also shows high adoption, moderate fidelity of implementation, and high maintenance across a variety of settings ranging from major urban to rural communities. Evidence-based, health behavior promotion interventions in Latino communities are limited in scope, with little published literature emphasis on the reach, adoption, implementation, or sustainability of the intervention [50]; accordingly, this study thus adds evidence to the literature about the successful implementation and dissemination of a regional scaled-up CWC to address behavior change in low-income Mexican Americans in a health disparate region.

Abbreviations

AOR: Adjusted Odds Ratio

CHW: Community health worker

CI: Confidence interval

CWC: Community-wide campaign

FPL: Federal poverty level

FV: Fruit and vegetable consumption

IQR: Interquartile range

MET: Metabolic equivalent

NCD: Non-communicable disease

OR: Odds ratio

PA: Physical activity

RE-AIM: Reach, effectiveness, adoption, implementation, and maintenance analysis model

RR: Relative Risk

SPH: School of Public Health [University of Texas Health Science Center at Houston]

TSSC: Tu Salud ¡Si Cuenta! (Your Health Matters!) initiative

Declarations

Ethics approval and consent to participate

This research was approved by the University of Texas Health Sciences at Houston Institutional Review Board, the Committee for the Protection of Human Subjects (HSC-SPH-05-0488). Adults provided their written consent to participate.

Consent for publication

Not applicable.

Availability of data and material

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

BR contributed to the conception and design of the original study upon which this paper is based, and wrote all sections of the manuscript. LMB contributed to the conception and design of this study and writing portions of the methods and limitations section of the manuscript. ML, TX, and SKP contributed to the development of study measures, developed the analytical plan, conducted analyses for this paper, designed the manuscript tables, and prepared the results and analysis section of the manuscript. PGY performed a literature review, and assisted with the analyses for this paper, interpreting the data, reformatting and editing the tables, and was a major contributor in drafting and proofreading all sections of the manuscript. AD and AGODT oversaw acquisition of data, data entry, and contributed to the methods and limitations section of the manuscript. BR was the Principal Investigator of the original study. All authors read and approved the final manuscript.

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Tables

Table 1
Tu Salud ¡Si Cuenta! Program Description

Community-wide Campaign Components	Operationalization of Component to promote fruit and vegetable (FV) consumption and physical activity (PA)
Mass and Social Media	Delivery of regularly scheduled health promoting messages tailored to local culture and language (social media, radio, TV, print, text messaging) using behavioral journalism featuring local role models.
Social Support and Tailored Health Education	Community-based groups tailored to local culture, language and identified health needs of community members including: 1) Exercise and nutrition groups, 2) Weight loss and disease self-management support groups, 3) Health education programming in community spaces, 4) Individualized motivational interviewing, 5) Motivational text messaging, 6) Home-based community health worker visits.
Risk Factor Screening	Provision of free and accessible health risk screening in home and community locations for: 1) Blood Pressure, 2) BMI, 3) Referrals for glucose/HbA1c, 4) Referral and follow-up to clinical and social services.
Environmental Changes	Physical improvements identified and implemented by the locations including: 1) availability and access to produce through community gardens and farmers markets, 2) activation of public spaces through free PA classes 3) community connectedness projects like sidewalks and trails, 4) safety and convenience projects like outdoor hydration and lighting
Policy Improvements	Regulation improvements by locations including: 1) Complete street ordinances and healthy vending policies, 2) Improved school nutrition policies, 3) Active transportation policies

Table 2: Baseline characteristics of Latino participants enrolled in the TSCC Program (n=5686)

Variable	Low exposure (n=4639)	High exposure (n=1047)	p-value [a]
Age, years, mean (SD)	46.87 (14.06)	48.62 (14.13)	0.8298
Female, N (%)	3644 (77.49%)	819 (78.22%)	0.8156
Have insurance, N (%)	1862 (40.14 %)	512 (48.95%)	<.0001
Number of program strategies received [b], median (IQR), [min, max]	2 (1, 2) [1,7]	2 (1, 2) [1,8]	0.0035
Below federal poverty level, N (%)	3312 (84.22%)	706 (76.58%)	<.0001
Meeting PA guideline (600 MET) at Baseline, N (%)	1747 (37.89%)	443 (43.95%)	0.0004
Meeting fruit & vegetable guideline (> 4 portions) at Baseline, N (%)	952 (20.60%)	281 (27.50%)	<.0001
Baseline MET-minutes, mean (SD)	166.35 (215.57)	306.33 (266.88)	<.0001
Baseline FV consumption, mean (SD)	3.15 (2.06)	3.38 (2.24)	0.0015

[a]Student's *t*-test or its non-parametric equivalent (i.e. Wilcoxon rank sum test) for continuous variables and Chi-square test for categorical variables were used.

[b] Number of program strategies received per participant has a range from 0 to 7 and includes newsletter, exercise classes, weight loss support groups, health education programming, motivational text messaging, and risk factor screening.

All participants received at least 2 community health worker home visits as part of the inclusion criteria for this study.

Table 3. TSSC program effect on change in FV and PA MET-minutes from baseline to last visit based on linear regression analysis (n=5686)

Variable	Change in Total FV consumption from baseline to the last CHW visit				Change in Total PA MET-minutes from baseline to the last CHW visit			
	Unadjusted		Adjusted		Unadjusted		Adjusted	
	mean difference in change	P-value	mean difference in change	P-value	mean difference in change	P-value	mean difference in change	P-value
Exposure high vs. low	0.67 (0.56, 0.79)	<.0001	0.65 (0.53, 0.77)	<.0001	168.55 (87.90, 249.21)	<.0001	185.62 (105.87, 265.37)	<.0001
Estimated Mean change (95% CI) from baseline to the last CHW visit in each group	*Low: 0.63 (0.58, 0.67)* *High: 1.30 (1.20, 1.40)*		*Low: 0.73 (0.65, 0.80)* *High: 1.38 (1.26, 1.50)*		*Low: 138.14 (106.45, 169.83)* *High: 306.69 (234.67, 378.72)*		*Low: 210.67 (162.09, 259.26)* *High: 396.29 (316.80, 475.79)*	
# program strategies received			0.16 (0.12, 0.20)	<.0001			147.77 (120.83, 174.72)	<.0001
Age, year			0.002 (-0.001, 0.005)	0.1663			-9.26 (-11.28, -7.25)	<.0001
Sex female vs. male			-0.06 (-0.16, 0.04)	0.2438			-30.21 (-98.24, 37.82)	0.3840
Have insurance yes vs. no			0.39 (0.29, 0.49)	<.0001			161.72 (95.14, 228.30)	<.0001
Poverty status below vs. above FPL			0.05 (-0.07, 0.18)	0.3789			-66.04 (-147.10, -15.02)	0.1103

Abbreviations: CHW, community health worker; FV, fruit and vegetable; MET, metabolic equivalents; PA, physical activity; TSSC, *Tu Salud ¡Si Cuenta!* program.

High program exposure defined as participants having 4-5 CHW visits (3-4 follow-up visits). Low program exposure defined as participants having 2-3 CHW visits (1-2 follow-up visits).

Table 4. TSSC program effect on meeting FV and PA guideline based logistic regression analysis

Variable	Meeting FV guideline by last CHW visit (n=4411)				Meeting PA guideline by last CHW visit (n=3429)			
	Unadjusted		Adjusted		Unadjusted		Adjusted	
	Odds Ratio (95% CI)	P-value	Odds Ratio (95% CI)	P-value	Odds Ratio (95% CI)	P-value	Odds Ratio (95% CI)	P-value
Exposure high vs. low	2.00 (1.64, 2.43)	<.0001	2.02 (1.65, 2.47)	<.0001	1.24 (1.10, 1.54)	0.0393	1.36 (1.10, 1.68)	0.0046
# program strategies received			1.30 (1.22, 1.39)	<.0001			1.18 (1.10, 1.26)	<.0001
Age, year			1.00 (1.00, 1.01)	0.2430			0.98 (0.97, 0.98)	<.0001
Sex female vs. male			1.18 (0.98, 1.42)	0.0737			1.35 (1.12, 1.61)	0.0014
Have insurance yes vs. no			1.24 (1.04, 1.48)	0.0151			1.36 (1.15, 1.63)	0.0004
Poverty status below vs. above FPL			1.02 (0.82, 1.26)	0.8951			0.73 (0.59, 0.91)	0.0005

Abbreviations: CHW, community health worker; FV, fruit and vegetable; MET, metabolic equivalents; PA, physical activity; TSSC, *Tu Salud ¡Si Cuenta!* program.

High program exposure defined as participants having 4-5 CHW visits (3-4 follow-up visits). Low program exposure defined as participants having 2-3 CHW visits (1-2 follow-up visits).

Table 5. TSSC program effect on change in FV, PA MET-minutes and meeting FV, PA guideline by location

Change in Total FV consumption from baseline to the last CHW visit

	City A (n=1251)	Town A (n=457)	Town B (n=747)	Rural A (n=702)	Rural B (n=540)	Rural C (n=467)	Rural D (n=587)
	Adjusted mean difference in change and 95% confidence interval with p-value						
Exposure high vs. low	0.63 (0.37, 0.88); p<0.0001	1.45 (0.71, 2.19); p<0.0001	0.62 (0.37, 0.88); p<0.0001	0.63 (0.44, 0.83); p<0.0001	0.71 (0.17, 1.24); p=0.0097	0.74 (0.24, 1.26); p=0.0041	0.44 (0.06, 0.82); p=0.0242
Estimated Mean change (95% CI) from baseline to the last CHW visit in each group	*Low: 0.66 (0.48, 0.83)*	*Low: 0.68 (0.27, 1.09)*	*Low: 0.53 (0.40, 0.65)*	*Low: 0.73 (0.58, 0.89)*	*Low: 0.91 (0.61, 1.22)*	*Low: 1.45 (1.01, 1.90)*	*Low: 0.55 (0.03, 1.08)*
	High: 1.28 (1.03, 1.53)	*High: 2.13 (1.31, 2.95)*	*High: 1.15 (0.94, 1.36)*	*High: 1.37 (1.23, 1.50)*	*High: 1.62 (1.06, 2.18)*	*High: 2.20 (1.50, 2.91)*	*High: 0.99 (0.39, 1.59)*

Meeting FV guideline at the last CHW visit

	City A (n=708)	Town A (n=304)	Town B (n=422)	Rural A (n=406)	Rural B (n=307)	Rural C (n=322)	Rural D (n=432)
	Adjusted Odds Ratio and 95% confidence interval with p-value						
Exposure high vs. low	2.04 (1.41, 2.96); p=0.0002	1.97 (0.77, 5.06); p=0.1567	0.84 (0.38, 1.84); p=0.6636	3.98 (2.19, 7.24); p<0.0001	2.40 (1.20, 4.82); p=0.0135	4.10 (1.36, 12.45); p=0.0125	2.73 (0.94, 7.94); p=0.0652

Change in Total PA MET-minutes from baseline to the last CHW visit

	City A (n=1251)	Town A (n=456)	Town B (n=747)	Rural A (n=702)	Rural B (n=540)	Rural C (n=467)	Rural D (n=587)
	Adjusted mean difference in change and 95% confidence interval with p-value						
Exposure high vs. low	38.55 (-102.20, 179.30); p=0..5911	897.62 (541.05, 1254.19); p<0.0001	-171.11 (-345.97, 3.74); p=0.0551	220.38 (65.05, 375.70); p=0.0055	-147.53 (-345.83, 50.76); p=0.1445	290.94 (-55.44, 637.33); p=0.0995	189.59 (-122.59, 501.65); p=0.2333
Estimated Mean change (95% CI) from baseline to the last CHW visit in each group	*Low: -3.91 (-103.26, 95.45)*	*Low: 512.21 (350.98, 673.45)*	*Low: 48.52 (-42.99, 140.02)*	*Low: 577.68 (458.00, 697.35)*	*Low: 155.81 (42.09, 269.54)*	*Low: 295.99 (-5.86, 597.84)*	*Low: -213.82 (-706.87, 278.22)*
	High: 34.64 (-104.02, 173.31)	*High: 1409.83 (1031.81, 1787.85)*	*High: -122.60 (-308.31, 63.11)*	*High: 798.06 (692.83, 903.28)*	*High: 8.28 (-199.60, 216.16)*	*High: 586.94 (107.68, 1066.19)*	*High: -24.24 (-456.66, 408.15)*

Meeting FV guideline at the last CHW visit

	City A (n=1007)	Town A (n=361)	Town B (n=608)	Rural A (n=445)	Rural B (n=375)	Rural C (n=375)	Rural D (n=511)
	Adjusted Odds Ratio and 95% confidence interval with p-value						
Exposure high vs. low	1.15 (0.73, 1.82); p=0.5382	3.84 (1.05, 13.95); p=0.0414	1.38 (0.56, 3.39); p=0.4903	2.42 (1.35, 4.32); p=0.0029	1.00 (0.47, 2.10); p=0.9923	5.41 (1.62, 18.08); p=0.0061	1.14 (0.42, 3.08); p=0.7933

Abbreviations: CHW, community health worker; FV, fruit and vegetable; MET, metabolic equivalents; PA, physical activity; TSSC, *Tu Salud ¡Si Cuenta!* program.

High program exposure defined as participants having 4-5 CHW visits (3-4 follow-up visits). Low program exposure defined as participants having 2-3 CHW visits (1-2 follow-up visits). Linear regression models were performed for the mean difference in the change of FV and PA in each location. Logistic regression models were performed on all individuals who did not meet FV or PA guidelines at baseline in each location.

All estimates are based on multivariable models after controlling for number of program strategies received, duration of follow-up, age, gender, insurance status and poverty status.

Figures

Tu Salud ¡Si Cuenta! Study Design: Each year people were enrolled serving as their own control. Sample size only represents individuals with enrollment plus a minimum of 2 additional outcome visits
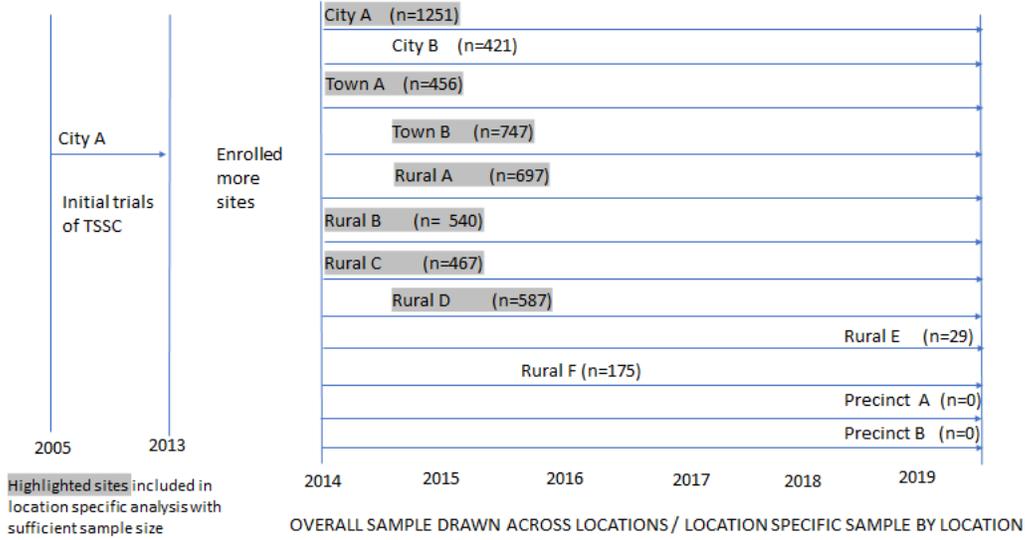
Figure 1

Tu Salud ¡Si Cuenta! Study Design