Food as Medicine:
Measuring Food Security in a Pilot Food Prescription Intervention

By

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Abstract

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Food insecurity predisposes individuals to poor diet, thereby increasing risk for diet-sensitive chronic conditions. Clinics across the country have started to institute food insecurity screening to identify patients who merit a priority for diet improvement. Estimates from pediatric populations suggest a household food insecurity rate of 31% (Bottino et.al, 2017), though less is known from predominantly Latino patient populations. The objective of this study was to 1) Identify the rate of food insecurity among families of pediatric patients during identification of households eligible for intervention, and 2) Report impact of a 3-month intervention of home-delivered vegetables and whole grains on food security status and dietary outcomes. Protocol was approved by the quality assurance board of the clinic as well as the Institutional Review Board (IRB) of the investigator academic institutions. The study design involved 1) Descriptive statistics of clinic food security screening; 2) Pre- and post-analysis of a pilot intervention study. From July 2018-January 2019 at a Federally Qualified Health Center (La Clinica de la Raza), screening for food insecurity was conducted with parents of patients 9-11 years presenting for a wellness check or routine follow-up visit who resided in Oakland, CA. The medical assistant asked a 2-item tool that screens for food insecurity (Hunger Vital Sign). Families who screened positive (one or both questions affirmative) were eligible for a pilot study, Food as Medicine (FAM), and enrolled as parent-child dyads. Main outcomes included 1) Screening results from recruitment and 2) measurements of the subset recruited for the pilot study: 18-item module and anthropometric measures (i.e. height, weight), and dietary income measures including frequency of vegetable consumption for child and parent, consumption of variety of vegetables, cooking/eating behaviors, parent preparedness to provide vegetable and whole grains, and parent perceptions on diet. A total of 180 caregivers were screened for food insecurity, and overall, 35% screened positive for food insecurity. Among Spanish-speaking households (n=158) 33% were food-insecure. Of the 57 families who screened positive for food insecurity, 30 were enrolled in the pilot study along with their child (9-11 years) attending the clinic visit. Of the initial participant dyads, 24 returned for a follow-up visit post-intervention, and had a follow-up phone call 4 months later and responses for 21 families was available. All families, who had been identified because of 2-item screen for food insecurity, were confirmed as being food-insecure when assessed with the full (18-item) food-security questionnaire, with 60% in the most severe category (‘very low food security’). There was a shift toward better food security and remained toward better food security at the 4 months follow-up phone call. Anthropometric measures showed that caregivers had a lower diastolic blood pressure at follow up compared to pre-intervention with a p-value of 0.04. Diet behaviors also improved among caregivers showing

improvement in daily vegetable frequency consumption which was significant with a p-value of 0.0…..This study used screening for food insecurity in a pediatric clinic and identified one-third of the patient (age 9-11 years old) population to be food insecure. This pilot food prescription program demonstrated improvements in food insecurity and in caregiver consumption of vegetables and variety eaten in a meal. It demonstrates the potential for implementing a food prescription that connects families who are food insecure and at high risk of for having poor diet quality

Part I: Literature Review on Food Insecurity and Clinic Interventions

Introduction

In 2017, 11.8% of US households were labeled as 'experiencing some form of low food security'. However, households with children, particularly Latino households reporting food insecurity at higher average prevalence of 18.5% (Coleman-Jensen, Gregory, & Singh, 2015), are especially vulnerable and experience food insecurity at higher rates. Understanding the impact of food insecurity in the United States goes beyond reported percentages and knowing that millions of households are affected. Food insecurity in a sense is the measurement of a prevalent food resource inequity that is associated with poor health outcomes. Transient periods of unreliable food availability and access, results in substituting nutrient-rich foods such as fruits and vegetables for calorie dense, cheaper, and highly palatable foods that are high in sodium and sugar content (Crawford & Webb, 2011). This fuels what has come to be known as the 'hunger-obesity paradox,' where obesity in youth sets the stage for increased risk of diet-related chronic disease such as diabetes and cardiovascular disease.

Food insecurity is associated with poor health outcomes in children and families, Families who are low-income are impacted the most because of their already limited resources. As a result, families tend to provide their children with a less nutrition rich dense diet that has been found to lead to poor health behaviors present day. Food insecurity touches on some of the more complex systematic issues that results in insufficient money for families to pay for the necessities of life. This manifests in poor health outcomes (stress, loss of dignity, school absenteeism, and increased risk of diet-sensitive chronic diseases). There is an opportunity for clinic-based approaches to improve nutrition among families who have difficulty obtaining a balanced diet due to resource constraints.

How is food security defined

In the United States, food security is defined by the USDA Economic Research Service (ERS) as 'a household-level social and economic condition that is characterized by having adequate food availability'. Food security can further be understood as the actual experience of obtaining a reliable and nutritionally adequate food source. A household or individual who has low to very low food security can experience one, some, or all forms of the following, 1) Not having an adequate quantity of food available for consumption in general for a household; 2) Not having nutritionally adequate food available in the household; and 3) The need to resort to emergency food supplies or other "socially unacceptable" means such as scavenging, stealing, or other means of obtaining food other than purchasing. Further assessments of food security have included additional categories such as the availability of food but having physical (i.e. transportation) or other constraints such as limited functionality from older age to prepare nutritionally adequate meals (Blumberg, Bialostosky, Hamilton, & Briefel, 1999). While important to include, this cause for food insecurity experience, it is much less prevalent compared to the economic constraints experienced among many more food insecure households.

Food security has gone through several iterations of definitions since it became a recognized public issue in the United States in the late 1960s during which period several social programs that had been created in the 1930s from the New Deal were being further developed by the War on Poverty

efforts of President Lyndon B. Johnson. Since its inception, food insecurity has been commonly been referred to as 'hunger' with measurements focusing on malnutrition and medical concerns for poor dietary intake that were indirectly measured by using poverty and food assistance program participation as proxies to predict outcomes (Wunderlich, 2006). Just as individual household reports of food insecurity fluctuate throughout the year and across several years, widespread U.S. food insecurity fluctuates and follows, to an extent, the availability of assistance programs. In the 1980's worsening economic conditions and limits in federal spending resulted in increased reports of in food insecurity. Due to the ongoing need to understand the prevalence of widespread hunger in the United States, Congress brought forth the National Nutrition Monitoring and Related Research Act in 1990 to implement a 10-year plan to assess the dietary intake and nutritional status of the United States population for the first time (Wunderlich, 2006).

Measuring food insecurity: Development of USDA questionnaire

Under the direction of Eleanor Singer and the Center of Survey Methods Research (CSMR), a representative food security questionnaire, titled the Food Security Supplement (FSS), was developed as a supplement to the Current Population Survey. While this survey contained more than 70 questions, there are subsections, including the Household Food Security Survey Module (HFSSM) that contains a set of 10 questions for those households without children, and a set of 18 questions for households with children. From here, the widely recognized gold standard of USDA food security measurement still in use currently came to be. The 18-item USDA HFSSM questionnaire has gone through several iterations of validation, less so in current years, and is used for assessing food security status and stratifying severity among U.S. households (Coleman-Jensen et al., 2015). The 18 questions ask about progressively more severe situations of food insecurity beginning with food anxiety (concerns or stress over having sufficient food supply), monotony of the diet (variety, quality, desirability), adult restriction of food (cutting down food portions only for adults in a household), and finally child restriction of food (food resources are so scarce children also experience depletion in meal portions) (Kersten & Beck, n.d.). Faced with scrutiny over the stigmatization that results from labelling a household as food insecure, the USDA brought out new language in 2006 to explain the levels of food security status.

	Earlier Version	2006 Current Categories Version
Food Secure	Food Secure	High Food Secure
		Marginal Food Secure
Food Insecure	Food insecurity without hunger	Low Food Security
	Food insecurity with hunger	Very low food insecurity

Table 1: Household Food Security Status-Categorical Measure. *Adapted from the USDA ERS*

Identifying food insecurity among households with children

Food insecurity is a dynamic process that changes in response to fluctuations in resources available to a household. (Ryu & Bartfeld, 2012). Among households reporting food insecurity, it is typically present 7 out of the 12 months in a given year (Kersten & Beck, n.d.). Additionally,

having enough food is described in the context of having the energy sources for an active and healthy life (Coleman-Jensen et al., 2015; Hager et al., 2010). It is important to understand that food insecurity is more than hunger a family experiences from not having enough food available to consume. Any person can experience hunger physiologically. Food insecurity refers to having an insecure access to food that is enough for having a healthy and active life. As a result, many food insecure families tend to use coping mechanisms to stretch their limited resources. This requires more time planning for finding the family's next meal and makes it difficult for families to engage in healthy behaviors. (Kersten & Beck, n.d.).

Overall households with children have an average food insecurity prevalence of 16.50%, this includes both categories of food insecurity (low food security and very low food security). In many cases where a household experiences food insecurity, adults prioritize children's appropriate food intake and will usually shield children from food restriction and hunger, even in households that report the most severe degree of food insecurity (very low food security). About 2.9 million households who are food insecure do report children also experiencing the effects of being food insecure with about 250,000 US households experiencing food insecure so severe that children experience a disrupted eating pattern with periods of hunger (Coleman-Jensen et al., 2015), this prevalence has remained virtually unchanged in the succeeding years with the most recent report from ERS in 2017.

Poor dietary intake is the most common outcome among food insecure households with children. It's been long understood in the literature that parent feeding practices influence how children will develop their health behaviors. Particularly in low income families, this becomes a greater challenge due to several barriers and results in poor diets and poor health outcomes. While ERS reports that food insecurity overall decreased from 12.3% in 2016 to 11.8% in 2017, with a decrease in the proportion of families in the most severe category (very low food security) from 4.9% to 4.5%, the prevalence among specific minority groups and households with children have not had significant decreases (Gerards & Kremers, 2015)**.** This suggests that families from the lowest income bracket with concurrent experience of food insecurity would greatly benefit from intervention to relieve the strains of having insecure food access.

The American Dietetic Association called for a systematic and sustained plan of action to achieve food and nutrition security for the entire United States population. They include the need for funding, increasing use of food and nutrition assistance programs, education incorporation in these programs, and finally to promote economic self-sufficiency in households as an acknowledgement of more systematic and institutional barriers to families achieving food security. Advice for addressing low food security includes using trained dieticians, and the collaboration of practices and research to create a safe, secure, and sustainable food supply, and the use of advocacy at several government levels. (Holben, 2010) (Makelarski, Abramsohn, Benjamin, Du, & Lindau, 2017)

Food security measurement in the clinic setting

Health care and social service providers are in a position to intervene with children and families to mitigate the effects of having a low-quality diet (S. Smith, Malinak, Chang, Schultz, & Brownell, 2017). However, because food insecurity is "invisible," it is worthwhile to understand

how to screen for household insecurity among the patient population in order to know how to reach families and individuals in need of intervention.

While more comprehensive, the 18-item Household Food Security Survey is too inefficient for healthcare providers to administer in a clinic setting. As a result, 6 questions of the 18 items were identified from the Current Population Survey in April 1995 and Blumberg et al. validated this 6-item HFSS form to use for national and state/local applications. The 6-item survey has a high sensitivity of 98% and specificity of 92% against the 18-item HFSS, the study did acknowledge that it may be less accurate in identifying food insecure households with certain characteristics, such as those with children (Blumberg et al., 1999). Further efforts to identify a shorter screening tool to use in clinic settings resulted in use of 1 or 2 questions taken from the 18-item HFSS. In 2010, in collaboration with Children's Healthwatch, Hager et al. developed a 2-item screening tool consisting of the first 2 questions of the 18-item HFSS seen on Figure 2. It has a high sensitivity 97% and 83% specificity against the 18-item HFSS. This is known as the Hunger-Vital Sign tool that has been more popularly used in clinic settings to identify families who may be experiencing food insecurity (Hager et al., 2010). It found that most food insecure families responded yes to questions 1 (97%) and 2 (81.9%) of the USDA 18-question survey, with a sensitivity of 97% and specificity 83%.

The Hunger-Vital sign has remained a popular screening tool and highly sensitive used in its original form. The American Academy of Pediatrics endorsed HVS although with an adaptation to the response categories for the two questions. Rather than having the original three response categories, 'Often', 'Sometimes', 'Never', the AAP suggested simplifying the responses to 'yes' and 'no'. A prospective diagnostic accuracy study was conducted in 2016 comparing the HVS and AAP form and found the original Hunger-Vital Sign tool to be more sensitive therefore recommending the continued use of the 3 response categories rather than further condensing the tool (Makelarski et al., 2017). It has remained a widely used tool in clinics and has continued to be recommended when compared to new suggestions of 1 question screening tools (Torres, De Marchis, Fichtenberg, & Gottlieb, 2017).

A positive screen requires a response of "often true" or "sometimes true" to either or both of the following statements: • "Within the past 12 months we worried whether our food would run out before we got money to buy more." • "Within the past 12 months the food we bought just didn't last and we didn't have money to get more."

Table 2: Hunger-Vital Signs 2 Question Item Screening Tool. *Hager ER, Quigg AM, et al. Development and Validity of a 2-item Screening to Identify Children and Families at Risk for Food Insecurity. Pediatrics. 2010.* (Hager et al., 2010)

Role of clinics in assessing food security

Screening for social determinants of health, has been increasingly utilized within primary care healthcare centers and emergency departments. Incorporating screening tools to specifically assess food security as a part of clinic workflow allows healthcare providers to connect families

experiencing food insecurity to services. Patients and providers have reported acceptance of screening tools in clinics especially if there are available and known resources for identified households to be referred (Torres et al., 2017). However, offering resources does not take the place of a formal screening for food insecurity. Bottino et al studied the use of referrals for identifying households experiencing food insecurity. Among 340 caregivers of pediatric patients ages 3-10, 57 (16.8%) reported both food insecurity and request for a referral. (Bottino, Rhodes, Kreatsoulas, Cox, & Fleegler, 2017). This incomplete overlap of food insecurity and request for resources highlight the existing stigma associated with experiencing food insecurity and the need for universal screening with adjunct referrals rather than either screening or referrals being given alone. Pediatric clinics are at the forefront of efforts to universally screen for food insecurity to begin intervention efforts to prevent the short- and long-term health outcomes associated with food insecurity (Schwarzenberg, Kuo, Linton, & Flanagan, 2015).

Food Insecurity and Health Outcomes

Food insecurity affects a variety of health outcomes in children this includes both socio-cognitive disruptions and increased risk for development of chronic diseases. Earlier research focused on relationship between food insecurity and poor academic achievement and psychological and cognitive functioning (Jyoti, Frongillo, Jones, & Al, 2005) (Kleinman et al., 1998). In more recent years, understanding the effects of food insecurity on children has been better understood with research that has been done on risk factors leading to diet-sensitive chronic disease among adults. These include increased risk for development of chronic diseases like type 2 diabetes (Hilary K. Seligman, Bindman, Vittinghoff, Kanaya, & Kushel, 2007), cardiovascular disease, and hypertension (Mendy et al., 2018), as well as poor associated disease management (Holben, 2010) (Makelarski et al., 2017) and inadequate nutrient intake. Currently there is much less research on food insecurity and disease risk among children.

Food insecurity and health outcomes among adults

Seligman et al, used data from NHANES 1999-2002 to find that among 4432 adults who were low income and some level of food insecure were found to have higher prevalence of type 2 diabetes, with those in the most severe food insecure category having the highest prevalence of 16.1% (Hilary K. Seligman et al., 2007). Cardiovascular disease, another public health concern, along with high blood pressure have been found to be associated with food insecurity. A surveillance survey conducted in Mississippi in 2015 consisting of 5800 participants found that individuals who were food insecure were 50% more likely to also have high blood pressure, or diabetes and low vegetable and fruit intake (Mendy et al., 2018). Food insecurity has also been found to be associated with poor disease management (Holben, 2010), as seen in a study of patients with diabetes nested from a larger study on cardiovascular disease and health literacy. It was found that among 40 low income patients who were food insecure, there was poor glycemic control and adherence to medications. (H. K. Seligman, Jacobs, Lopez, Tschann, & Fernandez, 2012).

Food insecurity and health outcomes among children

Children who experience persistent food insecurity throughout childhood are at higher risk for poor health outcomes later in life. The Early Childhood Longitudinal Study-Kindergarten cohort followed students beginning in kindergarten in 1998-1999 up until 8th grade. A secondary analysis of this study reported food security based on 4 observation years and estimated cumulative food security and health outcomes. It found that long term persistent food insecurity over a 9-year period

was related to lower health status among students in 8th grade (Ryu & Bartfeld, 2012). More specifically, there is a small growing body of research showing a potential association between food insecurity and prediabetes risk. Mendoza et al, used observational study data from SEARCH for Diabetes in Youth obtained in 2001, questionnaires on current status and blood samples to obtain HbA1c levels. While there was no significant association found between food insecurity level and HbA1c level, there were findings to show that youth from households with lower food security would have poor glycemic control (Mendoza et al., 2018). However, another study by Landry et al, conducted a cross-sectional study on 218 low income Latino 3rd-5th grade students living in Los Angeles CA who had participated in a school based nutrition intervention found that food secure children had 2.4% lower glucose values and food insecure children had greater insulin resistance (Landry et al., 2018).

Food insecurity and inadequate nutrient intake

Inappropriate consumption of fruits and vegetables contributes to many of the diet sensitive chronic disease associated with food insecurity. Poor nutrient intake explains the link between food insecurity and several health outcomes. Studies have shown that fruits and vegetables have a protective role in cancer prevention, coronary heart disease, and strokes as well as emerging data on the protective role in cataract formation, chronic obstructive pulmonary disease, diverticulosis, and hypertension (Van Duyn & Pivonka, 2000) (Sharpe, Whitaker, Alia, Wilcox, & Hutto, 2016)**.** Inadequate nutrient intake is closely associated with an unbalanced diet low in fruit, vegetables, and whole grains. The USDA dietary guidelines for Americans recommends a specific cup amount of daily fruits and vegetables depending on age, sex, and activity level. In general, the U.S. population's diet consists of very little fresh produce (Olsho et al., 2015). Few adults in the U.S. meet the daily recommended fruit and vegetable consumption (Sharpe et al., 2016) and less than 10% US children and adolescents eat the daily recommended amounts of fruits and vegetables, 3 cups a day for children ages 9-11 for example. The USDA Fresh Fruit and Vegetable program assessed whether providing simple access to fresh produce would lead to increasing the percentage of children in the U.S. that met the daily recommended amounts. While they found that participating children increased their intake by 1/3 of a cup per day, it was still not enough to successfully consume the recommended daily amount (Olsho et al., 2015). It is important to note that the Dietary Guidelines for Americans is currently under review and updates may change what is an appropriate daily fruit, vegetable, and whole grain daily amount.

Food security status further impacts availability of fruits and vegetables in a home. Price has been noted as one of the most significant barriers to purchasing nutrient-dense food (Darmon & Drewnowski, 2015). Healthier diet has a higher cost. Foods with lower nutritional value cost less per calorie and are more often purchased by individuals who have lower socioeconomic status and are food insecure. These households tend to spend about 25% of their income on food. While there is some availability of nutrient-dense foods, they are not always palatable or culturally acceptable.

Household Food Insecurity: Obesity risk among children and families

There is little known about children and obesity risk associated with food insecurity (Hernandez, Reesor, & Murillo, 2017). Hypotheses have been made regarding this relationship include belief that food insecurity is related to decreased physical activity, poor diet quality, and the body's adaptation to inconsistent periods of food intake as a physiological response to an external

depletion of a reliable food supply (Dhurandhar, 2016). Regardless of the cause, there is a hunger-obesity paradox that has become prevalent among households that are food insecure and the USDA questionnaire focus on weight loss due to food restriction may undercut the severity of food insecurity experienced particularly among households with children. (Kersten & Beck, n.d.)

In its earlier years food insecurity's impact on malnutrition was measured with a focus on potential weight loss and periods of chronic hunger due to low caloric intake. USDA questionnaire for example, asks about concerns or more clearly, stress, about food availability in a household which can have an impact on household members' weight status (Pan, Sherry, Njai, & Blanck, 2012). Currently in the U.S., the experience of food insecurity and general resource depletion involves a substitution of foods that are cheaper. Present day mass production of food results in items that are cheaper, highly palatable and calorie-dense due to their high concentrations of fats, salts and sugars, and easily accessible for families. With current methods of food production and availability, there is further need for measuring the observed "double burden" phenomenon that now takes the form of food insecure households who manage limited resources by consuming too little of certain nutrients and over-consuming others (Kersey, Geppert, & Cutts, 2007). While this can also be said for households that are not food insecure, this takes on a more severe form born out of necessity, not necessarily pleasure or choice.

Food security itself merits attention and it is also important to note the relationship between FI and low income households that can add to their risk of having low nutrient quality diets (Kersey et al., 2007). With the growing evidence demonstrating the impact of food insecurity on obesity outcomes among adults, these conditions are no longer being treated as exclusively separate. Food insecurity is important to measure as it demonstrates clearly a household's situation with their food sources and potential barriers to obtaining this basic necessity. Measuring food insecurity particularly among low income households can provide better insight to families' use of inexpensive, energy-dense, nutrient-poor food items foods in place of fruits, vegetables, and whole grains (Crawford & Webb, 2011).

Food insecurity and obesity among adults

Women who report food insecurity have been found to have increased risk for becoming obese (Larson & Story, 2011). In a study among 12 U.S. states, Pan et al. (2012) found a 27% prevalence of individuals who were obese. In assessing food stress and measuring "obesity" status, it was found that among the group that reported being food insecure, they had 32% increased odds of also being obese, particularly for low-income households and those that had 1-2 children, compared to households who were food secure (Pan et al., 2012). Palakshappa et al used data from 2007-2014 National Health Interview and Nutritional Examination Survey and found that obese adults that are food insecure have obesity-related comorbidities compared to adults who were obese and food secure (Palakshappa, D., Speiser, J.L., Rosenthal, 2019).

Food insecurity and obesity among children

In 2018, the U.S. reported an 18.5% (13.7 million) prevalence of children and adolescents who were considered obese. Children and adults at highest risk for obesity tend to also be food insecure (Kaur, Lamb, & Ogden, 2015). Data from NHANES years 2001-2010 analyzed the relationship between food security and health outcomes among children. Using logistic regression to adjust for

sex, race, and poverty level it was found that obesity is significantly associated with personal food insecurity for children ages 6-11 (Kaur et al., 2015). Although childhood low food security and low income experience among children ages 2-5 may not lead to obesity immediately it can still leave a child at higher risk for becoming obese later in childhood, adolescence and adulthood (Crawford & Webb, 2011). While less association has been found relating food insecurity to obesity among children and adolescents, a study conducted by Wu et al, using data from Taiwan Database of Children and Youth in Poverty, found that dietary behavior mediates the association between food insecurity and obesity (Wu et al., 2019). These findings demonstrate that creating interventions aimed at changing dietary behaviors can be a potentially effective approach to reducing rates of obesity among food insecure families, particularly youth.

Epidemiology of food insecurity: Latino population

Latino adults and children are among one of the most disproportionately affected groups with high rates of obesity (Holub et al., 2011). CDC reported data from 2015-2017 showing 32.6% Latino adults compared to Non-Hispanic White groups (28.6%) are considered obese (U. S. H. and H. Services, 2019). According to the CDC, 25.8% of Hispanic children are obese compared to non-Hispanic Caucasian children and the U.S average 18.5% (U. S. D. of H. and H. Services, 2019). Latinos experience high burden of disease including cancer, cardiovascular diseases (number 1 and number 2 cause of death in the population respectively), and of highest health disparity includes obesity and diabetes (National Council of La Raza [NCLR], 2014).

Food insecure individuals are more likely to use coping mechanisms such as consuming more calorie-dense, cheaper and highly palatable foods that contain higher sources of sugar, fat, and salt while obtaining a poor-quality diet and increasing risk for chronic diet-related diseases. Leung et al used data from NHANES 1999-2002 to determine diet quality association with food insecurity and found that among low income, food insecure households, diets consisted of highly palatable foods, high-fat dairy products, and salty snacks compared to low-income food-secure adults. Food insecure adults had higher consumption of sugar-sweetened beverages, red/processed meat, with lower consumption of vegetables. This is of concern because low diet quality has been found to be significantly associated with increased chronic disease risk (Leung, Epel, Ritchie, Crawford, & Laraia, 2014).

Latino families and children are particularly vulnerable to chronic disease development due to limited financial, healthcare and nutrition resources and limited access to disease prevention. ERS reported that households that were Latino, female-led, single-parent with children had higher prevalence of food insecurity and were especially vulnerable to poor health outcomes(Wunderlich, 2006). Using the National Health Interview and Nutritional Examination Survey (NHANES) from 2011 and 2012 Hernandez et al. found that the Latino population experienced a higher prevalence of food insecurity and Latino women had a 1.29 increased odds of being overweight compared to Caucasian women (Hernandez et al., 2017).

Latino households with children carry the double burden of being disproportionately affected by food insecurity and belong to a heterogenous ethnic population that experiences high burden of diet sensitive chronic disease, although not all subgroups experience the burden at the same rate. Undocumented immigrants are an important subgroup of this population who experience food

insecurity at much higher rates. Kasper et al, reported that the Latino immigrant population in California and Texas (2 states with the largest Latino population) had an estimated 41% low food security prevalence and 40% very low food security prevalence (Kasper, Gupta, Tran, Cook, & Meyers, 2000). Young children in Latino immigrant families are especially at high risk. Repeated cross-sectional surveys conducted in a multi-site study in Minneapolis reported significantly higher prevalence of Latino caretakers reporting food insecurity in their homes compared to non-Latino caretakers and increased likelihood of Latino children experiencing hunger (Kersey et al., 2007).

Latino households and food security impact on health outcomes

Similarly to general health outcomes related to food insecurity, children from Latino households are susceptible to psychosocial behavioral problems (Nagata, Gomberg, Hagan, Heyman, & Wojcicki, 2018) and risk for development of chronic diseases such as diabetes starting with poor glycemic control (Landry et al., 2018). Families' concerns about food insecurity drives frequent consumption of low-cost, energy-dense and low-nutrient foods instead of food with critical nutrients. Sharkey et al. found that among 50 Mexican youth from a town in the Texas border, 32 were from low and very low food secure households and had an increased dietary energy intake of total energy intake, fats and sugars. For children from low and very low food secure households most did not meet dietary recommendations including calcium, dietary fiber, vitamin D, potassium, vitamin C. (Sharkey, Nalty, Johnson, & Dean, 2012).

A study evaluated risk factors for young Hispanic children between 6months and 12 months of age and risk of being obese in childhood and later in life. Based on child measurements and parent surveys of food security, health behaviors, psychosocial, and economic factors, it was found that 55% of women from the sample had infants above the 85% percentile for BMI-for-age (i.e., overweight or obese); and these mothers displayed increased risk factors such as frequent consumption of fast food and sugar-sweetened beverages, stress, and the Supplemental Nutritional Assistance Program (SNAP) service that were found to be associated with overweight among infants (Watt, Appel, Roberts, Flores, & Morris, 2013).

Risk for becoming obese and having obesity-related comorbidities is also prevalent among Latino adults. A cross-sectional study using the 2011-12 California Health Interview Survey to gather data from 5280 Latino adults found that the prevalence of obesity differed across Latino subgroups and level of acculturation. Mexican-Americans had the highest prevalence of overweight and obesity (T. M. Smith, Colón-Ramos, Pinard, & Yaroch, 2016). Although a heterogenous ethnic group, it is important to identify groups in need of intervention to reduce the burden of disease that is still highly prevalent across the Latino population.

Because of limited time and resources, parents from food insecure households are less likely to model healthy behaviors. In a cross-sectional study, 31 Latino mothers were surveyed using parental Self-efficacy (PSE) and Parenting Practices (PP) measures to assess how parents encouraged vegetable consumption including modeling, planning, and ensuring the availability of vegetables in the households. "Hilmers et al. found that food-insecure caretakers had lower self-efficacy scores compared to food-secure caretakers (Hilmers, Hilmers, & Dave, 2012). Meanwhile a study conducted in Texas of 191 households obtained qualitative data regarding Latino food insecurity experiences and found that among a rural Hispanic population, particular

coping strategies included buying in bulk, purchasing items on sale, and cooking and eating at home while increasing the amount of starchy inexpensive foods and rice and beans (Murimi et al., 2018). While it may effectively keep households from going hungry, households run the risk of missing several important nutrients in their diets.

Despite the growing research on significant associations and increasing prevalence of diet-related diseases and proven low resources for changing diet quality and eating patterns, there is still a need for early prevention programs focused on the Latino population (Watt et al., 2013). Study findings show coping mechanisms are consistent with the hunger-obesity paradox of consuming inexpensive calorie-dense foods and that there is an increasing prevalence of diet-sensitive chronic disease and obesity among food insecure Latino adults and children. This is a potential target for intervention for families, Latino households in particular, to adopt inexpensive yet nutritionally balanced diets to prevent the development of diet-sensitive chronic disease.

Nutrition interventions to address food insecurity

Food insecurity and its associated health outcomes result from a variety of socioeconomic inequalities that will require multilevel solutions (Lee, Heinrich, Reese-Smith, Regan, & Adamus-Leach, 2014). Food assistance programs have been found to be potential contributors to the solution (Cohen et al., 2019) and ground-level interventions that can help improve food security through access and education can help ameliorate the effects of food insecurity (Crawford & Webb, 2011).

Food assistance programs: SNAP and WIC

According the a 2016 USDA report, there are 15 domestic nutrition assistance programs with the 3 largest consisting of the Supplemental Assistance Program (SNAP), the National School Lunch Program, and Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) (Coleman-Jensen et al., 2015). Nutrition assistance programs have played important roles in addressing food insecurity (Poblacion et al., 2017). For example, SNAP is a federally-funded entitlement program that aids low-income families for purchasing food. SNAP benefits can also be used in farmers markets to obtain fresh produce. Due to its potential to impact health behaviors through direct purchase of foods, incentives for using SNAP benefits on fruits and vegetables have included subsidies with programs like Double Up Food Bucks. This program doubles participants' money to purchase fruits and vegetables at participating grocery stores and farmers markets. Cohen et al. evaluated a SNAP enrollment program operating out of a Michigan health clinic that provided information regarding Double Up Food Bucks program to increase enrollment (Cohen et al., 2019). Findings included motivators to enroll in order to stretch SNAP benefits, opportunity for buying higher quality produce, and making healthier meals. Some limitations to SNAP as a nutrition intervention to improve health behaviors is the lack of knowledge for purchasing fruits and vegetables, transportation, limited locations and hours, and confusion about the incentives. In addition, SNAP is a benefit made available to families who are legal residents, therefore undocumented families would not be able to access SNAP. ("SNAP Policy on Non-Citizen Eligibility," 2013). Meanwhile programs such as WIC provide nutrition intervention for specific groups consisting of pregnant women, breastfeeding women and children under 5 years old with some nutritional condition or concern. Vouchers are given to purchase certain food items to meet

nutrition requirements (Poblacion et al., 2017).

Community-level approaches

Food availability in the neighborhood and parent behaviors such as cooking dinners at home more than 5 times a week are associated with children being more likely to consume fruits and vegetables (Dunaway et al., 2017). Increasing availability of fresh produce that is affordable can encourage engaging in healthy behaviors. Many low-income communities have been identified as "food deserts" with limited access to stores selling affordable fresh produce, contributing to food insecurity In 1996 the USDA Community Food Projects Competitive Grants Programs was started as a way to fund local nonprofit organizations with small grants that would create interventions in the communities, many of which have focused on nutrition and diet quality (Kirkendall, House, & Citro, 2013). According to the USDA site, the grants are required to meet one of the 6 goals for community food security; these include justice and fairness, strong communities, vibrant farms and gardens, healthy people, and sustainable ecosystems and thriving local economies. Community-level programs have taken the form of farmer's markets, community gardens (Cabello et al., 2012), farm to cafeteria initiatives, community food assessments, food policy councils and related initiatives, community economic development, youth programs and most recently growing in popularity, community supported agriculture (Bellows, n.d.).

School-based approaches

Interventions aimed at addressing food insecurity among households with children have been concentrated around schools (Sharma et al., 2015) in the form of food cooperatives, school gardens, pantries (Martin, Colantonio, Picho, & Boyle, 2016) and some more creative forms using photovoice to assess the impact of Community Service Agriculture-like interventions operating out of school sites (Alcazar, Raber, Lopez, Markham, & Sharma, 2017). For example, Landry et al. conducted a 12-week nutrition, cooking and gardening intervention based out of after-school programs and focused on reducing obesity among Latino children. Student participation was facilitated by partnership with an afterschool program in a location the students were familiar with (Landry et al., 2018).

Clinic-based interventions

Food and nutrition interventions to address food insecurity have also been implemented through primary care and pediatric clinics. Some interventions have focused on improving parents' perspectives, specifically how they value food, self-efficacy to make choices, preparation and knowledge (Cason-Wilkerson, Goldberg, Albright, Allison, & Haemer, 2015). Other interventions have been more pragmatic in delivering access to fruits and vegetables with a nutrition education component. This form of intervention has become more popular among clinic interventions and has come to be known as a food prescription (Sharma et al., 2015). A food prescription, like a medication prescription, is a provider's form of identifying this nutritional need in a patient with intended treatment of a health condition or risk that they are presenting to the clinic. While food prescriptions have been carried out through various forms, emerging interest in farmers' markets and growingly popular, community-supported agriculture (CSA) are currently front-lining clinic nutrition interventions.

<u>Clinic partnership with communities: CSA interventions</u>

About 6000-6500 Community Support Agriculture forms exist throughout the United States

(Wilkins, Farrell, & Rangarajan, 2015) with the first one established in 1986 (Forbes & Harmon, 2008). In a Community-Supported Agriculture (CSA) program, customers pay for 'shares' of produce and farmers provide seasonally available fruit and vegetables weekly for a certain period depending on the service's subscription. CSAs are a potential local source for fresh produce; they can exist in the communities they serve and have higher-quality, lower-cost vegetables and other produce available compared to grocery stores which may not be as easily accessible or even available in certain neighborhoods (Seguin et al., 2017). CSAs were originally started to improve economic and social connection between farmer and customer. Later, it received attention due to its growing potential as a source for increasing vegetable and fruit intake among individuals whose diets were lacking in these food types.

The issue is that most current CSA members are usually from middle- to high-income households. Its use has not been widely applied as a model to serve low income communities despite movements for food justice growing in urban low-income neighborhoods. Barriers considered for some CSA services include set inflexible prices, limited selection choices of produce based on seasonality, and novelty of items that households may not have the capacity to learn to prepare or like the taste of it. Additionally, it may be difficult for families from low-income communities to participate due to an upfront payment structure for weekly deliveries and the logistics of the delivery. Some farms offer home delivery while pick up locations have been more commonplace for further reaching service to households.

With the establishment of more local food CSA services, prices can be adjusted based on income (Hanson et al., 2017). For example, price matching incentives among SNAP participants can encourage using this form of food service to acquire more fresh produce. Other potential solutions have included subsidizing participation with tailored nutrition messages to engage low-income families with children. The Farm Fresh Foods for Healthy Kids 3-year CSA study, for example, engaged families of children ages 2-12 years to participate in a local CSA reduced-price program across 4 states in the Eastern US region, either receiving intervention or delayed intervention (Seguin et al., 2017). Building on formative and longitudinal research, the intervention studied the impact of cost-offset community-supported agriculture on diet and other health behaviors and economic impact on local economies; and as the nutritional education component, included 9 skill and healthy eating classes and kitchen tools to participating families (Seguin et al., 2017).

A New York quantitative study linking CSA to low-income communities compared full-paying vs subsidized payers, including subsidies for SNAP benefits or WIC benefits eligible families. The CSA delivery format consisted of seasonal specific CSA service with 2 designated spots in lower income neighborhoods rather than home delivery service. The shared price was $500 for 24 weeks and $250 for subsidized customers with option for payment in monthly installments. Survey data from 151 respondents, over half with children, was taken at 3 time points at initiation of the shareholder, after participating in the 24-week service, and 3 month follow up after the end of the CSA service. The study found that with greater exposure to a variety of vegetables, intake was reported to be higher for 11 of the 30 specific vegetables, (dark leafy greens, carrots, garlic, onions, winter squash, beets, Brussels sprouts, cabbage, eggplant, root vegetables and potatoes) and to consisted of several more vegetables that were not commonly consumed (Wilkins et al., 2015). CSAs like this one have demonstrated the potential to serve as interventions that provide participants with examples of the different existing and seasonally available produce that avoids

price shock.

Assessing the impact and feasibility of cost-offset CSA services is usually carried out through assessing increased intake of vegetables and additional questions focused on assessing health behavior changes. How food security is ameliorated or not through these interventions is also important to understand. The motivation for these interventions is based on the use of social needs assessments like the hunger-vital signs to identify patients being affected by risk factors less controlled by medical intervention, however programs more commonly use these needs measures to identify participants who will potentially benefit and reassessment regarding stress over having sufficient resources for purchasing enough food is not as commonly performed. Adults and children participating in cost-offset CSA program in Vermont found that participants increased vegetable and fruit intake when compared to USDA recommendations and current nation averages. Food security level was measured using a 6-item survey, although did not assess for reported changes in food security status (Hanson et al., 2017).

A pediatric fruit and vegetable prescription program assessed change in food security status among 578 mostly Latino (65%) households who participated in a clinic-based prescription program and found that 72% increased their overall food security score over the course of the program. Using an adapted survey from the USDA 18-item household food security survey, they found significant improvements in reported food security status (Ridberg et al., 2018).

Gaps in the literature

Food insecurity directly affects diet quality among food insecure households, especially those with children. Diet quality acts as a moderator between food insecurity and poor health outcomes resulting from nutrient poor-calorie dense diets. This places food insecure adults in particular at risk for obesity, obesity-related comorbidities including cardiovascular disease, metabolic syndrome and diabetes. While less significant associations have been found for children, there is some evidence of increased pre-diabetic risk among adolescents who are from food insecure households. Children from Latino households especially have a high burden for diet-sensitive chronic diseases with higher incidence of diabetes, high blood pressure, and other cardiovascular diseases in Latino adults. Households that are Latino and food insecure are particularly vulnerable to these poor health outcomes. Despite the mounting research, there is still a need for interventions for low-income food insecure Latino households to improve diet quality and health behaviors to reduce the risk of disease in this group. Future research is needed to demonstrate that these nutrition interventions can help reduce food insecurity, improve diet quality and potentially reduce burden of disease

Part 2: Food As Medicine: Measuring Food Insecurity in a Pilot Food Prescription Intervention

Background

Food insecurity is defined by the United States Department of Agriculture (USDA) as a household- or individual-level condition in which there is inadequate food availability, due to social and/or economic constraints (Wunderlich, 2006)(Baer, Scherer, Fleegler, & Hassan, 2015). Inadequate availability can be characterized as insufficient quantity, decrease in quality, and not having enough funds in a household budget to purchase food (Coleman-Jensen, Rabbitt, Gregory, & Singh, 2016).

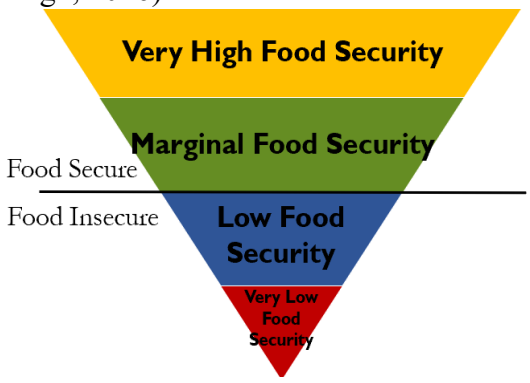

Figure 1. Food Security Categories Adapted from the USDA Economic

The USDA's 18-item food security questionnaire is a validated measure in which a household representative answers questions regarding their experience with food availability, and are assigned to one of the 4 categories: The first two categories, "very high food security" and "marginal food security, are considered "food-secure"; the following two categories, "low food security" and "very low food security," are considered "food-insecure" (Bickel, Nord, Price, Hamilton, & Cook, 2000).

While in 2017, 11.8% of US households experienced some form of food insecurity, households with children had higher rates (16.5%), and Latino households reported even higher rates of food insecurity (18.5%) (Coleman-Jensen et al., 2015). From 2016 to 2017, overall household food insecurity decreased from 12.3% in 2016 to 11.8% in 2017, and the proportion of families with very low food security decreased from 4.9% to 4.5%, however the prevalence of food insecurity in ethnic minority populations and households with children have not significantly decreased (Gerards & Kremers, 2015).

Adults in food insecure households, particularly those with the most severe food insecurity, tend to prioritize feeding the children to shield them from food restriction and hunger. However, despite parent efforts, about 2.9 million food insecure households report that children experience a direct effect of food insecurity in their household. About 250,000 US households experience food insecurity so severe that children have disrupted eating patterns with periods of hunger (Coleman-Jensen et al., 2015). While, in general, individuals in the U.S. do not meet the daily recommended intake for vegetables and whole grains, children in food-insecure households are less likely to meet the daily recommended intake (Burwell & Vilsack, n.d.).

As a result of poor food intake, food insecure children are at risk for poorer health outcomes such as socio-cognitive disruptions and developing chronic diet-related conditions later in life, obesity, including type 2 diabetes (Hilary K Seligman, Davis, Schillinger, & Wolf, 2010), hypertension, and metabolic syndrome (South, Palakshappa, & Brown, 2018). Ethnic minority households, particularly Latinos and African Americans, experience both high rates of food insecurity and

increased risk for chronic diet-related conditions such as obesity, Type 2 diabetes and cardiovascular disease.

Clinics are now screening patients and their families for food insecurity using more abbreviated versions of the USDA questionnaire to effectively incorporate it into the workflow. Several variations have been formed including a 6-item questionnaire to 1-question screen and the 2-question screen also known as the Hunger-Vital Signs (Bottino et al., 2017) (Baer et al., 2015). Screening for food insecurity, especially in pediatric clinics, has grown due to the association of child food insecurity with poor dietary intake and lower nutrition quality (Darmon & Drewnowski, 2015).

Food insecurity and its associated health outcomes result from many socioeconomic inequalities that require multilevel solutions (Lee et al., 2014). Health care and social service providers are in a position to intervene with children and families to mitigate the effects of having a low-quality diet (S. Smith et al., 2017). Food assistance programs like Supplemental Nutrition Assistance Program, Women (SNAP), Infants, and Children (WIC) and the National School Lunch Program have increased availability of food among households that are food insecure (Coleman-Jensen et al., 2016). Incorporating community-level, school, and clinic-based approaches, leads to more intensive interventions. Programs have included connecting food assistance programs to local food resources such as farmer's markets using vouchers offering a few dollars' worth of fresh produce or doubling the value of SNAP vouchers at local farmers markets. Community approaches have promoted local food ecosystems such as farmer's markets and community gardens. School-based approaches have included food cooperatives, gardens, pantries and Community Service Agriculture collaborations. Clinic-based interventions, particularly in pediatric and primary care clinics, aim to partner with local food systems to identify and connect patients who need additional food resources. Practical approaches operating out of primary care and pediatric clinics are usually accompanied by some form of nutrition education. These interventions, known as "food prescriptions" deliver nutrition education with improved access to vegetables and fruits through vouchers to use at farmer's markets, prescriptions to obtain food from pantries, and partnerships with urban farms to subscribe families to community-supported agriculture that makes weekly vegetable deliveries to participating family households.

This study aims to understand how families of pediatric patients from a majority Latino-serving Federally Qualified Health Center reported food security and diet behaviors before and after participating in a pilot food prescription program. We hypothesized that increased access to healthy food and nutrition education would lead to improved health behaviors and food security among the participating families.

Methods

***Study Design**:* This is a pre- and post-intervention data analysis of food insecurity, dietary behaviors and physical examination measures for food-insecure families with children age 9-11, before and after participating in a food prescription intervention, Food as Medicine.

***Participant Recruitment*:** From July 2018 – January 2019, study recruitment was done on a rolling basis through screening in the pediatric clinic at La Clinica de la Raza, which is a Federally-Qualified Health Center serving a low-income, primarily Latino population. All

medical assistants (MAs) were trained to incorporate the 2-item Hunger Vital Signs food security screening questions for parents/caregivers during intake and measurement of children's vital signs, for children age 9-11 presenting for routine well-child visit or a brief follow-up visit. The food security screening questions were: 1. Within the past 12 months, we worried whether our food would run out before we got money to buy more." 2. Within the past 12 months, the food we bought just didn't last and we didn't have money to get more." If the parent responded 'yes' to one or both of the items on the 2-question food security screening tool, they were screened as food-insecure.

If the family met the study inclusion criteria—the child was age 9-11 years, the parent/caregiver responded "yes" to one or both of the food security screening questions, and the family lived in Oakland—then they were directed to one of the two MAs trained for study recruitment. The MA explained the study in the parent's and patient's preferred language and obtained written informed consent for study participation, starting during the same clinic visit in their assigned clinic room and continuing over a total of 10 months. The parent and patient signed their own separate consent forms. The MA also obtained the family's delivery preferences for vegetables and whole grains, phone number and texting permission for sending recipes, and scheduled follow-up visits with reminders to return to complete the post-intervention surveys. The MA also measured parent and child blood pressure, weight, height, and waist circumference prior to completing the baseline surveys. Figure 1 shows the process of screening and final enrollment of 30 children and families. Given resources available for the pilot project, there was a prior decision to enroll families until a study sample of 30 was obtained. During immediate post-intervention follow-up, 24 families returned, and 21 families returned for the 4-month post-intervention follow-up.

Intervention: All 30 participating families received a 3-month, 16-weekly vegetable and whole grain delivery service from an Oakland urban farm, beginning 2 weeks after enrollment. Participants completed surveys at 3 time points: Baseline paper surveys (prior to beginning the 3-month vegetable and whole grain delivery service); Post-intervention (at the completion of the 3-month delivery service), and 4-month follow-up phone call surveys (4 months after the completion of the delivery service) were completed on Redcap (an online survey service). Families were given incentives of a $50 dollar gift card during their in-person post-intervention follow-up survey completion, and a $15 gift card to be mailed to their address after completing a 4-month follow-up phone call survey.

Study Instruments and Variables: Survey packets consisted of 5 different surveys including 1) My Veggies survey: consisted of 28 different vegetables that caregivers and children were asked to respond which had been consumed in the past 7 days. 2) Fruit & Vegetable Checklist: questions asking frequency of caregiver vegetable and fruit consumption 3) The full food security USDA module: consisted of 18 questions increasing in severity of food insecurity experience 4) Food As Medicine: La Clinica de la Raza Caregiver survey: Questions regarding parent feeding, shopping, perceptions regarding whole grains and vegetables, demographic data, food assistance program use , 5) Food As Medicine: La Clinica de la Raza Child survey: child experience with vegetables and wholegrains in their households, including perception, consumption and likeability. Survey collection was done at baseline, follow-up visit, and follow-up phone call surveys was carried out by health coaches who were trained to administer the surveys to the families. They aided participants with answering survey questions by reading the options, clarifying any confusion, and

encouraging them to answer to best of their ability. Measurements obtained included: Demographic information (age, gender, race/ethnicity of both child and caregiver, caregiver education, household income, family composition-number children and adults in the household), anthropometric measures (blood pressure, weight, height, bmi, and waist circumference), and survey data (full food security module, food assistance program use, diet behaviors use for child and caregiver consumption).

Statistical Analysis: Stata software (version 16, StataCorp LP, College Station Tx 2018) was used for all statistical analysis. Descriptive statistics were used to characterize the study sample. Responses from post-intervention points were then eventually compared baseline data. Wilcoxon Signed-Rank test was used for ordinal variables (eg. food security categories and diet behaviors-vegetable consumption) and paired-t test analysis was performed for continuous variables (e.g. anthropometric measures). AnthroPlus calculator was used to determine child BMI-for-age z scores. Statistical significance was determined by a $p < 0.05$.

Approval for the project was obtained from the Quality Review Board of La Clinica de la Raza, which functions as their Institutional Review Board (IRB). Personal Health Information (PHI) was kept within La Clinica. Investigators from collaborating institutions obtained approval to work with de-identified data (The University of California Berkeley IRB, Committee for the Protection of Human Subjects and UCSF Benioff Children's Hospital Oakland). The study Principal Investigator, Dr. June Tester, obtained Institutional Review Board (IRB) approval at UCSF Benioff Children's Hospital as well as the study site, La Clinica de la Raza. The University of California Berkeley IRB, Committee for the Protection of Human Subjects, determined that this data analysis of de-identified data was "not human subjects research."

Results

Part I: Screening

Figure 1 provides the flow of screening, participant enrollment, and follow-up. Of the 179 families screened, 63 families (35%) were found to have positive food insecurity. including 17 who responded yes to one of the 2 Hunger-Vital sign questions and 46 who responded yes to both questions. Out of the 63 who screened positive, 57 were eligible for being considered to participate in the pilot study, and 6 were not included in this group because they did not meet the "resides in Oakland" inclusion criteria. The aim was for 30 families to be enrolled from the 57 eligible families. Of the families who were approached to enroll, 27 were unable to enroll due to time constraints, unavailable health coach or did not want to participate in the study. Most families were Spanish speaking, specific numbers at each stage are not reflected in the figure.

Part 2: Pilot Intervention

Demographics

A total of 30 parent/caregiver-child dyad families enrolled in the study. The average age of participating children was 10.5 years, and the average age of participating caregivers was 40.9 years. Child gender was 57% male and 43% female, while parent/caregiver gender was 83% female and 27% male. Most participating caregivers (77%) were the child's mother and 17% were the father. The majority of participants identified as Hispanic, 81.1% of children and 79% of

caregivers. On average, households consisted of 3 adults and 3 children, and most (90%) lived in the same household 1 year ago. Regarding caregiver education level, 54% completed less than or up to a high school education, 16% completed college or up to a graduate degree and 30% had another form of education with unknown U.S. school equivalent. Participants were generally low income—all families who reported their income earned under $60,000 per year, and 31% of family households earned between $0-$15,000. Approximately half of caregivers were employed, including 33% employed part-time and the 20% employed full time; and 47% of caregivers reported not being employed outside the home (Table 1).

Participants were asked about their use of food assistance programs including Supplemental Nutrition Assistance Program (SNAP, or CalFresh for California) and Women Infant and Children Program (WIC) at all three-survey time-points. Regarding SNAP, at baseline, 34.5% of participant households were currently enrolled, and 31% had been enrolled in the past; and similar levels were reported across the study time-points. Regarding WIC, at baseline, 21% of participants were currently enrolled and 43% had used WIC in the past; and greater current WIC use (33%) was seen at 4-month follow-up. For both SNAP and WIC, at all 3 survey timepoints, approximately one-third of participants reported never being enrolled. For the Free & Reduced Price Lunch Program (FRPL), 83% of families reported currently using this food assistance program at pre-intervention and remained the same at post-intervention. Few families reported never using FRPL, (pre-intervention, 14% and post-intervention, 8.3%) (Table 2).

Food Security Outcomes

There was a shift toward better food security and remained toward better food security at the 4 months follow-up phone call. At baseline, among the 30 participating families who were all food-insecure according to the Hunger Vital Signs screening, 60% of families were in the "very low food security" category and 40% of families were in the "low food security category" according to the USDA food security questionnaire. At the immediate post-intervention follow-up, among the 24 returning families 83% were food insecure (54% low food secure and 29% very low food insecure) and 17% were now food secure (Figure 2). Changes in food insecurity were evaluated two ways. First, responses were dichotomized on presence of food insecurity. Paired t-test comparing pre to immediate post-intervention (pre-intervention versus immediate follow up,) showed that there was a significant decrease in the proportion of families that were classified as food-insecure (p-value 0.04). Second, because food security can be evaluated as a 4-category ordinal variable, a Wilcoxon Signed Rank test was performed to compare the distribution of food security responses from pre- to post-intervention.

From pre- to immediate post-intervention, it was found that there was a trend but not statistically significant change (p-value 0.10).

At the 4-month post-intervention follow up, among the 21 families who responded, 72% were food insecure (48% "low food secure" and 24% "very low food secure") and 28% were now food secure (14% "food secure" and 14% "marginally food secure"). Paired t-test comparing pre to 4-month post-intervention follow up showed there was also a significant decrease in the proportion of families that were classified as food-insecure with a p-value 0.005. A Wilcoxon Signed Rank Test was performed and showed that there was a statistically significant change of p-value 0.05 toward better food security (Table 3).

Additionally, responses from the 9 participant families that were lost to follow up were also assessed. It was found that for these participants, there was a baseline distribution of food security status of 55% who were "low food secure" and 44% who were "very low food secure". A paired t-test was performed to compare average of these participants to the remaining participants, there was no statistically significant difference in the baseline average food security status.

Physical Examination Measurements

Physical examination measurements were obtained for 30 caregivers and children pre-intervention and for the 24 caregiver-child dyads who returned at immediate post-intervention follow-up. For children, at baseline, the mean BMI-for-age Z scores for girls (1.21) are within the overweight category (Z >1.04) and boys (1.87) are within the obesity category (Z >1.64). Pre- and post-intervention comparison of child physical exam measurements was done for the 24 children who returned, and no statistically significant changes were observed for child BMI, BMI-for-age z-scores, or waist circumference (Table 4).

Caregiver physical examination measurements are presented in Table 5. At baseline, caregivers' mean BMI was 32.0, within the obese category. Paired t-test was performed to assess for significant changes in physical exam measures from pre- to post-intervention. From pre- to post-intervention there was a significant reduction in caregiver mean diastolic pressure from 72.5 mmHg to 69.6 mmHg, (p-value = 0.04). There was no significant change in caregiver mean systolic blood pressure or waist circumference.

Dietary Behavior Outcomes

The Myveggies survey was modified and translated to Spanish due to the majority of participants being Spanish speaking. Caregivers and children answered questions regarding frequency of their consumption of vegetables and whole grains. One question listed 28 vegetables and asked caregivers and children how many of those vegetables they had consumed in the past 7 days. At baseline, caregivers reported consuming an average of 55% of the vegetables listed, and at post-intervention follow-up caregiver consumption had increased significantly to 63.6% (p=0.03). At baseline, children reported consuming an average of 27.9% of the vegetables listed, and at post-intervention follow-up child consumption showed an increasing trend to 33.9%, which was not statistically significant (Table 6).

Other dietary information was obtained from statements for caregivers the respond yes or no. For the statement, "I eat more than 2 kinds of vegetables in a main meal". At pre-intervention 23% responded "Yes, everyday", 7% responded "Yes, often", and 57% "Yes, sometimes" and 13% responded "No". At post-intervention 29% responded "Yes, everyday", 33% responded "Yes, often", 33% responded "Yes, sometimes" and 4% responded "No". At 4-month follow-up 29% "Yes, everyday", 33% responded "Yes, often", and 33% responded "Yes, sometimes" and 0% responded "No". A Wilcoxon Signed Rank test was performed and demonstrated a significantly increased frequency of eating more than 2 kinds of vegetables in a meal at immediate post-intervention follow-up (P=0.04) and at 4-month post-intervention follow up (P=0.02) (Table 7).

Discussion

This study incorporated food security screening in a pediatric clinic to identify families to enroll in a pilot food prescription study. It found that during screening, 35% of this primarily-Latino

FQHC population was food insecure, twice the rate for U.S. families with children (16.5%) and for U.S. Latino families (18.5%) (Coleman-Jensen et al., 2015). Among our participating families, all of who were in a "food insecure" category, 60% were in the "very low food insecurity" category, and study participants reported very low income in a region with a very high cost of living, indicating that food insecurity in this population is both prevalent and severe. It is clear that this food-insecure population is in need of food assistance. Although most participating families reported successfully accessing SNAP, WIC, and FRPL currently or previously, approximately one-third of participating families reported never accessing SNAP and WIC. Free and Reduced-Price Lunch Program had the highest participation throughout the study, therefore making it a highly utilized source of food availability and relief. It is also indicative of the move toward providing meals to more students. In addition, submitting applications for FRPL is facilitated by its location at the school where the child goes and the lessened stigma of it being widely accessed across children of their respective schools. Undocumented immigration status, which was not asked about in this study, could preclude some families from receiving SNAP. In addition, although undocumented families are eligible for WIC, some may be deterred from accessing food assistance due to the federal government's proposed extension of the definition 'public charge' in 2018, occurring during the enrollment period of this study, which would make applicants for U.S. citizenship ineligible if they used Medicaid or SNAP services. Another study cited recipients of entitlement programs cancelling their enrollment out of fear of being impacted by this possible new rule (Kerwin, Warren, & Nicholson, n.d.); and it is possible the same effect may have occurred among our study participants.

Incorporating food insecurity screening into the workflow of patient visits proved feasible, and patients responded positively to the food delivery intervention and the introduction of resource packets containing the Alameda Food Bank Hotline that provides updates on neighborhood food resources without requiring identifying information to receive aid. Post-intervention, the increased proportion of participant households who became food secure, at both follow-up points, and the significant shift toward better food security at the 4-month post-intervention follow-up is a promising demonstration that food prescription with CSA delivery and nutrition education can help relieve food insecurity among Hispanic households. A previous intervention of vouchers for fresh produce in a pediatric clinic serving Hispanic families found improved food security post-intervention (Ridberg et al., 2018). It is important to note however, that while participant households may report improved food security, if these families continue to experience fluctuations in income and other resources, then food security reports may fluctuate over time depending on resource availability. This study provided, to some extent, resource relief by supplementing available food in participant households with vegetables and whole grains that are filling and nutrient-rich, and therefore the improved food security status at 4- month post-intervention follow-up may be a continued residual effect of the intervention.

To our knowledge, this is the first study evaluating a food prescription collaboration with an urban farm providing a weekly vegetable and whole grain CSA home delivery service, and the first pilot food prescription intervention using a CSA program implemented in a Federally Qualified Health Center (FQHC) serving a largely Hispanic population.

While child physical examination measurements did not demonstrate significant changes post-intervention, caregiver physical examination measurements showed statistically significant

reduction in diastolic blood pressure. Caregivers' improved blood pressure measures associated with the intervention could result from additional food resources leading to reduced food insecurity, improved dietary intake and reduced psychological stress. This is a promising finding since the high prevalence of obesity in this population places them at risk for hypertension and heart disease.

Caregivers' dietary behaviors showed improvement in the frequency of consumption of vegetables, the total consumed daily, as well as the variety consumed in a meal. The lack of significant improvement in children's vegetable consumption may highlight the difficulty of introducing and convincing children to consume novel food items (Ong, Ullah, Magarey, Miller, & Leslie, 2017). However, the trend for increased percentage of vegetables consumed from the list of vegetable suggests that repeated positive exposures to vegetables over time may encourage children's uptake of vegetables.

Implications for Future Research

While this pilot study demonstrated some promising results, a longer and more comprehensive intervention might demonstrate greater improvements in household food security, caregiver and child dietary behaviors and health measures. Due to the busy clinic workflow, it was challenging to incorporate and maintain the Hunger Vital Signs screening, requiring consistent communication across MAs and health preventive services manager. While caregiver diastolic blood pressure reductions may be promising, measuring blood pressure longitudinally during a longer food prescription intervention might demonstrate positive cardiovascular health impacts associated with better food security. While it is known that an improved quality diet promotes better health outcomes, making dietary behavior changes is challenging and may require a longer intervention with exposure to novel foods, particularly for children. Finally, food prescriptions that also address structural and individual barriers to optimum diet and health may be more effective.

Limitations

As a pilot food prescription intervention, the sample size was small (N=30) and is not necessarily representative of the local population. Since families needed to reside in Oakland to receive the CSA food deliveries, the study may not have captured families with the most severe food insecurity who resided in outlying areas. As an intervention study, there was no control group to compare to the food prescription participants, therefore post-intervention comparisons could be made only with participants' pre-intervention responses.

The availability of trained health coach volunteers was limited to certain days of the week, which may have introduced biases in recruitment. Since the study population's literacy level was low, health coaches were needed to read survey questions and assist participants. The USDA 18-item food security questionnaire contains sensitive questions that may be perceived as neglectful of children (such as whether children in the household go hungry for a full day due to lack of food availability), and respondents may have under-reported food insecurity due to shame or fear of reporting to Child Protective Services.

The interventions had planned for an educational component consisting of video recipes and demonstrations that had been used in previous pilot studies but unfortunately were unable to be provided to participating families.

Conclusion

This pilot food prescription study showed that incorporating a food screening form into the flow of a pediatric clinic is feasible. This should be tailored to the clinic in which this measure is being implemented in order to ensure smoother transition of using a food screening measurement tool. Screening results of this majority Hispanic patient population showed that one third of families were food insecure, and all participant families were in one of the food insecure categories. Partnering with local urban farms is promising for incorporating CSA collaboration with food prescriptions operating from clinics to provide more connection between healthcare institutions and local food systems.

Overall, food insecurity improved among participant families and dietary behaviors improved among caregivers. There were some trends in increased vegetable consumption among the children. Among health outcome measurements, caregiver diastolic blood pressure improved suggesting a potential for improved cardiovascular outcomes.

Recommendations would be to implement this food prescription on a larger scale using the intended nutrition education component for more effective incorporation of vegetables and whole grains received in the CSA. Measurement of anthropometric outcomes should be done in more frequent successions to obtain a trend and consider other laboratory measurements that can complement caregiver and child responses. To have this form of food prescriptions be more successfully adopted, programs should consider using produce that is more culturally relevant to the population receiving the intervention. Finally, this food prescription is effective in addressing health behaviors and mitigating food insecurity but is not a solution to it. It would be beneficial to consider assessing barriers, such as stable housing, employment, and other social factors, that are not immediately associated to diet behaviors but can be stressors on resources that influence families' relationship with food access.

Figures and Tables

Figure 1: Screening and Study Enrollment and Follow-up of Families

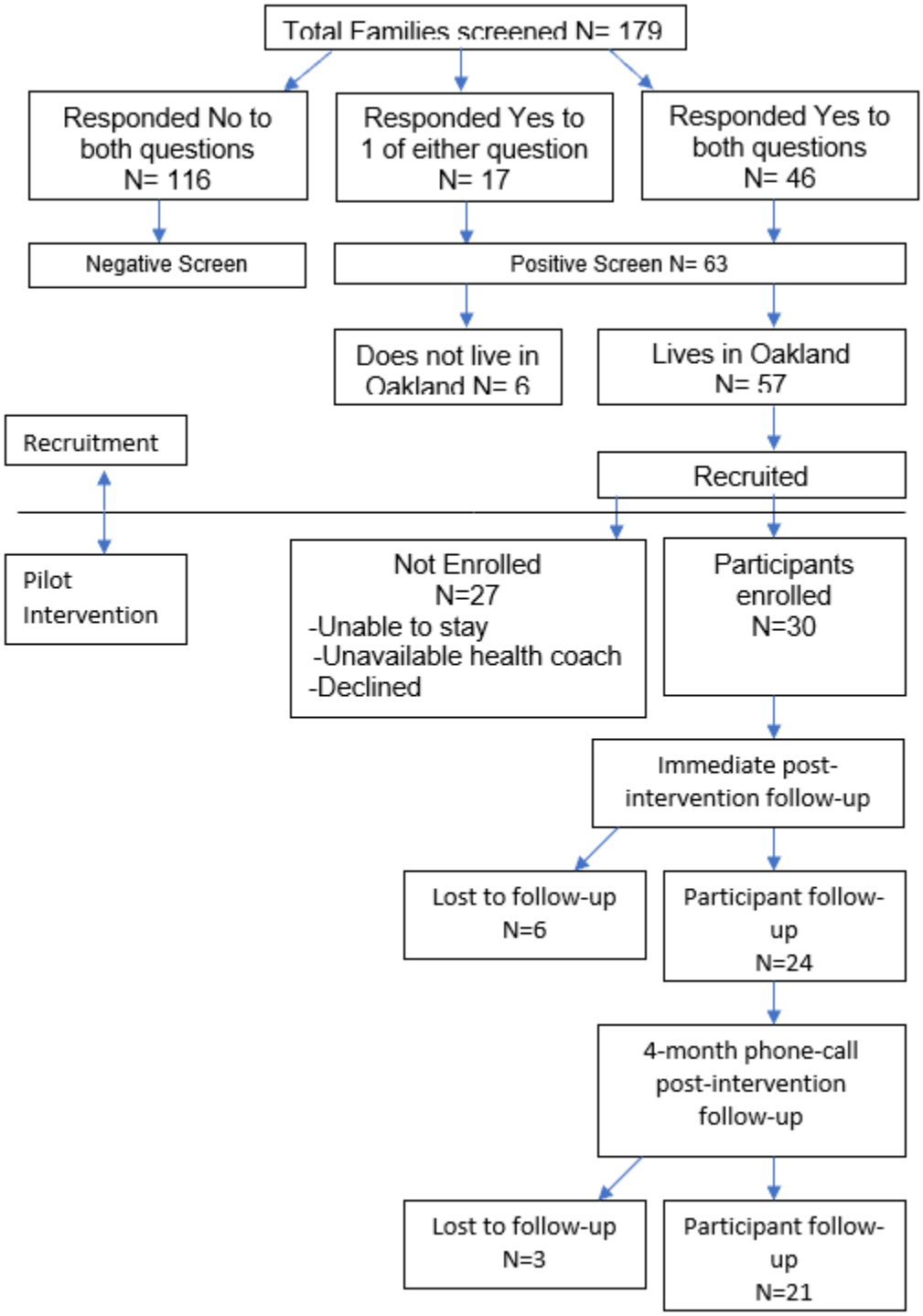

Table 1: Baseline descriptive characteristics of participating families

Child, Caregiver and Family Characteristics	N or mean (%) (Baseline total N=30)
Child age, mean in months (SD)	10.5
Child age in years, n (%)	
9	6 (20%)
10	14 (46.7%)
11	10 (33.3%)
Child sex, n (%)	
Male	17 (57%)
Female	13 (43%)
Child race/ethnicity, n (%) (more than one if applicable)	
Non-Hispanic White	3(9.3%)
Hispanic	26 (81.1%)
Non-Hispanic Black/African American	1 (3.2%)
Asian	1 (3.2%)
American Indian/Alaska Native	1 (3.2%)
Caregiver age, mean in years (SD)	40.9 (8.4)
Caregiver gender, n (%)	
Male	5 (17%)
Female	25 (83%)
Caregiver Race/Ethnic Background n, (%) (more than one if applicable)	
Non-Hispanic White	3 (9%)
Hispanic	26 (79%)
Non-Hispanic Black/African American	2 (6%)
Asian	1 (3%)
American Indian/Alaska Native	1 (3%)
Relationship to Child n, (%)	
Biological mother	23 (77%)
Biological father	5 (17%)
Stepparent (or parent's partner)	1 (3%)
Grandmother	1 (3%)
Household income, n (%)	
$0 – $15,000	9 (31%)
$15,001-$30,000	5 (17%)
$30,001-$45,000	4 (14%)
$45,001- $60,000	3 (10%)
Don't Know/Decline	8 (28%)
Caregiver Education level, n (%)	
Completed up to 8th grade	5 (17%)
Up to high school	11 (37%)
Up to college	4 (13%)
Finished graduate degree	1 (3%)
Other	9 (30%)
Caregiver Employment Status, n (%)	
Not employed outside home	14(47%)
Employed part-time	10 (33%)
Employed full-time	6 (20%)
Number adults in the household, mean n (SD)	3.3(1.7)
Number children in the household, mean n (SD)	3.2 (1.7)
Living in Household 1 year ago? n, (%)	
Yes	26 (90%)
No	3 (10%)

Figure 2: Food security categorization of participating families

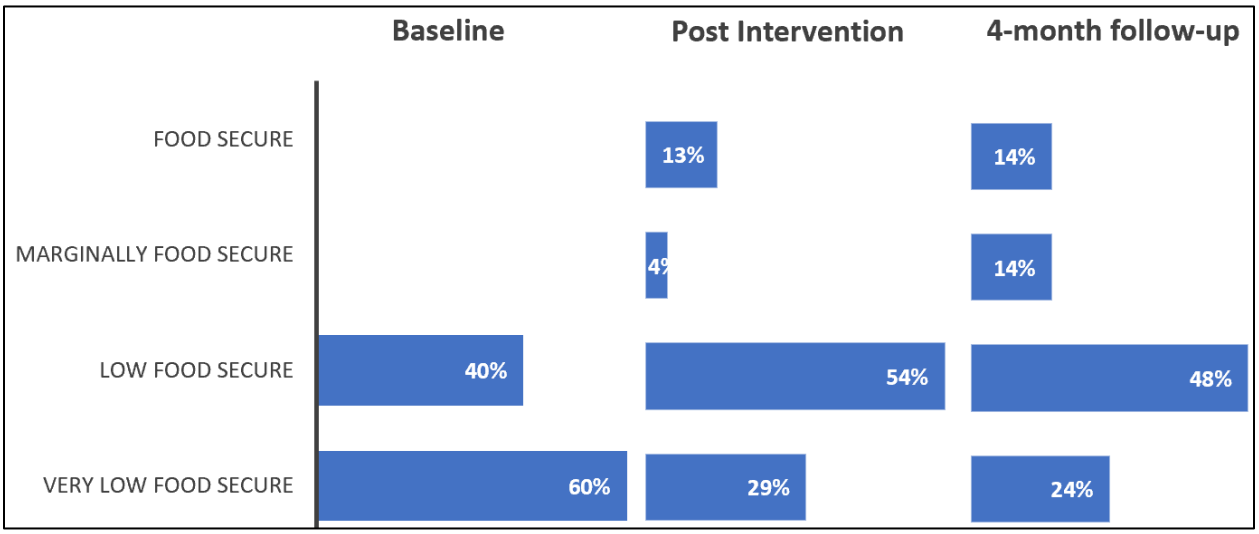

Table 2: Family Food security status and category status

	Pre-Intervention N =30	Post-Intervention N=24	4-month follow-up N=21
Dichotomized food security status, %			
Food insecure	100%	83%	72%
Food secure	0	17%	28%
Paired T-test P-value (Compared to pre-intervention)		0.04	0.005
Food security category status, %			
Food secure	0	13	14
Marginally food secure	0	4	14
Low food secure	40	54	48
Very low food secure	60	29	24
Wilcoxon Sign Rank Test P-value (Compared to pre-intervention)		0.1	0.05

Table 3: Family food assistance program use

Food Assistance Program participation		Pre-Intervention N=30	Post-Intervention N=24	4-month Follow up N=21
Supplemental Nutrition Assistance Program (SNAP), n (%)				
	Currently			
	In the past	10 (34.5%)	8 (33.3%)	6 (29%)
	Never	9 (31%)	8 (33.3%)	11 (52%)
		10 (34.5%)	8 (33.3%)	4 (19 %)
Women Infant & Children (WIC), n (%)				
	Currently	6 (21%)	3 (13%)	7 (33.3%)
	In the past	13 (45%)	14 (58%)	7 (33.3%)
	Never	10 (34%)	7 (29%)	7 (33.3%)
Free/Reduced Price Lunch Program (FRPL)				
	Currently	24 (83%)	20 (83.3%)	
	In the past	1 (3%)	3 (8.3%)	
	Never	4 (14%)	3 (8.3%)	

Table 4: Child Physical Examination Measurements Pre- and Post-Intervention

Child measurement	**Pre-intervention** Mean (SD)	**Post-intervention** Mean (SD)	**P-value**
Weight average, kg (SD)	45.6 (3.2)	48.2 (3.1)	0.06
Height average, cm (SD)	140.4 (1.9)	140.8 (2.5)	0.3
BMI avg (SD)	22.7 (1.1)	24.3 (1.5)	0.08
BMI-for-age z-score	1.6 (0.3)	2.0 (0.3)	0.1
Waist circumference avg, cm (SD)	86.6 (5.8)	79.5 (3.1)	0.2

Table 5: Caregiver Physical Examination Measurements Pre- and Post-Intervention

Caregiver measurement	**Pre-Intervention N = 30**	**Post-Intervention N = 24**	**P- value**
Weight average, kg (SD)	76.3 (15.5)	76.4 (14.7)	0.86
Height average, cm (SD)	154.9 (11.5)	154.5 (11.3)	0.13
Caregiver BMI avg (SD)	32.0 (6.5)	32.3 (6.8)	0.09
Caregiver waist circumference avg (SD)	102.7 (10.9)	102.3 (12.7)	0.62
Caregiver systolic pressure avg. (SD)	119.4 (15.9)	125.0 (26.1)	0.27
Caregiver diastolic pressure (SD)	72.5 (7.0)	69.6 (9.2)	0.04

Table 6: Caregiver and Child Percentage consumption of 38 vegetables in past 7 days

	Pre-Intervention N=30	**Post-Intervention N= 24**	**P-value**
Caregiver, %	55.0	63.6	0.03
Child, %	27.9	33.9	0.12

Table 7: Caregiver Consumption of Vegetables Pre- and Post-Intervention (MyVeggies Survey)

Caregiver Statements	**Pre-Intervention N = 30**	**Post-Intervention N= 24**	**4-month Follow-up N=21**
I eat more than 2 kinds vegetable in a main meal, %			
No	13.0	4.0	0
Yes, Sometimes	57.0	33.0	38.0
Yes, often	7.0	33.0	33.0
Yes, everyday	23.0	29.0	29.0
P-value (compared to Pre-Intervention)		0.04	0.02
I consume__cup(s) of vegetables consumed daily. %			
Less than 1 ½ cups	73.3	66.7	23.8
1 ½ cups or more	26.7	33.3	76.2
P-value (compared to Pre-Intervention)		0.2	0.001

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