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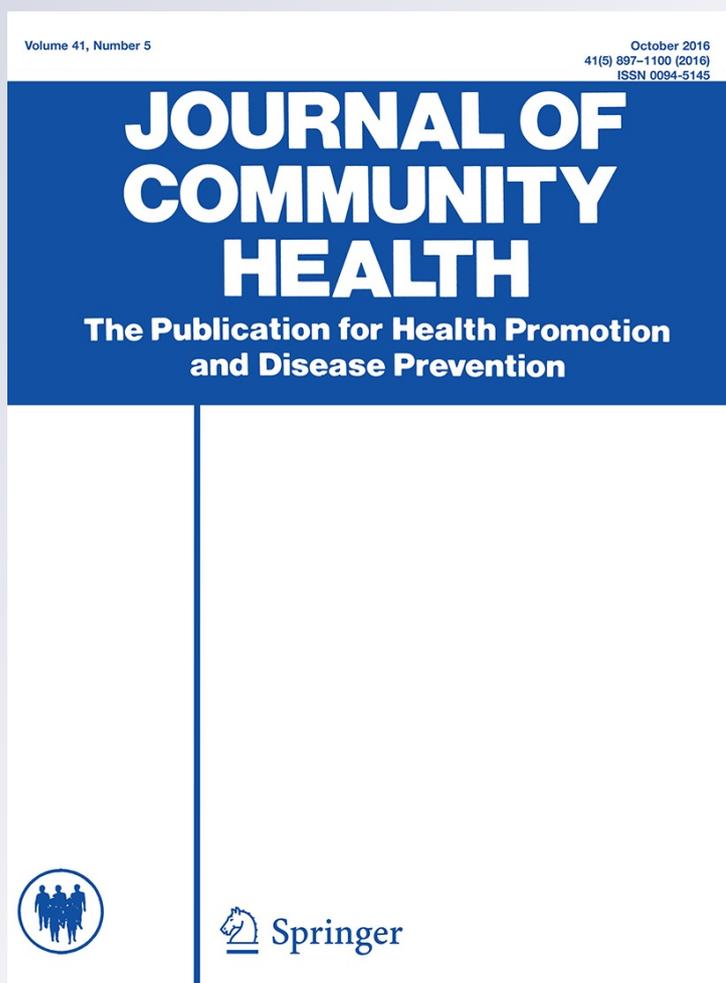
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# Analyzing the Role of Community and Individual Factors in Food Insecurity: Identifying Diverse Barriers Across Clustered Community Members

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**Abstract** This paper uses the results from a community food security assessment survey of 684 residents and three focus groups in Pueblo County, Colorado to examine the question: what community and individual factors contribute to or alleviate food insecurity, and are these factors consistent throughout a sub-county population. Importantly, we use a technique called cluster analysis to endogenously determine the key factors pertinent to food access and fruit and vegetable consumption. Our results show significant heterogeneity among sub-population clusters in terms of the community and individual factors that would make it easier to get access to fruits and vegetables. We find two distinct clusters of food insecure populations: the first was significantly less likely to identify increased access to fruits and vegetables proximate to where they live or work as a way to improve their household's healthy food consumption despite being significantly less likely to utilize a personal vehicle to get to the store; the second group did not report significant challenges with access, rather with affordability. We conclude that though interventions focused on improving the local food retail environment may be important for some subsamples of the food insecure population, it is unclear that proximity to a store with healthy food will support enhanced food security for all. We recommend that future research recognizes that determinants of food insecurity may vary within county or zip code level regions, and that multiple interventions that target sub-population clusters may elicit

better improvements in access to and consumption of fruits and vegetables.

**Keywords** Food security · Food insecurity · Community interventions · Cluster analysis · Fruit and vegetable consumption

## Introduction

Measuring US food insecurity and its causes has spurred a rich and multi-disciplinary literature. Defined by the U.S. Department of Agriculture (USDA) as, “access by all people at all times to enough food for an active, healthy life [1],” (4) its prevalence rate was relatively stable at 10–12 % until 2008, when concomitant with the Great Recession, it grew to almost 15 % nationwide [2]. Though many economic indicators signal an end to the Great Recession, national food insecurity incidence rates remain above 14 %, raising questions about the efficacy of traditional interventions, including how households or communities of need are identified, and what strategies are pursued to support increased access to and consumption of healthy food [3].

Since 1997, the USDA Food and Nutrition Service (FNS) has provided standardized estimates of food security at the state and national level [4]. Though the USDA does not provide sub-state level estimates, Feeding America, the country's largest domestic hunger-relief organization, generates county-level estimates to fill this gap [5]. These standardized approaches to the measurement of food security have attracted substantial attention in the literature, as well as with policymakers, funders, and nonprofit organizations. Although food security is primarily defined by a household's stated need to compromise the food offerings or alter eating patterns, it may also suggest that

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cheaper food options are chosen because of budget constraints. In USDA Economic Research Service estimates of food security, one of the key questions is on the ability of households to offer well-balanced meals [6]. The USDA/HHS and CDC both report that, among dietary guidelines, fruits and vegetables are most commonly below recommended intake levels [7, 8]. So, a focus on compromised fresh produce choices is commonly integrated into food security studies, especially those funded by public health agencies and non-profits.

The challenge with these data's emphasis on identifying specific geographies (i.e., the state, county, or neighborhood) as food secure or insecure is that sub-regional variations or delineations that define populations by non-geographic identifiers may be obscured. Identifying this within-region heterogeneity can be important in eliciting more targeted and appropriate interventions [5, 9–13].

This paper uses the results from a community food security assessment survey of 684 residents and three in-depth focus groups in Pueblo County, Colorado (CO) to examine the question: what community and individual factors contribute to or alleviate food insecurity, and are these factors consistent throughout a sub-county population. An additional contribution of this research is to use a clustering approach to examine the responses, which allows the data to endogenously determine the key factors pertinent to food access and fruit and vegetable consumption.

## Previous Literature and Key Study Variables

The need to better understand the heterogeneity of food insecurity and access within communities is well-documented in recent literature. Authors involved in generating Feeding America's estimates note reliance on county-level data available from the Current Population Survey, American Community Survey, and Bureau of Labor Statistics, cannot elucidate questions about heterogeneity within county populations, or reflect local-level efforts to reduce food insecurity [5]. Likewise, researchers caution that using a specific geography may disregard segments of food insecure populations [11, 13]. Carter et al.'s review of the literature found that none of the studies control for the potential for disadvantaged areas to confound relationships between the place factors and food insecurity [9]. Similarly, Harris et al. [10] motivated their research by stating that, despite a large literature on food insecurity, very little is known about its distribution at the community level.

## Community and Individual Factors

One innovation of this study's methodology is to divide potential factors related to food insecurity into two broad

categories: community and individual factors; the review of literature on these factors is summarized here.

### Community Factors: Food Retail Access

Within the US context, interventions to support improved food security outcomes are framed in terms of improving access to healthy foods [14]. Wilde et al. [15] classify three dominant approaches to assess the environment (low-income low-access, low-vehicle low-access, and relative distance), each of which includes varying assumptions about the relationships between poverty, vehicle access, population density, and proximity to supermarkets.

Research, however, is mixed on the relationship between food security and adequacy of the food retail environment. The Food Acquisition and Purchase Survey (FoodAPS) data provide strong evidence that households, including those that are low-income, do not do their primary food shopping at the closest available store. Rather, there are a variety of other factors, including price, quality, and selection, that affect where households do their primary food shopping. Interestingly, this holds true even for people who walk, bike, or use other transit to get to the store [1].

Concerns about well-balanced diets among the food insecure led to fruit and vegetable consumption being integrated as a key indicator in many food security studies [7, 8], including connection between the availability of supermarkets, healthier eating outcomes, and lower food prices [9, 16]. However, Kyureghian et al. [11] suggest that the densities of supermarkets and other retail outlets do not have significant effects on household fruit and vegetable purchases. Dean and Sharkey found that the relationship between the food retail environment, fruit and vegetable purchases, and subsequent intake differs when considering urban and rural settings [17].

### Community Factors: Transportation

There is a substantial literature on the relationship between access to transportation and food security; travel modes and distances may be important if food access depends on proximity to food retailers and/or access to a vehicle. Preliminary FoodAPS data show that the majority of households (88 %) use their own vehicle to get to the store where they do their main grocery shopping, but this share increases to 91 % if looking only at food secure households, and decreases to 70 % if looking only at food insecure households [1]. Carney found that physical proximity of outlets was the main determinant in household decisions, as those without adequate transportation were often reliant on walking for food shopping trips [18].

### Community Factors: Community Food Assistance

There is very limited evidence that the utilization of community food assistance programs reduces food insecurity (note that these are distinct from government sponsored programs like SNAP). Loopstra and Tarasuk [19] found that “among families who used food banks, there was no evidence that food bank use alleviated food insecurity” (508), which was consistent with an earlier study by Tarasuk and Beaton [20].

### Community Factors: Locally Grown Food Access

There is a small body of literature that examines the relationship between access to “locally grown” food and food security. Taylor and Lovell hypothesize that home gardens in developed countries contribute to food security by increasing the production and sharing of food, thus increasing overall daily consumption of fruit and vegetables [21]. Kortright and Wakefield [22] conclude that growing food contributes to enhanced food security at all income levels. Carney et al. [23] evaluated 163 household members who participated in a community garden program and found the frequency of both children and adult vegetable intake increased.

### Individual Factors: Cost

There is broad agreement in the literature about the inverse relationship of food insecurity and household income [12]. Guo [24] concludes that household assets have a significant association with food security in both the total population and among low-income households. Similarly, Gundersen et al. [25] find that perhaps the most important factor is the resources available to a household. Using representative data from the Canadian Community Health Survey, Olabiyi and McIntyre [26] find that food insecurity was higher among single-parent households and those with greater household size. Similarly, Harris et al. [10] find that fewer adults and the presence of children in the household predicted lower rates of household food security.

Several authors note that the relationship between food cost and food insecurity deserves additional attention. In part this is driven by disparities in percentage of income spent on food budgets: US households in the middle income quintile spent 13.1 % of their incomes on food, but the lowest income households spent 36.2 % [27]. Gregory and Coleman-Jensen [28] find that the average effect of food prices on the probability of food insecurity is positive and significant for households participating in the SNAP. Carney and Hendrickson et al. [18, 29] reported similar results: increases in food prices during the economic

recession translated to less robust food budgets and dietary consequences for low-income households.

### Individual Factors: Time and Education

There is also literature exploring the relationship between time, level of education, and food security. Beatty et al. find a significant relationship between time spent on food-related activities and food insecurity, and further conclude that low education, low food knowledge, and low healthy eating self-efficacy are associated with food insecurity [30]. Likewise, Davis and You argue that a better understanding of home food production may explain shortcomings in current nutrition programs since time is a more important factor in achieving nutritional targets than money [31].

Whereas for some of these factors there is broad agreement on the relationship (i.e., increased income leads to improved food security), for other factors, more research is needed (i.e., the relationship between the availability of food assistance programs or nearby retail food stores and food security).

### Methodology

This study shares a community-driven process to explore food insecurity in one region of Colorado. According to the USDA's Food Environment Atlas, Pueblo County has the highest percentage of the population in the state that is low income and also has low access to stores (1780 households, 67,049 people, 2010) [27]. Additionally, it is one of the poorest counties in Colorado. Almost 1 of 5 residents (19.1 %) are below the poverty line (compared to 13.2 % in Colorado, 2009–2013), with 45 % of students eligible for the free lunch program (2006). In the 2015 County Health Rankings, Pueblo County ranks 57 out of 60 for health behaviors (e.g., adult obesity, food environment index, physical inactivity), and 56 out of 60 for socioeconomic factors (e.g., income inequality, education, unemployment, children in single-parent households) [32]. Demographically, Pueblo's high percentage of the population that is Hispanic or Latino, 42.3 % compared to 21 % of Colorado, stands out [33].

In 2013, the Health Disparities Program at the Pueblo City-County Public Health Department (PCCCHD) initiated a food security assessment with a health disparities grant from the Colorado Department of Public Health & Environment in partnership with Colorado State University and WPM Consulting, LLC. The project team developed, implemented, and documented this food system assessment, based on guidance from a community-recruited Advisory Council consisting of 17 members organizations.

## Data Collection

The research team conducted surveys with 684 residents between March and June of 2013. The survey protocol was approved by Colorado State University's Institutional Review Board in March 2013 (ID# 13-4142H). Survey questions were framed based on food security literature, initial discussions with the Advisory Council and themes that emerged from a focus group with stakeholders. The food security questions were based on the six-item food security scale, developed by researchers at the National Center for Health Statistics.

A variety of outreach methods were used to reach and disseminate the survey to county residents, including: social media, radio, newspaper, flyers in public areas, and city and county government website postings. In addition, hardcopy surveys were distributed in-person at county emergency food pantries, CSU Extension Cooking Matters classes, the Care and Share Food Bank, the County's Department of Social Services, one local hospital, numerous faith-based organizations, and classes given in the Pueblo County Women, Infant, and Children program. Referral sampling from community partners and stakeholders was used to reach targeted groups that use free and reduced food assistance, a demographic that was otherwise under-sampled in the initial surveys collected by the research team.

Summary statistics of the socio-demographic information from the survey are reported in Table 1. Although referral sampling is a form of non-probability sampling, the sample demographics are quite similar to the population of Pueblo. Differences do appear in the percent of female and Hispanic respondents. The research team asked for survey respondents to be the primary household food shopper, which likely explains a skew towards female respondents (80 %) compared to the 51 % female sample expected in Pueblo County. In contrast, the sample is slightly under-representative of the Hispanic population; 34 % in our sample reported being Hispanic or Latino compared to the 42 % Hispanic share of population expected in the Pueblo region given US Census estimates [33].

In an effort to better familiarize the reader with the study region, we present Tables 2 and 3. Table 2 shows how some key demographics in Pueblo County, including how measures of food security, vary by race. Table 3 illustrates how one of the food security questions, "how frequently the respondent compromises their family's food choices," varies by key demographics. Some patterns emerge, such as larger households being more likely to have periods of insecurity, nonwhites having larger households, and subsequently, nonwhites being food insecure a bit more frequently.

In addition, the research team conducted three focus groups in June 2013 that included five randomly-selected individuals (for a total of 15 people). Qualitative responses provide additional context to the differing challenges with access to and consumption of healthy food.

## Factor and Cluster Analysis to Identify Pockets among the Food Insecure

The literature review suggests broad-sweeping recommendations with respect to food insecurity are likely to be flawed since such a diverse set and mix of factors may be underlying the food choices and constraints faced by households. For these reasons, we chose to use factor and cluster analysis methods to explore how a variety of similarly-constrained groups may see food insecurity factors similarly to one another, but in a distinctly different manner than other parts of the Pueblo community. Given that we wanted to make sure to present respondents with the full range of potential community or individual factors that might contribute to food insecurity, our survey includes over one hundred possible variables.

This large set of variables, however, encompasses too many dimensions to allow us to delineate concise themes and make useful recommendations. To narrow down to the most relevant issues, we first use factor analysis to identify clustering variables. Factor analysis allows us to confirm and understand the variability across people and the key variables that are most relevant to explain behavior [34]. This study's factor analysis focused on the variables summarized in Table 4. These variables had high factor loadings among our respondents; the internal reliabilities of factors exceeded the minimum criterion of 0.60 generally used with this method [35, 36].

Based on the results of the factor analysis, we narrowed to a subset of 31 variables to statistically formulate and create segmented household profiles based on purchasing patterns, preferences, and food security measures. Beyond those groups of variables with high factor loadings, some demographics were also maintained as a means to describe cluster populations using metrics that commonly define a community.

Using these key factors as attributes to define groups, a k-means clustering technique was used to segment respondents into subgroups such that individuals within a subgroup share similar behaviors relative to other subgroups, but factors and choices between the subgroups differ. In other words, respondents are grouped such that there is relative homogeneity within subgroups, yet the heterogeneity between subgroups suggests different approaches are needed to address food insecurity and challenges.

**Table 1** Summary of descriptive statistics (n = 684)

Variable	Description (Coding)	M	SD
Age	In years	43.82	14.64
Gender	1 if female; 0 if male	0.80	0.40
Household size	Actual no. in household, range: 1–5 or more	3.01	1.28
Members of household under age 18	Actual no. in household, range: 0–3 or more	1.99	1.10
Hispanic or Latino	1 if yes; 0 if otherwise	0.34	0.47
Education	Less than high school graduate	3 %	N/A
	High school graduate/GED	14 %	N/A
	Some college, no degree	28 %	N/A
	Associate's degree	18 %	N/A
	Bachelor's degree	23 %	N/A
	Graduate or professional degree	14 %	N/A
Household income	<10,000	16 %	N/A
	\$10,000–\$14,999	10 %	N/A
	\$15,000–\$24,999	10 %	N/A
	\$25,000–\$34,999	15 %	N/A
	\$35,000–\$49,999	17 %	N/A
	\$50,000–\$74,999	12 %	N/A
	\$75,000–\$99,999	10 %	N/A
	\$100,000–\$149,000	6 %	N/A
>\$150,000	4 %	N/A	

N/A not applicable

**Table 2** Selected demographic variables, by race (n = 684)

Household reported race	Frequency respondent compromises on healthy food items based on budget concerns (1 always, 5 never)	Frequency unable to feed your household (1 = always, 5 = never)	Household size	Gender (0 = male, 1 = female)	Education (see Table 1 categories)	Income (see Table 1 categories)
White (n = 368))	3.35	3.70	2.92	0.80	4.20	5.43
Nonwhite (n = 316)	3.24	3.66	3.13	0.92	3.41	4.62
Full sample	3.30	3.68	3.01	1.86	3.85	5.05

**Table 3** Responses to “how frequently the respondent compromises their family’s food choices” by key demographics

Frequency respondent compromises on healthy food items based on budget concerns	Household size	Gender (0 = male, 1 = female)	Education (see Table 1 categories)	Income (see Table 1 categories)
Always (n = 108)	3.10	0.85	3.91	5.28
More than half the time (n = 124)	3.23	0.85	3.80	5.15
Half of the time (n = 106)	3.15	0.81	3.63	4.71
Less than half the time (n = 147)	2.86	0.88	3.87	4.69
Never (n = 199)	2.88	0.87	3.94	5.33
Full sample	3.01	1.86	3.85	5.05

**Table 4** Community and individual variables used to determine clusters

Questions	Community and individual variables
Where do you get most of the foods that your family eats?	Fast food restaurants Other restaurants Work place and public cafeterias Senior centers Food assistance program Meal delivery program Large chain grocery stores Wholesale store Convenience store Natural food store Independent local food store Direct from meat processor or ranch Online purchases I grow make or hunt my food
How do you get to the places where you buy or receive fruits or vegetables?	Bike Walk Shuttle or taxi In someone else's car Personal car Bus It is delivered to me
What makes it challenging to get fruits and vegetable?	Ease of access Ability to carry what I buy Store hours Cost Physical limitations Amount of time available Fruits and vegetables are not available where I get food Not applicable I do not eat fruits and vegetables Not applicable I have no challenges

After testing for significant difference in variables across cluster groups, they are labeled as suggested by key attributes. Then, comparisons across clusters are used to explore the diversity of food access perceptions and challenges.

**Results**

We divide our cluster results into two sections. First, we define and name the clusters, based on each cluster subgroup's responses. Second, we present individual and community variables, differentiating by cluster, and draw inferences on what factors may affect, alter or constrain the purchasing and consumption of fruits and vegetables of each cluster group. Finally, we use qualitative data from

the focus groups to substantiate these results and better inform our inferences as applicable.

**Cluster Descriptive Statistics and Levels of Food Security**

Commonly shared demographic and descriptive statistics, by cluster, are presented in Table 5. Table 6 provides more detail on food security, fruit and vegetable consumption, and where households purchase most of their food, by cluster. Table 7 shows the differences in modes of transportation to fruit and vegetable purchase source among clusters. Though the significant differences between clusters are presented using pairwise comparisons, we additionally conducted f-tests for each of the clusters on two variables key to our research question: how often they

**Table 5** Key demographics, by cluster

n		# In household	# In household under 18	Gender (0 = male, 1 = female)	Age (years)	Avg. income per household member (\$)	Hispanic/Latino (0 = no, 1 = yes)	Education (1 = less than high school grad, 6 = grad or professional degree)
173	Food engaged and secure	2.80 <sup>c</sup> (.09)	1.79 <sup>c</sup> (.08)	0.81 (.03)	45.98 (1.10)	19,160.92 (1643.00)	0.37 (0.04)	3.89 (0.11)
54	Away from home price conscious fruit and vegetable eaters	3.15 (0.18)	2.12 (0.16)	0.81 (0.05)	47.06 (2.07)	16,652.62 (2464.92)	0.33 (.06)	3.80 (0.20)
115	Food secure with inconvenient access to fruits and vegetables	2.74 <sup>h</sup> (0.12)	1.87 (0.10)	0.67 <sup>h</sup> (0.04)	45.31 (1.59)	24,765.10 (2,967.04)	0.35 (0.04)	3.99 (0.13)
299	Compromised consumers	3.24 <sup>ch</sup> (0.07)	2.11 <sup>c</sup> (0.07)	0.88 <sup>hj</sup> (0.02)	42.02 (0.84)	17,011.16 (1,161.49)	0.34 (0.03)	3.74 (0.08)
43	Single and food insecure	2.86 (0.23)	2.13 (0.19)	0.6 <sup>i</sup> (0.08)	38.72 (2.52)	22,367.89 (5,452.24)	0.19 (0.06)	4.10 (0.21)

Standard errors in parentheses. Superscripts denote statistical differences in means, where tests were based on pairwise comparisons. The codes defined in the footnote below indicate significant differences between the clusters of respondents analyzed in this study and are the findings from combinations of pairwise tests

<sup>a</sup> Cluster 1&2, <sup>b</sup> Clusters 1&3, <sup>c</sup> Clusters 1&4, <sup>d</sup> Clusters 1&5, <sup>e</sup> Clusters 2&3, <sup>f</sup> Clusters 2&4, <sup>g</sup> Clusters 2&5, <sup>h</sup> Clusters 3&4, <sup>i</sup> Clusters 3&5, <sup>j</sup> Clusters 4&5

compromise their food choices; and how often they are unable to feed their household. The f-tests present additional, strong evidence that Pueblo citizens are effectively grouped into segments with similar perceptions (see Table 8).

Cluster 1 (173 individuals, or 25 % of the sample), labeled *Food engaged and secure*, is the second largest subgroup. This group self-reports as the most food secure (4.38), and least likely to compromise healthy food choices because of budget concerns (4.12) (see table for detail of ranges). With high levels of access to their own personal vehicles (1.20) these households rarely use other forms of transportation. One reason for this group's label is because they are more interested in enhancing local food infrastructure (farmers' markets, 2.40, producer or farm stands, 3.08) to make it easier to access fruits and vegetables, and less likely to purchase food away from home. This cluster also self-reported the second highest daily consumption rate of fruits and vegetables compared to the other groups (3.92/day). This cluster has the smallest average number of household members under 18 (1.79) and the highest percentage of Hispanic and Latino respondents (0.37). Given their self-reported food security, it was a bit surprising they report one of the lowest average per capita incomes (\$19,160).

Cluster 2 (54 individuals, 8 % of the sample), labeled *Away from home price conscious fruit and vegetable eaters*, most commonly eat food away from home

and is most likely to get some food assistance from food banks, food pantries, or churches (3.26), as well as through senior centers or meal delivery programs (7.52). The cluster label indicates that individuals report the largest average number of fruit and vegetable servings per day (4.17/day) and are fairly food secure (3.56). Still, they are very price sensitive—they are the second most likely group to compromise on healthy food items because of budget concerns (3.11), are most likely to shop at wholesale stores (3.17), and have the lowest per capita income (\$16,652). This group has the second largest number in its household (3.15), as well as the second largest number in household under 18 (2.12), and is largely comprised of female respondents (0.81).

Cluster 3 (115 individuals, 17 % of the sample), labeled *Food secure with inconvenient access to fruits and vegetables*, is highly food secure (3.97), and has the second highest daily consumption of fruits and vegetables (3.74/day). However, on average this group gets its fruits and vegetables from sources a further distance away (3.85), and yet is slightly less likely to use a personal car to buy fruits and vegetables (1.29). They are also least likely to get food from food assistance programs (3.89). This cluster has the smallest average number in its household (2.74), which may explain why they have the highest per capita income (\$24,765), and supports their perception of strong food security. This subgroup is comprised of the second lowest share of females (0.67), as well as the

**Table 6** Food security, fruit and vegetable consumption, and most frequent place households get food, by cluster

n	Frequency unable to feed your household (1 = always, 5 = never)	Frequency compromise on healthy food items b/c of budget concerns (1 = always, 5 = never)	# Fruit and vegetable servings per day	How far do you live from where you get most of your fruits and vegetables (1 = closest, 7 = farthest)	Fast food, restaurant, work place, public cafeteria (1 = most common, 12 = least common)	Senior center, meal delivery (1 = most common, 8 = least common)	Food assistance, food bank, food pantry, church (1 = most common, 4 = least common)
173	Food engaged and secure 4.38 <sup>abcd</sup> (0.08)	4.12 <sup>abcd</sup> (0.09)	3.92 <sup>d</sup> (0.11)	3.51 (0.10)	10.75 <sup>a</sup> (0.12)	7.91 (0.03)	3.72 <sup>a</sup> (0.06)
54	Away from home price conscious fruit and vegetable eaters 3.56 <sup>a</sup> (0.19)	3.11 <sup>a</sup> (0.21)	4.17 <sup>e</sup> (0.19)	3.41 (0.19)	8.96 <sup>defg</sup> (0.30)	7.52 <sup>f</sup> (0.18)	3.26 <sup>efg</sup> (0.16)
115	Food secure with inconvenient access to fruits and vegetables 3.97 <sup>bhi</sup> (0.13)	3.74 <sup>hi</sup> (0.12)	3.82 <sup>i</sup> (0.13)	3.85 <sup>i</sup> (0.15)	10.84 <sup>e</sup> (0.13)	7.87 <sup>h</sup> (0.05)	3.89 <sup>e</sup> (0.04)
299	Compromised consumers 3.26 <sup>ch</sup> (0.08)	2.78 <sup>ch</sup> (0.08)	3.85 <sup>j</sup> (0.09)	3.42 (0.08)	10.84 <sup>f</sup> (0.07)	7.99 <sup>h</sup> (0.01)	3.87 <sup>f</sup> (0.03)
43	Single and food insecure 3.19 <sup>di</sup> (0.22)	2.70 <sup>di</sup> (0.23)	3.09 <sup>deij</sup> (0.21)	3.05 <sup>i</sup> (0.23)	10.81 <sup>g</sup> (0.22)	7.88 (0.83)	3.86 <sup>g</sup> (0.09)

Standard errors in parentheses. Superscripts denote statistical differences in means, where tests were based on pairwise comparisons. The codes below were used for different combinations of pairwise tests

<sup>a</sup> Cluster 1&2, <sup>b</sup> Clusters 1&3, <sup>c</sup> Clusters 1&4, <sup>d</sup> Clusters 1&5, <sup>e</sup> Clusters 2&3, <sup>f</sup> Clusters 2&4, <sup>g</sup> Clusters 2&5, <sup>h</sup> Clusters 3&4, <sup>i</sup> Clusters 3&5, <sup>j</sup> Clusters 4&5

**Table 7** Usual modes of transportation to the places where they buy/receive fruits and vegetables, by cluster

n		Bus	Shuttle/taxi	It is delivered to me	Bike	In someone else's car	Walk	Personal car
173	Food engaged and secure	3.99 <sup>d</sup> (0.01)	4.00 <sup>cd</sup> (0.00)	3.99 <sup>cd</sup> (0.01)	3.94 <sup>d</sup> (0.03)	3.68 <sup>d</sup> (0.05)	3.84 <sup>cd</sup> (0.04)	1.20 <sup>d</sup> (0.06)
54	Away from home price conscious fruit and vegetable eaters	4.00 <sup>g</sup> (0.00)	4.00 <sup>efg</sup> (0.00)	3.98 <sup>e</sup> (0.02)	3.96 (0.04)	3.61 <sup>g</sup> (0.10)	3.74 <sup>g</sup> (0.08)	1.06 <sup>g</sup> (0.06)
115	Food secure with inconvenient access to fruits and vegetables	3.98 <sup>i</sup> (0.01)	3.92 <sup>e</sup> (0.04)	3.81 <sup>e</sup> (0.06)	3.90 <sup>i</sup> (0.04)	3.56 <sup>i</sup> (0.08)	3.69 <sup>i</sup> (0.07)	1.29 <sup>i</sup> (0.08)
299	Compromised consumers	3.99 <sup>j</sup> (0.01)	3.98 <sup>efj</sup> (0.01)	3.92 <sup>e</sup> (0.02)	3.95 <sup>j</sup> (0.02)	3.48 <sup>j</sup> (0.05)	3.66 <sup>ej</sup> (0.04)	1.13 <sup>j</sup> (0.03)
43	Single and food insecure	2.07 <sup>dghj</sup> (0.11)	3.70 <sup>dghj</sup> (0.13)	3.91 <sup>d</sup> (0.04)	4.00 <sup>dij</sup> (0.00)	1.19 <sup>dghj</sup> (0.06)	3.00 <sup>dghj</sup> (0.19)	3.60 <sup>dghj</sup> (0.12)

Standard errors in parentheses. Superscripts denote statistical differences in means, where tests were based on pairwise comparisons. The codes below were used for different combinations of pairwise tests

<sup>a</sup> Cluster 1&2, <sup>b</sup> Clusters 1&3, <sup>c</sup> Clusters 1&4, <sup>d</sup> Clusters 1&5, <sup>e</sup> Clusters 2&3, <sup>f</sup> Clusters 2&4, <sup>g</sup> Clusters 2&5, <sup>h</sup> Clusters 3&4, <sup>i</sup> Clusters 3&5, <sup>j</sup> Clusters 4&5

**Table 8** F test results for selected variables

	Frequency unable to feed your household	Frequency compromise on healthy food items b/c of budget concerns
Food engaged and secure	2.33***	14136.24***
Away from home price conscious fruit and vegetable eaters	1.03	1.58*
Food secure with inconvenient access to fruits and vegetables	1.24*	5.54***
Compromised consumers	148.37***	2.84***
Single and food insecure	2.66***	1.44*

Asterisks indicate significance at: \* $\alpha = 0.1$ ; \*\* $\alpha = 0.05$ ; \*\*\* $\alpha = 0.01$

smallest number of household members under 18 (though insignificant).

Cluster 4, (299 individuals, 44 % of sample), labeled *Compromised consumers*, is the largest subgroup. This is the second most food insecure cluster (3.26), and the second most likely to compromise on choosing healthy food due to budget concerns (2.78). Compared to other clusters, this group is most likely to walk to access fruits and vegetables (3.66), yet they do have access to a personal vehicle (1.13) and are not using other forms of transportation. This cluster is generally not using food assistance programs (3.87), despite reporting interest in accessing more affordable fruits and vegetables. This subgroup also has the largest average number in their household (3.24), with relatively low income per household member (although insignificant), the highest percentage of females (0.88) and

lowest average educational attainment (3.74, although insignificant).

Cluster 5 (43 individuals, 6 %), labeled *Single and food insecure*, is most frequently unable to feed their household (3.19) and commonly compromise on choosing healthy food items because of budget concerns (2.70). They also consume fewer average servings of vegetables a day than any other subgroup (3.09/day). On average, this is the cluster with the highest proportion of male respondents (0.6), has an average number of people in its household (2.86), but the highest number in household under 18 (2.13), suggesting a higher prevalence of single parents. They are more likely than other subgroups to use a variety of transportation methods including: bus (2.07), shuttle or taxi (3.70), and someone else's car (1.19), and are statistically less likely to use a personal vehicle (3.60). And

perhaps, as a result, they live closer to where they get their fruits and vegetables than any other cluster (3.05).

**Individual and Community Variables that would Change Purchasing Patterns by Cluster**

The clusters are perhaps even more informative when one considers how those diverse households may view strategies that could impact their choices and lessen their perceived food insecurity. We see both evidence of heterogeneity and homogeneity among household groups, and consider qualitative focus group discussion to enrich the data.

There are four statistically significant differences in community factors that households report might make it easier to get more fruits and vegetables (Table 9). As one would expect, the *Single and food insecure* cluster, the group of households least likely to use a personal vehicle to get fruits and vegetables, was the most likely to support increasing bus routes or shuttle services to places that sell fruits and vegetables (3.74) or would welcome “more grocery stores near where I live or work” (3.53). One focus group attendee illustrated the importance of this with the remark that “they are thinking about cutting bus service on Saturday. That eliminates one of our grocery shopping

days. There’s no service at all on Sunday. Period.” For the majority of respondents, however, transportation was not an issue.

To the point of addressing the retail food environment, one cluster, *Food secure with inconvenient access to fruits and vegetables*, was significantly more likely to prioritize more grocery stores near “where I live or work” (3.55). Yet the other clusters—including *Single and food insecure*, the most food insecure cluster—did not think having more convenient access to fruits and vegetables would be that important. One focus group participant remarked, “I would rather go to Double J once per month and buy all of the meat that I would need for the month and buy the rest of my groceries at Walmart because the quality is better.” This finding that the majority of households do not shop at the nearest store is directly in line with Ver Ploeg et al.’s [1] findings using the USDA FoodAPS data. Accordingly, transportation and nearby markets are a concern for some, but suggesting they may be a broadly impactful strategy to address food insecurity would be misguided.

The *Single and food insecure* cluster was most likely to want increased offerings of produce in these food assistance programs (3.07). One focus group participant stated, “I think what we need to look at this type of food that is distributed. Having access to healthier options at food

**Table 9** Community and individual factors that would make it easier to get access to fruit and vegetables, by cluster

n		Community factors					Individual factors	
		More farmers’ markets	More producer or farm stands	Bus routes or shuttle service to places that sell them	More grocery stores near where I live/work	More provided at my food bank/food pantry/meal delivery program	More affordable to me	More time to prepare/cook them
173	Food engaged and secure	2.40 (0.10)	3.08 <sup>d</sup> (0.08)	3.99 <sup>d</sup> (0.01)	3.84 <sup>b</sup> (0.05)	3.91 <sup>cd</sup> (0.03)	2.75 <sup>acd</sup> (0.11)	3.06 (0.09)
54	Away from home price conscious fruit and vegetable eaters	2.48 (0.17)	3.39 (0.14)	3.87 (0.07)	3.76 (0.11)	3.91 <sup>g</sup> (0.06)	1.85 <sup>ae</sup> f (0.17)	2.98 (0.16)
115	Food secure with inconvenient access to fruits and vegetables	2.58 (0.12)	3.37 (0.09)	3.93 (0.04)	3.55 <sup>b</sup> (0.09)	3.81 <sup>i</sup> (0.07)	2.61 <sup>chi</sup> (0.13)	3.07 (0.12)
299	Compromised consumers	2.44 (0.07)	3.20 (0.07)	3.97 (0.02)	3.73 (0.04)	3.75 <sup>cj</sup> (0.05)	1.35 <sup>cfhij</sup> (0.05)	3.27 (0.06)
43	Single and food insecure	2.93 (0.19)	3.56 <sup>d</sup> (0.15)	3.74 <sup>d</sup> (0.10)	3.53 (0.14)	3.07 <sup>dgi</sup> j (0.20)	1.91 <sup>dij</sup> (0.20)	3.23 (0.16)

\* 1 = yes, would make it easier, 4 = no, would not make it easier

Standard errors in parentheses. Superscripts denote statistical differences in means, where tests were based on pairwise comparisons. The codes below were used for different combinations of pairwise tests

<sup>a</sup> Cluster 1&2, <sup>b</sup> Clusters 1&3, <sup>c</sup> Clusters 1&4, <sup>d</sup> Clusters 1&5, <sup>e</sup> Clusters 2&3, <sup>f</sup> Clusters 2&4, <sup>g</sup> Clusters 2&5, <sup>h</sup> Clusters 3&4, <sup>i</sup> Clusters 3&5, <sup>j</sup> Clusters 4&5

pantries is going to improve the health of the population because they are going to access that.” But, the other four clusters did not prioritize this strategy, even though the *Away from home price conscious fruit and vegetable eaters* were more likely to access that source of produce. One focus group participant remarked, “You are ashamed because the system makes you feel ashamed,” indicating the stigma associated with community food assistance programs as one of the barriers to utilization.

The most food secure cluster, *Food engaged and secure*, was the most likely to want more producer or farm stands to support improved fruit and vegetable consumption (3.08). One focus group participant stated, “There is a couple that comes and sells produce out of a truck... quality is great, and it is cheaper than the grocery market, but it is only available a couple of months out of the year.” However, the least food secure group, *Single and food insecure*, was the least likely to support more producer or farm stands (3.56). Subsequently, focus group participants described concerns about distance as perceived challenges with farm stands. One focus group participant stated, “A lot of people like to buy their food from the...farms directly...but it’s really far to get there.”

The community factor questions also revealed pockets of homogeneity among the subgroups: every subgroup gave ‘more farmers’ markets’ the highest marks as a method to facilitate their access to more fruits and vegetables. Focus group remarks about farmers’ markets also included positive perceptions toward direct channels with comments like, “getting local foods is very important because they are fresher and have more nutrients.” And, “...food from the farmers’ market...is fresher and cheaper.”

Still, price matters. The individual factor that all of the clusters consistently ranked ‘if they were more affordable’ as the most important method to get more fruits and vegetables. Despite the relative homogeneity of this response, it is the only individual factor with statistically significant differences between the clusters, and not surprisingly, the *Food engaged and secure* group being least likely, the *Single and food insecure* were the second least likely, followed by *Away from home price conscious fruit and vegetable eaters* (1.85), with *Compromised consumers* reporting increased affordability as most important (1.35). One focus group participant, for example, said, “Affordability would be the top of the list for most people.”

‘More time to prepare and cook fruits and vegetables’ was collectively ranked the second most important personal factor and focus group participant stated, “For me, it would probably be having the time to fix what I like the most. I work again, and it is kind of hard to go home and roast a chicken in 30–45 min.” But, time was not as

important to any of the clusters as affordability, and there are no statistically significant differences.

## Discussion and Future Research

This research examines community and individual factors that may contribute to or alleviate food insecurity. Using responses and cluster results from a community food security assessment that included a survey of 684 residents and focus groups, we find that there are significant differences in the determinants of food insecurity within subgroups of the population. Based on our results, we conclude that, though interventions focused on addressing the local food retail environment may be important for some subsamples of the food insecure population, it is not clear that proximity to a store with healthy food will support enhanced food security for all. In fact, the most food insecure cluster, *Single and food insecure*, was significantly less likely to identify increased access to fruits and vegetables near “where I live or work” as a way to improve their household’s consumption of these healthy foods – even though this group was also significantly less likely to use a personal vehicle to go to the store. Further, the second most food insecure cluster, *Compromised consumers*, did not report significant challenges with *access* to fruits and vegetables, rather, making fruits and vegetables more affordable was significantly more likely to make it easier for them to consume these goods. For ease of exposition, Table 10 provides a summary of key findings.

Our findings align with the recently released data from the USDA FoodAPS survey, both of which provide substantial evidence that there are a variety of factors other than proximity that affect where households shops. This research shows that price is by far the most important of those factors: all respondents cited reduced cost as the primary factor that would support increased access to and consumption of fruits and vegetables.

Accordingly, interventions that focus on getting more healthy foods into geographies identified as inadequate food retail access may not result in the intended outcomes for some segments of food insecure populations. This is particularly true as it is not clear that increasing access to healthy food at these local establishments—e.g., corner or neighborhood stores—will result in cost effective options for food insecure residents.

In our study, though improving the local retail environment was desired in the eyes of the *Food secure with inconvenient access to fruits and vegetables* cluster, increased access to reliable, convenient, and cost effective transportation was reported to be significantly more important for the most food insecure cluster, *Single and*

**Table 10** Summary of key findings

	Frequently unable to feed your household	Frequency compromise on healthy food items b/c of budget concerns	# Fruit and vegetable servings per day	Where household gets food:		Usual mode of transportation to where household buys/receives fruits and vegetables:		Individual factors that would make it easier to get access to fruits and vegetables:	
				Fast food, restaurant, work place, public cafeteria	Food assistance, food bank, food pantry, church	Bus	In someone else's car		More provided at my food bank/food pantry/meal delivery program
Food engaged and secure	-	-		-	-	-	+	-	-
Away from home price conscious fruit and vegetable eaters				+	-	-	+	-	+
Food secure with inconvenient access to fruits and vegetables				-	-	-	+	-	-
Compromised consumers	+	+		-	-	-	-	-	+
Single and food insecure	+	+	-	-	+	+	-	+	+

'+' significantly more likely than other clusters, '-' significantly less likely than other clusters

*food insecure*. Given the latter is a more susceptible population, too narrow a focus on the retail environment would be problematic and minimize the chances for a meaningful food security outcome.

Based on our results, we recommend that future research recognizes that determinants of food insecurity may vary and that multiple interventions that target sub-population clusters within a geography (regardless of its definition) may elicit better improvements in access to and consumption of healthy food. As is the case with so many significant societal challenges, a portfolio of policy and program options should be considered, along with metrics that are meaningful to the target populations of those interventions.

### Implications for the Pueblo Community

The assessment uncovered both challenges and opportunities including untapped potential to feed more local residents, as well as data on the current realities of Pueblo's residents who currently lack consistent access to healthy foods. Accordingly, after several presentations of results to Pueblo County stakeholders, the Food Assessment Advisory Council made the decision to transition to a Food Action Council under the Health Disparities Mid-Level Obesity Stakeholder group in order to provide long-term sustainability for the group.

From the broader assessment's recommendations on consumers and markets, as well as findings from the survey clustering, there is evidence that both education (on growing your own produce) and increasing outreach and awareness about current direct market outlets would benefit many Pueblo residents. Given the widespread popularity of farmers' markets as a potential community solution, and how strong and well-established federal food assistance programs are in the region, Pueblo County immediately began enacting policies in support of EBT access at farmers' markets, the use of Women, Infants, and Children (WIC) vouchers at markets or CSAs, and the Senior Farmers' Market Nutrition Program that will effectively lower the cost of buying at some outlets. Moreover, they are actively (and successfully) exploring partnerships to establish an incentive program that would enhance the dollar amount of SNAP benefits redeemed at farmers' markets. Pueblo is also assessing the option to host regular farmers' markets at District 60 and District 70 schools that are in low retail food environment census tracts, allowing residents to experience increased access to safe, healthy foods each week without needing to construct a full-service grocery store.

However, there were limitations to our study and its ability to drive changes that would benefit some of the food insecure. Although some of the most food insecure did see

transportation barriers and time as a challenge, few of the recommended steps by Pueblo's Advisory Council address those issues, perhaps because of the inability to engage those that lead transportation planning in the region.

In a more general sense, this community-driven study provides a rich context to explore those perceptions among the food insecure that are consistently held, and contrast them with those factors, determinants, and strategies that are viewed quite differently among households. Our hope is that this moves the field forward to consider the multiplicity of factors, individual and community-based, that may be of importance to future programming and policies.

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### Compliance with Ethical Standards

**Conflict of interest** The authors declare that they have no conflict of interest.

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