

Impact of a Community-Wide Multi-Level Obesity Prevention Intervention for Children in Rural
Communities

Emily Brown

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Committee:

Linda K. Ko

Hendrika Meischke

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Emily Brown

University of Washington

Abstract

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Emily Brown

Chair of the Supervisory Committee:

Linda K. Ko, PhD

Department of Health Services

Childhood overweight and obesity are serious public health concerns in the US. Certain populations are disproportionately affected based on race/ethnicity and geographic area (HRSA, 2015). Multiple components constitute a child's obesogenic environment, but there is inadequate research on obesity prevention interventions to address these multiple facets, especially in rural settings. The purpose of this paper is to examine the preliminary effectiveness of Together We STRIDE, a multi-level intervention on nutrition and physical activity behaviors among 3rd to 5th graders in a rural community of Eastern Washington.

The intervention community received multi-level intervention activities at the individual, family, school, and community levels. Anthropometric measurements were collected at baseline and 6-month follow up, and a subgroup of participants provided information on nutrition and physical activity behaviors. Changes in the subgroup's consumption of fruit, vegetables, and sugar from sugar sweetened beverages (SSBs); physical activity (PA); and sedentary behaviors (including screen time) were analyzed for differences within and between intervention and comparison groups, and by gender.

Fruit intake increased for both groups, with the intervention group consuming slightly more. Vegetable consumption decreased for both groups, but the intervention group showed a smaller decrease compared to the comparison group. The intervention group decreased, while the comparison group significantly increased ($p=0.002$), sugar intake from SSBs. The intervention group reported a significant increase in light PA ($p=0.007$), an increase in moderate PA, and a decrease in vigorous PA, while the comparison group reported a decrease at all three levels, revealing a significant difference between intervention and comparison groups at all three levels ($p=0.009$, 0.012 , 0.032 , respectively). Weekend sedentary behavior increased in the intervention group, while it decreased in the comparison group. Weekend screen time increased for both groups. Differences by gender showed: intervention boys consumed significantly less sugar than their comparison group counterparts ($p=0.019$); vigorous PA between intervention and comparison groups of boys was significant ($p=0.028$), while light PA between intervention and comparison groups of girls was significant ($p=0.030$); and no significant differences by gender on sedentary behavior.

The intervention had a significant effect on increasing PA, and revealed small but meaningful improvements in fruit consumption and sugar intake from SSBs. Vegetable consumption decreased slightly, but the trend for the intervention group may be less solidified as children had not received all of the intervention components during the preliminary assessment. These preliminary results show intervention effectiveness in addressing fruit and sugar consumption, as well as physical activity behaviors at the midpoint assessment. Thus, it is anticipated that a larger magnitude of difference will be seen at 18-month follow up.

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Introduction

Childhood Obesity is a Public Health Concern in the US

Childhood overweight and obesity and the negative health impacts they perpetuate are serious public health concerns across the United States. In 2013-2014, the prevalence of overweight and obesity was 33% among youth, and 17% of those were obese (Centers for Disease Control and Prevention [CDC], 2016). The obesity epidemic continues to be a public health issue exacerbating social (e.g., impact of stigmatization of overweight individuals) and economic costs (e.g., increased healthcare spending), and worsening the nation's overall health due to its associated health consequences (Cawley & Meyerhoefer, 2012; Pont, Puhl, Cook, & Slusser, 2017). For instance, obesity is associated with an increased risk of developing chronic diseases including the metabolic syndrome, type 2 diabetes and associated complications, and cardiovascular disease, each of which constitute further negative health problems (Kelsey, Zaepfel, Bjornstad, & Nadeau, 2014). Moreover, childhood overweight and obesity have been shown to negatively affect long-term health, such as increased cardiovascular risk in adulthood, highlighting the need for public health interventions to address youth obesogenic factors and behaviors early on to achieve an improved continuum of health (Reilly et al., 2003).

Obesity Risk Factors

The obesity epidemic is a national concern, but certain populations are disproportionately affected based on race/ethnicity and geographic area (US Department of Health and Human Services, Health Resources and Services Administration [HRSA], 2015). Children living in rural areas are significantly more likely to be obese than their urban counterparts, suggesting that where one lives and plays contributes to overweight and obesity risk (HRSA, 2015). Additionally, within rural areas, Hispanic children are more likely to be overweight or obese compared to non-Hispanic White children (49.7% vs. 31.7%), revealing that race/ethnicity is another vulnerability factor of unhealthy weight (HRSA, 2015). Preliminary data from Together We STRIDE show that 54.8% of study participants (3rd-5th graders), of which approximately 80% are Hispanic and living in a rural area, are overweight or obese, corroborating evidence that race/ethnicity and geographic area impact overweight and obesity risk. In addition, research shows that gender also plays a role – among children living in large rural areas, boys have higher rates of overweight and obesity than girls (38.4% vs. 32.4%, respectively) (HRSA, 2015). Overall, higher obesity

prevalence among children living in rural communities, especially Hispanic children, implies a disproportionate burden of negative health consequences later in life, including increased risk for adult morbidity and premature mortality (Reilly et al., 2003). Furthermore, from 2007-2010, there was a lack of significant change in obesity rates among Hispanic children which reveals an opportunity – need, even – to reverse this obesogenic trend (Ogden, Carroll, Kit, & Flegal, 2012).

Multi-Level Interventions to Address the Multi-Faceted Risk Factors of Obesity

Multiple components influence a child's obesogenic surroundings and behavior – from individual food and beverage choices, to family influences on how physically active a child is, to the healthfulness of food offered at school, to the availability of community spaces (e.g., parks) for physical activity, and many factors in between, such as foods offered at home and cultural norms around food. Furthermore, macro-level factors, such as environmental, social, and economic conditions and policies, influence individual and community choices, which in turn can lead to positive or negative health outcomes, including childhood obesity (Kochitzky, 2011). For instance, the degree to which a community is obesogenic – that is, surroundings or conditions of life that promote obesity – affects a child's access, or lack thereof, to healthy foods and physical activity opportunities, and therefore impacts the nutrition and activity choices they make. The effects of an obesogenic environment are especially significant for children as they have limited control over their geographic mobility (Jenkin, Pearson, Bentham, Day, & Kingham, 2015). Where and for how long they spend their time is limited to their immediate surroundings, where the built environment and social conditions within that environment may not be conducive to health. From this, we see that a host of environmental factors play a significant role in determining health behaviors as they are linked with built, social, and socioeconomic environmental assets (Carroll-Scott et al., 2013). This signifies the need for a framework that accounts for the various contributors to childhood obesity risk and the need for multi-level interventions to address unhealthy weight.

Individual biological factors and inherent behaviors affect an individual's risk to obesity. However, the individual is only one factor of a multifactorial sphere of influence affecting a child's risk towards an unhealthy weight. Influences outside the individual, such as social and environmental factors, most likely exceed any genetic factors in causing obesity (Grundy, 1998). Because obesity risk factors go beyond the individual, so should obesity prevention interventions to address the impact of the environment on

individual behavior. For example, the home environment – through the types of food offered to a child and encouragement of physical activity – have significant effects on a child's weight status (Kropski, Keckley, & Jensen, 2008). Children are also influenced by the behaviors modeled by their parents and therefore parents can incite healthy behaviors on their children by modeling healthy habits, such as healthy dietary patterns and daily physical activity (Golan & Weizman, 2001). This shows that family is an important factor to consider when implementing obesity prevention interventions.

Schools are another key place in which to integrate nutrition and physical activities, especially since most children attend school and spend a large portion of their day at school. Programs that incorporate a range of activities, including school curriculum (e.g., integrating lessons on healthy eating into regular curriculum, and increased physical activity sessions) and teacher support (e.g., capacity building activities) have shown positive effects in reducing BMI among children (Waters et al., 2011). On a higher level, the community provides a valid intervention platform for childhood obesity prevention. Community norms may act as barriers to healthy eating and physical activity, such as preferences to drive children to school instead of having them walk, or the presence of highly processed foods overshadowing fresh produce at community farmers' markets. Thus, community culture is an important factor to consider when strategizing how to mobilize limited community resources for promoting better nutrition and physical activity among community members.

Filling the Research Gap

Despite there being evidence on multiple components to obesity risk, there is inadequate research on implementing obesity prevention interventions to address these multiple facets. Many interventions have focused on the individual rather than integrating an ecological perspective – that is, how influences outside the individual and how one interacts with their environment (e.g., walking around their community rather than driving) affect health. Furthermore, more research is needed to understand best practices for obesity prevention given limited resources, such as that of rural settings. Analysis of National Health and Nutrition Examination Survey (NHANES) data from rural and urban adults revealed associations between rural residency and overweight and obesity risk, and has suggested mechanisms for improving access to obesity prevention-type care in rural settings (Befort, Nazir, & Perri, 2012). However, most multi-level intervention studies have focused on urban settings. More research is needed

from the community's perspective to elucidate obesity prevention practices that are acceptable and feasible for rural communities and their resources.

Together We STRIDE fills this research gap by implementing a multi-level intervention addressing the multiple factors contributing to childhood obesity risk in rural areas through a community-based approach. This includes engaging the individual, multiple generations within the family, schools, and the community to ensure a more holistic approach towards impacting multi-faceted obesity risk. Community engagement is crucial for developing interventions that are salient to the specific needs of the community and is an effective approach for increasing potential for sustainability; this, in turn, allows for continued impact towards improved health among community members (Holden et al., 2016; Wallerstein & Duran, 2010). STRIDE further fills the research gap by targeting a largely Hispanic population in a rural setting.

Community-Based Approach

Together We STRIDE applied a community-based participatory research (CBPR) approach throughout the design of the study by integrating community input, especially that of a community advisory board focused on promoting health in the community. Community advisory boards have been integral to health promotion in the Lower Yakima Valley of Eastern Washington for several years. The STRIDE Community Advisory Board (CAB) is a diverse group of community members, including school representatives, community-based organizations, community advocates, and community health organizations. The CAB identified childhood obesity as a community-wide concern and thus it became the focus of the study. The academic research team worked in close collaboration with the CAB to design the study, including the multi-level intervention, as well as to conduct evaluation and dissemination plans.

Conceptual Framework and Intervention Levels

Another important component of the study is the application of the socioecological framework (SEF) to the identification and design of the intervention. STRIDE's intervention levels align with the multiple spheres of influence within the SEF (CDC, 2018). The study's multi-level intervention builds upon the interaction between facets comprising an obesogenic environment as each intervention level has a unique set of sub-interventions to probe unhealthy weight status from multiple angles.

At the individual level, participants received comic books that promoted healthy eating and physical activity through story telling. At the family level, children and their families participated in nutrition

and physical activity classes that emphasized a didactic component, goal setting, healthy recipes, and group physical activity. The school level included media literacy education and classroom-based physical activity. Finally, the community level included a family night to kick off the study and emphasize a healthy lifestyle, a *ciclovía* (open streets event) to promote community-wide physical activity opportunities, and a partnership with the community farmers' market to build synergy with STRIDE's nutrition-based initiatives.

Importance of STRIDE

Intervening at multiple levels influencing a child's health behavior, while maintaining a strong CBPR approach, allows for meaningful insights into empowering resource-limited communities to combat childhood obesity. Furthermore, STRIDE's multi-level approach creates the potential for positive changes to extend through multiple factors mirrored in the SEF. The comprehensive nature of STRIDE addresses gaps in research around multi-level interventions focused on a rural setting and targeting obesity among multi-generational participants. Therefore, evaluating STRIDE's efficacy in motivating and improving dietary and physical activity behaviors among study participants will provide valuable insight into implementing effective and relevant community-based obesity prevention initiatives in rural communities. The study's findings will unveil evidence that can facilitate adoption of the intervention in resource-limited settings, thus working towards greater health equity across populations – through policy and practice.

The purpose of this paper is to examine the effectiveness of Together We STRIDE on dietary patterns and physical activity behaviors (including sedentary behavior). The results will help reveal the effectiveness of this multi-level approach in reducing obesity among children in the Lower Yakima Valley and incite evidence for replication among other disproportionately affected populations in rural communities. The research questions and related hypotheses are summarized below:

Targeted Behavior	Research Question	Hypothesis
Nutrition	1) Did the intervention group significantly increase fruit and vegetable consumption compared to the comparison group? Are there significant differences in fruit and vegetable consumption between intervention and comparison groups by gender?	1) Difference in means of daily fruit and vegetable consumption (T2-T1) is <i>positive</i> and significantly greater for intervention community than for comparison community.
Nutrition	2) Did the intervention group significantly decrease sugar consumption from SSBs compared to the comparison group? Are there	2) Difference in means of daily sugar intake (T2-T1) is <i>negative</i> and significantly lower for

	significant differences in sugar consumption between intervention and comparison groups by gender?	intervention community than for comparison community.
Physical Activity	3) Did the intervention group significantly increase physical activity, especially moderate and vigorous physical activity (MVPA) compared to the comparison group? Are there significant differences in PA between intervention and comparison groups by gender?	3) Difference in means of daily PA minutes (T2-T1) is <i>positive</i> and significantly greater for intervention community than for comparison community.
Sedentary Behavior	4) Did the intervention group significantly decrease sedentary behavior, including screen time, compared to the comparison group? Are there significant differences in sedentary behaviors between intervention and comparison groups by gender?	4) Difference in means of weekend sedentary hours (T2-T1) is <i>negative</i> and significantly lower for intervention community than for comparison community.

Methods

Research Design

Together We STRIDE was a quasi-experimental, community-wide multi-level obesity prevention trial testing the effect of a multi-level intervention on BMI z-scores, dietary intake, and physical activity among children in rural communities of the Lower Yakima Valley of Eastern Washington. The study included two communities – one intervention and one comparison – matched with consideration to town population, population density, number of elementary schools, and characteristics of students in the schools (standardized test scores, percent of student body eligible for free or reduced-price lunch, and school size).

Intervention Types

The intervention community received the multi-level intervention activities at the child, family, school, and community levels, as described below. The comparison community received two newsletters directed to the children.

Individual.

Children received four comic books modeled from the CDC’s BAM! Body and Mind “Immune Platoon” (CDC, 2017). The comic books also utilized messaging from the Go, Slow, and Whoa tool from the Coordinated Approach to Child Health (CATCH), which describes healthy food choices (Go), foods that should be eaten in moderation (Slow), and foods to avoid (Whoa) (Hoelscher et al., 2001; Luepker,

1996; Osganian, Parcel, & Stone, 2003; Perry et al., 1990; Perry et al., 1997). Participants in the comparison community received newsletters with healthy eating and physical activity messaging.

Family.

An eight-week curriculum focused on nutrition and physical activity was delivered to participants and their families by community health workers. The classes took place at various local community spaces that were accessible and convenient to participants and had space conducive to a classroom setting. Each module addressed approaches to a healthier lifestyle for the whole family and included an icebreaker, a didactic component on healthy eating or physical activity, a healthy recipe share, and group-based physical activity. The goal of these classes was to promote healthy behaviors among multiple generations as modeling behavior is important in motivating behavior change among children. The family classes created the space for families to learn and work together towards healthier lifestyles and, consequently, combat obesity within multiple generations.

School.

School level interventions included using GoNoodle, a computer-based program that provides activity breaks for teachers to implement in their classroom throughout the school day. Additionally, media literacy education was incorporated to teach children the roles marketing and advertising play in encouraging certain behaviors, especially unhealthy food consumption (Byrd-Bredbenner, & Grasso, 2000). The curriculum promoted strategies children can employ to think critically about how food marketing might affect their food choices, as well as ways to determine the healthfulness of a food product.

Community.

The community level intervention included a family night and community-wide open streets event, called a *ciclovía*. The family night served to kick off the study and included a healthy meal, learning about current nutrition and physical activity programming in the community, discussion about community-specific issues related to obesity, and group physical activity. The entire community was invited to the *ciclovía* event, which took place on July 14, 2017. Event activities included, but are not limited to, group Zumba, a bicycle riding course, organized physical activities for kids, and several booths promoting nutrition and physical activity, such as a fruit stand and information on Safe Routes to School. In addition,

the study team worked to build a partnership with the community farmers' market with the hopes of creating a synergistic impact with the interventions' nutritional components.

Participant Recruitment

Eligible participants included children in 3rd-5th grade who attended elementary schools in the intervention (3 schools) and comparison (2 schools) communities. Recruitment took place via recruitment packets distributed to children through their teachers. Packets were sent in two waves over a 6-week period, in which robocalls (reminder calls) to students to complete their packets and two packet pick-up days took place. Students who completed their packet were entered into a raffle to receive movie tickets. The packets included an option for parents to enroll their children in a subgroup that included an enhanced protocol with additional measurements (see data collection below). From September 12, 2016 to November 30, 2016, the study recruited a total of 665 children between the intervention (n=282) and comparison (n=383) communities to assess BMI. The recruitment response rate was 60% (62% comparison and 57% intervention). The subgroup of children were recruited to provide more information on nutrition and physical activity behaviors (n=205, about 100 students from each community). This subgroup was limited to third and fourth graders. Fifth graders were not included in the subgroup because they would be lost to follow-up after one year as they would have moved on to middle school. Of those that enrolled in the general height/weight assessment, 37% of participants from the comparison community and 52.9% of participants from the intervention community enrolled in the subgroup. This paper focuses on the data collected from this subgroup of children.

Data Collection

We collected information on anthropometric measurements (height and weight), diet, physical activity, sedentary behavior, and demographic data.

Height and weight data were collected at schools, by grade level, at baseline (T1) and 6-month follow up (T2). Community Health Workers (CHWs) from the research team set up data collection stations at the schools on pre-determined data collection days. Participants that were absent on measurement days were followed up with and were measured at a place of their preference. This was done for all 665 children. Baseline measurements were completed between November 17, 2016 and December 6, 2016 while 6-month measurements took place between May 17, 2017 and May 25, 2017.

The children in the subgroup were scheduled for a home visit to collect information on diet and physical activity. During the visit, CHWs administered a questionnaire on dietary patterns and provided the participant with an accelerometer device to capture their physical activity over a seven-day period. The participant was given detailed instructions on how to wear the accelerometer and informed to return the accelerometer at the end of the week period by scheduling a time for staff to pick it up, or by dropping it off at the Valley study office.

Measures

Height and weight.

CHWs followed a BMI Measurement and Quality Control Protocol to measure each child's height and weight. Height was measured in centimeters using a stadiometer. CHWs performed two initial measurements and a third one if the first two were not within 0.5 cm of each other. If the third measurement was different from the first two, they started over. Height was measured to the nearest 0.1 cm. Weight was measured using a scale set to measure in kilograms. Participants removed shoes and heavy outer garments before stepping on the scale. CHWs performed two initial measurements and a third if the first two were not within 0.2 kg of each other. If the third was different from the first two, the CHW started over. Weight was measured to the nearest 0.1 kg. CHWs recorded height and weight on the student's sheet.

Nutrition.

During the in-person visit for children in the subgroup, CHWs administered the Dietary Screener Questionnaire (DSQ), developed by the National Cancer Institute (National Cancer Institute [NCI], 2018). The DSQ was done in the child's preferred language. Data on dietary patterns was collected with a focus on fruit and vegetable consumption and sugar intake from sugar sweetened beverages (SSBs). Daily fruit and vegetable consumption was measured in cups while daily sugar intake from SSBs was measured in teaspoons.

Physical activity.

Subgroup participants' physical activity minutes and levels (light, moderate, vigorous) were measured using ActiGraph GT3X-BT accelerometers. Accelerometers were given to participants during the in-person visit. CHWs provided instructions on how to wear the accelerometer and reminded

participants to wear the accelerometer for seven consecutive days for at least 10 hours per day. All accelerometers were returned to the study team for data analysis.

Sedentary behavior.

The research team developed a Nutrition and Physical Activity Questionnaire to collect self-reported data on sedentary behavior, specifically the number of hours spent in sedentary activities. These activities included watching television, playing video games on a gaming system, playing games (on a tablet, smartphone, or computer) or using the internet, and sitting doing non-computer activities, such as homework, reading, and listening to music. For each of these activities, participants were asked how long they spent doing them on a usual school day and, separately, on a usual weekend day. Response categories ranged from “none” to “more than six hours.” The accelerometers also captured sedentary activity by collecting sedentary data in number of minutes per wear day. For the purposes of this evaluation, sedentary behavior assessment is limited to that of weekend days to distinguish it from sedentary time spent in school (i.e., sitting in a classroom learning).

Demographic data.

Demographic data was collected using the Study Screener Survey, completed by the parent/guardian of the participant. Demographic variables collected included total number of people and, separately, number of children living in the household; each child’s age, date of birth, grade level, teacher name, race/ethnicity, and insurance provider; and annual household income. See **Table 1**.

Procedure and Statistical Analyses

The purpose of this evaluation is to test the effectiveness of STRIDE in improving nutrition and physical activity behaviors among study participants. The analysis focused on participants in the subgroup as they provided data on physical activity and nutrition behaviors, as previously described. Data were analyzed for statistically significant differences between the intervention and comparison groups from baseline (T1) to 6-month follow up (T2) in relation to: (1) fruit and vegetable consumption, (2) sugar intake (from SSBs), (3) physical activity levels (light, moderate, and vigorous), and (4) sedentary behavior (including screen time). Within group analyses were also performed for each of these four categories to unveil significant differences between time periods by intervention arm. It is important to note that T2 was only a midpoint and participants had only received two comic books and school-level interventions (i.e.,

GoNoodle and media literacy education) by this point. Thus, the results show midpoint trends and do not capture a comprehensive intervention impact.

Nutrition behavior analysis: Research questions and hypotheses 1 & 2.

A t-test tested the difference in means, separately, of fruit, vegetable, and sugar intake between the intervention and comparison participants from T1 to T2, as well as differences within each group from T1 to T2. Further t-tests analyzed differences in fruit, vegetable, and sugar consumption for boys and for girls to unveil any differences in dietary patterns by gender between intervention arms from T1 to T2. See **Table 2.**

PA and sedentary behavior analyses: Research questions and hypotheses 3 & 4.

A t-test tested the difference in means of daily physical activity minutes and, separately, sedentary hours (including screen time) between the intervention and comparison participants from T1 to T2, as well as within group changes from T1 to T2. To assess any differences by gender between intervention arms, t-tests were conducted using data for girls, and, separately, for boys from T1 to T2. See **Tables 3 and 4.**

Results

Demographic Characteristics

Table 1 includes demographic characteristics of the subgroup (n=205: 101 comparison community, 104 intervention community). The mean age of participants was 9.4 years old and participants' gender was split evenly between girls and boys. Grade level was also evenly split between third and fourth graders. Race/ethnicity was significantly different between the intervention and comparison communities. Parents of participants preferred Spanish, followed by English. The mean number of people in participants' households was approximately five people, with about three people in the household being children. Over half of the participants' annual family income was less than \$35,000 per year, the next most common annual income category was \$35,000-\$50,000, followed by \$50,000 or more. The number of people living in the household, number of children, and family income were not significantly different between the intervention and comparison groups.

Table 1. Demographic characteristics by community.

Characteristic	Total	Comparison	Intervention	p-value (2-tailed)
N (%)	205	101 (49.3)	104 (50.7)	
Mean (SD) age, years	9.42 (0.613)	9.44 (0.629)	9.40 (0.598)	0.652
Sex, n (%)				0.298
Male	103 (50.2)	47 (46.5)	56 (53.8)	
Female	102 (49.8)	54 (53.5)	48 (46.2)	
Grade level, n (%)				0.944
3rd	103 (50.2)	51 (50.5)	52 (50.0)	
4th	102 (49.8)	50 (49.5)	52 (50.0)	
Race/Ethnicity, n (%) ^a				0.047
White	11 (5.45)	8 (8.00)	3 (2.94)	
Hispanic	167 (82.7)	86 (86.0)	81 (79.4)	
American Indian / Alaskan Native	8 (3.96)	0 (0)	8 (7.84)	
Multiple races chosen	16 (7.92)	6 (6.00)	10 (9.80)	
Language, n (%)				0.404
English	79 (38.5)	36 (35.6)	43 (41.3)	
Spanish	126 (61.5)	65 (64.4)	61 (58.7)	
Mean (SD) number of people in household, n ^b	4.95 (1.35)	4.99 (1.40)	4.91 (1.31)	0.684
Mean (SD) number of children in household, n	2.86 (1.21)	2.98 (1.29)	2.75 (1.11)	0.172
Income, n (%) ^c				0.451
<\$15,000	42 (22.5)	23 (25.3)	19 (19.8)	
\$15,000 to <\$35,000	55 (29.4)	25 (27.5)	30 (31.3)	
\$35,000 to <\$50,000	33 (17.6)	15 (16.5)	18 (18.8)	
\$50,000 or more	26 (13.9)	17 (18.7)	9 (9.4)	
Don't Know	31 (16.6)	11 (12.1)	20 (20.8)	

^aMissing values on 3 participants.

^bMissing value on 1 participant.

^cMissing values on 18 participants.

Nutrition

Changes across and within intervention arms.

Fruit consumption increased for both the intervention and comparison groups, with the intervention group consuming about 0.02 more cups than the comparison group. Vegetable consumption decreased for both groups, with the intervention group showing a smaller decrease compared to the comparison group. These differences were not statistically significant within or between groups. Within group analysis of sugar intake from SSBs shows that the intervention group decreased sugar intake,

although it was not statistically significant, while the comparison group significantly increased sugar intake (0.67 teaspoons; $p=0.002$). See **Table 2**.

Differences by gender.

Fruit consumption increased for boys regardless of their intervention assignment; the mean difference in consumption between intervention and comparison groups of boys was not significant. Within group analysis showed that vegetable consumption increased for boys in the intervention group, but decreased for boys in the comparison group; however, the difference in consumption between groups of boys was not significant. Within group analysis of sugar consumption from SSBs showed that boys in the intervention group reported a decrease in sugar consumption, while boys in the comparison group reported a significant increase in sugar consumption ($p=0.017$); the difference consumption between groups of boys was significant ($p=0.019$). See **Table 2**.

For girls, fruit consumption increased, vegetable consumption decreased, and sugar consumption increased regardless of the intervention group. Although both groups of girls showed changes in the same direction, there were mean differences between the groups, but they were not statistically significant. See **Table 2**.

Table 2. Mean change (T2-T1) of diet-related behavior by community and gender.

Diet-related behavior	Comparison	sig. (2-tailed)	Intervention	sig. (2-tailed)	Mean Difference	sig. (2-tailed)
Fruit consumption (cups)	0.045	0.541	0.067	0.324	0.022	0.825
Boys	0.066	0.587	0.117	0.255	0.051	0.745
Girls	0.027	0.767	0.009	0.922	-0.018	0.885
Vegetable consumption (cups)	-0.026	0.295	-0.000	0.991	0.026	0.523
Boys	-0.039	0.373	0.006	0.896	0.044	0.464
Girls	-0.015	0.589	-0.007	0.884	0.008	0.885
Sugar consumption, from SSBs (teaspoons)	0.670	0.002	-0.118	0.752	-0.788	0.071
Boys	0.807	0.017	-0.825	0.150	-1.63	0.019
Girls	0.550	0.060	0.706	0.120	0.156	0.764

Note: a negative value denotes a decrease in consumption from T1 to T2. Mean difference is from the perspective of the intervention group compared to the comparison group.

Physical Activity

Changes across and within intervention arms.

There was a significant difference from pre- to post-intervention in all three levels of physical activity (light, moderate, and vigorous) between the intervention and comparison groups ($p=0.009$, 0.012 , and 0.032 , respectively). Within group analysis showed that the intervention group reported an increase in light and moderate physical activity and a decrease in vigorous physical activity; the change in light physical activity was statistically significant ($p=0.007$). On the other hand, the comparison group reported a decrease at all three levels, with the decrease in moderate and vigorous activity being statistically significant ($p=0.005$ and $p<0.0001$, respectively).

Differences by gender.

Accelerometry data showed that both intervention and comparison groups of boys had a decrease in vigorous PA, with boys in the comparison group showing a significant decrease ($p=0.004$), thus revealing a significant difference between groups ($p=0.028$). Within group analysis showed that boys in the intervention group had a 1.40 minute increase in moderate PA, while boys in the comparison group decreased moderate PA; the difference between groups of boys was not statistically significant. Boys in the intervention group also increased their light PA by 11.3 minutes, while boys in the comparison group decreased their light PA; however, the difference between groups of boys was not statistically significant.

See **Table 3**.

Like the boys, girls showed a decrease in vigorous PA regardless of their intervention group assignment, with girls in the comparison group having a significant decrease in vigorous PA ($p=0.015$); the difference was not significant between groups of girls. Within group analysis showed that moderate PA increased for girls in the intervention group by 0.24 minutes, while girls in the comparison group had a significant decrease in moderate PA ($p=0.021$); however, the difference was not significant between groups of girls. Girls in the intervention group had a significant increase in light PA (14.6 more minutes; $p=0.029$), while girls in the comparison group decreased light PA; this difference was statistically significant between groups of girls ($p=0.030$). See **Table 3**.

Table 3. Mean change (T2-T1) of physical activity minutes (light, moderate, vigorous) by community and gender.

Physical Activity (PA)	Comparison	sig. (2-tailed)	Intervention	sig. (2-tailed)	Mean Difference	sig. (2-tailed)
Light PA (min)	-2.66	0.458	12.8	0.007	15.5	0.009
Boys	-2.56	0.644	11.3	0.095	13.9	0.118
Girls	-2.74	0.562	14.6	0.029	17.3	0.030
Moderate PA (min)	-2.68	0.005	0.862	0.414	3.54	0.012
Boys	-2.40	0.098	1.40	0.392	3.80	0.086
Girls	-2.93	0.021	0.242	0.851	3.17	0.079
Vigorous PA (min)	-2.83	0.000	-0.633	0.384	2.20	0.032
Boys	-3.47	0.004	-0.042	0.968	3.42	0.028
Girls	-2.27	0.015	-1.31	0.195	0.960	0.477

Note: a negative value denotes a decrease in physical activity from T1 to T2. Mean difference is from the perspective of the intervention group compared to the comparison group.

Sedentary Behavior

Changes across and within intervention arms.

According to both self-reported data and accelerometry, weekend sedentary behavior increased from pre- to post-intervention in the intervention group, while it decreased in the comparison group; the difference between groups, however, was not statistically significant. There was a discrepancy in sedentary time as gathered by self-reported data and accelerometry. Specifically, both the intervention and comparison groups' self-reported sedentary time was higher than that captured by their accelerometers. This discrepancy is discussed further in the discussion section. Self-reported weekend screen time increased for both the comparison and intervention groups from pre- to post-intervention; the difference between groups was not statistically significant. See **Table 4**.

Differences by gender.

Boys in both the intervention and comparison groups reported an increase in screen time on weekend days. Within group analysis showed that boys in the intervention group reported about 6.30 less minutes of screen time from pre- to post-intervention than boys in the comparison group, but the difference was not significant between groups of boys. Self-reported data and accelerometry data both show that boys in the intervention group increased sedentary time on weekend days from pre- to post-

intervention, while boys in the comparison group showed a decrease on both measures; however, the difference was not statistically significant between groups of boys on either measure. See **Table 4**.

Like the boys, girls in both groups reported an increase in weekend screen time. Within group analysis showed that girls in the intervention group reported 5.22 more minutes of screen time from pre- to post-intervention than girls in the comparison group; the difference, however, was not significant between groups of girls. Also like the boys, according to both self-reported and accelerometry data, girls in the intervention group showed an increase in sedentary time on weekend days, while girls in the comparison group showed a decrease on both measures; the difference between groups of girls was not significant on either measure. See **Table 4**.

Table 4. Mean change (T2-T1) of sedentary behavior and screen time by community and gender.

Sedentary Behavior	Comparison	sig. (2-tailed)	Intervention	sig. (2-tailed)	Mean Difference	sig. (2-tailed)
Self-reported weekend sedentary time (hour)	-0.149	0.489	0.226	0.433	0.375	0.299
Boys	-0.181	0.614	0.152	0.686	0.333	0.526
Girls	-0.120	0.641	0.312	0.488	0.432	0.390
Accelerometer-measured weekend sedentary time (min)	-1.35	0.864	5.49	0.571	6.84	0.583
Boys	-2.37	0.820	2.86	0.841	5.23	0.772
Girls	-0.453	0.969	8.514	0.517	8.97	0.608
Self-reported weekend screen time (hour)	0.144	0.490	0.144	0.601	0.001	0.998
Boys	0.266	0.464	0.161	0.670	-0.105	0.842
Girls	0.037	0.872	0.125	0.761	0.087	0.847

Note: a negative value denotes a decrease in sedentary/screen time from T1 to T2. Mean difference is from the perspective of the intervention group compared to the comparison group.

Discussion

This study examined the effect of a community-based multi-level obesity prevention intervention on dietary intake and physical activity behaviors among children in a rural community of the Lower Yakima Valley of Eastern Washington. Our most significant finding was that children in the intervention group had significantly more physical activity at all three levels from pre- to post-intervention compared to

the comparison group. Changes in dietary behaviors moved in the same direction for both groups, with the exception of sugar consumption, which decreased in the intervention group and increased in the comparison group. Weekend sedentary behavior increased in the intervention group, while it decreased in the comparison group, but both groups increased weekend screen time. Significant gender effects between intervention and comparison groups were seen in that intervention boys consumed significantly less sugar and had significantly more vigorous PA than comparison boys, while intervention girls had significantly more light PA than comparison girls.

Significance of Findings

There were small changes in diet and physical activity behaviors among the intervention group. When compared to children in the comparison group, the findings reveal that the intervention is producing a trend in moving some behaviors toward the hypothesized direction, even if not statistically significant. A review of other interventions on obesity in children six to twelve years old show some consistent findings on children's diet and physical activity behaviors, as described below (Waters et al., 2011).

Nutrition.

Although the difference in fruit consumption was not significant between intervention and comparison groups, it did increase, as hypothesized, while vegetable consumption did not. In reviewing other childhood obesity prevention trials at the school level, one randomized control trial (RCT) employing a diet and PA intervention reported a significant increase in self-reported fruit and vegetable consumption among the intervention group at 6-month follow up (Gentile et al., 2009). Another RCT intervention implemented a game-based intervention in school classrooms to increase nutrition knowledge, which could be compared to GoNoodle videos with nutrition education content. This study showed that the intervention group had a significant increase in weekly vegetable consumption compared to the control group at 6-month follow-up (Amaro et al., 2006). However, unlike STRIDE, these studies' 6-month data collection periods were inclusive of all intervention activities, thus contributing to a strong intervention effect, while STRIDE participants had only received part of the intervention by this same time point. Therefore, STRIDE's limited intervention effect on dietary intake is likely due to the fact that the intervention had only been going for four months at T2 data collection, by which point the intervention group had only received two comic books and the school-level activities. It is expected that a greater

intervention effect will be seen at 18-month follow up, by which point the intervention group would have also received the family and community-level interventions.

Sugar consumption from SSBs did decrease at 6-month follow-up in the intervention group, although not significantly. Other interventions targeting children's SSB consumption have also shown reduced intake, albeit insignificant, of sweetened/carbonated beverages compared to a control group (Hamelink-Baksteen, Houben, Bun, & De Wit, 2008; James, Thomas, Cavan, & Kerr, 2004; Sichieri, Paula Trotte, de Souza, & Veiga, 2009). However, these changes were seen at the end of the intervention, while STRIDE participants were already showing a decreasing trend at the midpoint. This comparative analysis suggests STRIDE participants may show a significant decrease at 18-month follow-up. On the other hand, continued insignificant results may be resultant of the fact that the intervention activities did not include changes to the food environment; high availability of SSBs and unhealthful foods, as well as limited access to fruits and vegetables may counteract intervention effects.

Although there was an overall decrease in sugar consumption among the intervention group, it is important to note that girls in the intervention group were less likely to report decreased sugar intake (mean change=0.70 teaspoons) than boys (mean change=-0.82 teaspoons). The fact that intervention boys decreased their intake while girls increased their intake suggests the need for tailored messaging to encourage less sugar intake from SSBs among girls. Further research might explore which kinds of SSBs girls may be more likely to drink, or drink more of, so that health messages and education can be targeted specifically around those SSBs. Additionally, STRIDE interventions might be adapted to include water promotion to educate participants about the benefits of drinking water, including health, cost, and availability. Intervention girls also had less of an increase in fruit consumption and decreased vegetable intake, further emphasizing the need for tailored messaging for girls.

Physical activity.

Interestingly, many studies in Waters and colleagues' (2011) systematic review examining intervention effect on childhood obesity prevention did not find significant differences in physical activity between intervention and control groups of six to twelve year old children, while STRIDE did. This suggests a strong intervention effect for STRIDE's physical activity interventions as significant changes were seen at all three levels of physical activity (light, moderate, and vigorous) between the intervention

and comparison groups. It is also possible that there was an overemphasis on PA at the time of T2 data collection and that the midpoint results are a reflection of this. Nonetheless, it is important to mention that although children had a brief exposure to the intervention, we saw significant changes in light physical activity. Children in the intervention groups increased their light physical activity by an average of 12.82 minutes per day. This significant finding may be a reflection of children engaging in physical activity in steps – that is, moving into light physical activity and hopefully even further to MVPA. Increased MVPA is hypothesized to be observed at final follow-up as the intervention group hopefully continues to advance step-by-step into reaching physical activity recommendations.

The significant increase in light physical activity among the intervention group was largely due to girls in the intervention group significantly increasing their light physical activity, revealing the effectiveness of STRIDE in encouraging girls to be more physically active in steps. This has important implications considering that, according to baseline data, girls in the intervention group were more likely than boys to be less physically active. The small degree to which girls were engaging in MVPA is consistent with other research – one study found important barriers to increasing physical activity in some girls with lack of social support, resources, and suitable places for physical activity limiting their real or perceived ability to adhere to a physical activity intervention program (Robbins, Gretebeck, Kazanis, & Pender, 2006). STRIDE is helping to change that pattern as the intervention appears to encourage girls to initiate more physical activity behaviors and they do so by starting slowly with light activity.

Sedentary behavior.

Contrary to our hypothesis, children in the intervention group increased sedentary behavior and screen time on weekend days. At first glance, it may be construed as the intervention having a reverse effect on sedentary behaviors; however, at a closer look, it may be a reflection of children's awareness of their own sedentary behaviors. Specifically, we saw a large discrepancy in sedentary behaviors reported via the Nutrition and Physical Activity Questionnaire and captured by accelerometry, with questionnaire data showing a larger increase. The fact that both boys and girls in the intervention group reported that they were more sedentary during weekend days than was measured by their accelerometers suggests that participants in the intervention group may have a broader definition of what constitutes sedentary time than what is picked up by the accelerometer. For example, participants might consider using

GoNoodle on the weekend to be sedentary time as they are using the internet (which was included as sedentary behavior in the Nutrition and Physical Activity Questionnaire), but may have actually been physically active during GoNoodle, which would have been picked up by their accelerometer. In other words, including the internet as a sedentary activity when many physical activity exercises are disseminated through internet-based videos – including on GoNoodle and in the family classes group physical activity – leaves the potential for participants to report these activities as screen and/or sedentary time. Thus, these behaviors may have been inflated due to the overlap in definitions on the Nutrition and Physical Activity Questionnaire. Discrepancies seen between the data collection methods emphasize the need for more research on including tighter definitions of sedentary behavior in self-report instruments.

Other studies have found a similar lack of change in self-reported screen viewing between intervention and control groups of children (Gentile et al., 2009; Harrison, Burns, McGuinness, Heslin, & Murphy, 2006; Paineau et al., 2008). Future research may want to examine this topic further by combining a daily log with accelerometry data, or by otherwise assessing time spent in schoolwork, art, and reading, and aim to define sedentary behavior more acutely. The Nutrition and Physical Activity Questionnaire questions should be re-worded to mitigate confusion with internet-based physical activities (e.g., GoNoodle) and internet-based sedentary behavior (i.e., online computer games that do not require bodily movement). Focus groups with children could help inform better language use to ensure the questions are interpreted as intended by the researchers.

Finally, the increase in sedentary behavior and screen time among intervention group boys and girls is particularly interesting given that STRIDE was effective in increasing light and moderate physical activity – especially the former – among intervention group participants. Although it makes logical sense that increasing physical activity leaves less time for sedentary behavior, it is important to note that analysis of sedentary behavior was limited to weekends (for reasons previously mentioned) and thus one could argue that the increases in physical activity happened during the week while sedentary time remained high on the weekends. If this were the case, school-level physical activity intervention activities (e.g., GoNoodle) might be responsible for the increases in physical activity and future studies might develop strategies to emphasize home-based physical activity opportunities to help children achieve the CDC-recommended 60 minutes of MVPA every day, including the weekend (CDC, 2015).

Alternative Explanations to Findings

As shown in the socioecological framework, there are many levels of influence around individual behavior. Thus, given the multi-level nature of STRIDE, it is difficult to tease out which intervention level was most responsible for behavior changes. Furthermore, it is possible that environmental and social factors unrelated to the study contributed to participants' dietary and physical activity behavior changes.

Because the only significant result between intervention and comparison groups was that of physical activity, I limited my search for alternative explanations to this part of the intervention. To my knowledge, there were no concurrent physical activity programs taking place in addition to STRIDE in the intervention schools from baseline to follow-up. However, participation in organized sports during the 6-month follow up period may have caused participants to increase their physical activity from baseline. In addition, the use of GoNoodle may have led students to seek out other internet-based physical activities (e.g., YouTube exercise videos) to increase their physical activity. Although not STRIDE activities, the STRIDE intervention may increase the potential for participants seeking out other ways to be physically active, which would contribute to STRIDE's aims.

Limitations

The findings that were not significant or revealed changes that did not go in the hypothesized direction suggest limited intervention effect during the 6-month follow-up period. More significant changes in dietary, physical activity, and sedentary behaviors likely require a longer follow-up period. This is corroborated in childhood obesity prevention research reviewed by Waters and colleagues (2011), several studies of which reveal limited changes at 6-month follow-up. This review reveals findings that suggest successful interventions see desired effect at 12 months, with less sustained effects at 2 year follow-up (Waters et al., 2011). Thus, analysis of 18-month data may show more statistically significant differences in diet-related and physical activity behaviors among participants in the intervention community.

For example, vegetable consumption remained low at 6-month follow-up. It is plausible that given many children's dislike of vegetables, changing vegetable consumption requires more time to overcome distaste of certain vegetables (e.g., broccoli) and to try new vegetables they enjoy. The fourth installment of the comic book series (distributed after 6-month follow up) aims to address this – the main characters

encourage their friends to try a vegetable they do not like because it may give them superpowers. This illustration may change children's attitudes towards vegetable consumption, and 18-month follow up data may capture this change. If so, future research should aim to understand the nuances that encourage children to initiate the behaviors modeled by STRIDE comic book characters, or other like-minded messages.

Another limitation of this analysis is that it relied on participants' self-reported data to evaluate changes in dietary and sedentary behaviors pre- and post-intervention. Participants' self-reported data may have been subject to social desirability bias. For example, intervention participants may have under-reported sugar consumption from SSBs given that they learned high sugar intake has ill health consequences. This is supported in one study that found significant underestimates of sweetened beverage preferences (Klesges et al., 2004). The same study found overestimates of self-reported activity were related to social desirability (Klesges et al., 2004). Thus, self-reported data may be biased with what the participants thought they should or should not be eating or drinking or how active they thought they should be, as opposed to actual intake or activity. This calls for more research into the accuracy of self-reported instruments and for methods to corroborate self-reported data.

Another limitation is that STRIDE did not look at the influence of the built environment, which is suggested by the socioecological framework as an important factor for encouraging desired behavior change (CDC, 2018). Furthermore, the environmental level is of special significance given barriers to accessing healthy food and physical activity opportunities in rural areas. Thus, the small changes we saw could have been due to limited access from more macro-level forces, such as access to a grocery store to purchase healthy foods, or community safety in terms of opportunities for physical activity at home.

Because this intervention targeted Hispanic children in a resource-limited setting of a rural community, the results may not be generalizable to children in urban populations or of other racial/ethnic communities. However, given that the intervention was implemented in a resource-limited setting suggests that this intervention may be more accessible in terms of its feasibility across settings of differing research and intervention capacities.

Implications for Future Research and Practice

The implications from this research will contribute to the body of knowledge for preventing obesity among Hispanic children in rural settings, thus working to reverse the disproportionate burden of obesity faced by this population. Our formative research aimed to leverage community members' setting-specific understanding of healthy food and physical activity access barriers, both observed and perceived. Future research should further explore how environmental changes can be included in STRIDE-like interventions in rural communities to improve dietary and physical activity behaviors. For example, research could include speaking with children to better understand the environmental barriers – real or perceived – to engaging in MVPA, especially at home, as weekend sedentary behavior remained high. School-level activities to promote nutrition might include cafeteria remodeling to make healthy food choices more visible and attractive, as shown with the successful Smarter Lunchroom Movement (Smarter Lunchrooms Movement National Office, 2017). Continued research should consider community asset mapping to help ensure limited resources are prioritized to changing behaviors of particular concern, such as low MVPA minutes and low vegetable consumption among children.

In addition, discrepancies in sedentary data from self-report and accelerometry disclose the need for more research regarding the reliability of self-reported instruments compared to observational or technological tools, such as accelerometers. Such research can help inform adaptations to self-report instruments to better elicit the determinants of sedentary behaviors that need to be specifically targeted by future obesity prevention interventions. Furthermore, tighter definitions of sedentary behavior should be developed to better distinguish sedentary behaviors from screen-based physical activities. Questionnaires might also consider gathering data on different types of 'productive' sedentary behaviors, such as art, reading, or doing homework, to explore patterns in different types of sedentary activity among children.

Finally, our preliminary findings suggest that diet and physical activity behaviors can be resistant to significant change, especially given a short time period. This research and future work will benefit from prolonged intervention follow-up periods targeting important underlying factors to behavior change, such as environmental factors. Moving the needle on these macro-level factors increases the reach of obesity prevention practices by changing infrastructure and policies where the people are, thus offering a place

where anyone can easily engage in healthy lifestyle choices. Moreover, changing the environment in which children live, play, and learn reaches across generations, therefore increasing the potential for sustainability as the environment works to make the healthy choice the easy choice for everyone.

Conclusion

Our findings help fill a gap in knowledge about nutrition and physical activity behavior change among Hispanic children in rural communities, yet also suggest there are greater forces at play than individual change. The intervention had a significant effect on increasing physical activity levels for the intervention group compared to the comparison group, and revealed small but meaningful improvements in fruit consumption and sugar intake from sugar sweetened beverages among children in the intervention group. Vegetable consumption remained largely unchanged, but is likely to increase as at later follow-up as children's attitudes towards eating vegetables improve and taste preferences expand. Sedentary behavior was resistant to change, but our findings suggest that children likely move towards being more active step-by-step, eventually leading to more vigorous levels and extended periods of physical activity. The innovativeness of STRIDE's multi-level framework can be stretched by future researchers to target macro-level factors, such as school nutrition programs or access to physical activity spaces, to help further close the gap in disparate access to healthy food and physical activity opportunities for children in rural communities.

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