Current Research

Seasonal Variation in Fruit and Vegetable Consumption in a Rural Agricultural Community

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ABSTRACT

Background Seasonal variation in fruit and vegetable consumption has been documented in a limited number of previous investigations and is important for the design of epidemiologic investigations and in the evaluation of intervention programs.

Objective This study investigates fruit and vegetable consumption behaviors among Hispanic farmworkers and non-farmworkers in a rural agricultural community.

Design A larger study recruited 101 farmworker families and 100 non-farmworker families from the Yakima Valley in Washington State between December 2004 and October 2005. All families were Hispanic. An in-person administered questionnaire collected information on consumption of locally grown fruits and vegetables and sources of obtaining fruits and vegetables. Data on dietary intake asked whether or not the respondent had consumed a given fruit or vegetable in the past month. Data were collected longitudinally, coinciding with three agricultural seasons: thinning (summer), harvest (fall), and nonspray (winter).

Statistical analyses performed Generalized estimating equations were used to test for statistical significance between proportions of the population who consumed a given fruit or vegetable across agricultural seasons. Multivariable logistic regression was performed and corresponding odds ratios and 95% confidence intervals are reported.

Results The proportion of respondents who ate apples, pears, plums, peaches, apricots, peppers, corn, and cucumbers was highest in the fall harvest season, whereas the proportions of those who ate cherries and asparagus were highest in the summer thinning season. Compared to non-farmworkers, a higher proportion of farmworkers reported having eaten peaches, apricots, cherries, green beans, carrots, peppers, corn, pumpkin, squash, and onions, in the past month.

Conclusions Epidemiologic investigations and public health interventions that examine the consumption of fruits and vegetables should consider seasonal variation in consumption patterns, especially in agricultural communities.

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Differences across chronologic season in the quantity of fruits and vegetables consumed has been documented in several previous epidemiologic investigations (1-5). Ziegler and colleagues (1) documented that vegetables are generally eaten year-round, whereas certain fruits are eaten primarily in a single season. Several international studies have documented substantial seasonal variation in fruit and vegetable consumption (2-5). Variation in these studies has ranged from a 5.3% increase in fruit consumption between seasons among Spanish women (3), to a twofold increase in vegetable consumption between seasons among Slovak men (4). Indeed, the relative change in consumption patterns across seasons and the populations of previous research vary. To our knowledge, the seasonal variation of fruit and vegetable consumption has yet to be studied in an agricultural setting.

Because the types and quantity of fruits and vegetables consumed are thought to vary across seasons, nutritional epidemiologic studies that rely on dietary information collected cross-sectionally may be limited by systematic variability in participant responses (5,6). Failure to account for this variability may obscure associations between dietary consumption and disease risk. Seasonal variation in consumption practices, moreover, may bias evaluations of intervention programs that promote fruit and vegetable intake, if pre- and postintervention data are collected during different seasons.

Several characteristics of agricultural communities make unique the study of the seasonal variation in fruit and vegetable consumption. First, the supply of fruits and vegetables in rural communities is high during the harvest season, when farmers markets are flooded with fresh locally grown produce. The heightened supply leads to lower prices, which rebound in the winter and spring. The supply and cost of local fruits and vegetables is thought to be more variable in agricultural communities compared to urban centers, where it is generally believed that a greater percentage of produce is obtained from supermar-

kets, and transportation and handling costs serve to stabilize prices in neighborhood produce markets. Thus, we hypothesize that members of a rural agricultural community experience a greater seasonal variation in fruit and vegetable intake compared to the general United States' population.

Hispanic farmworkers are of particular interest regarding fruit and vegetable consumption. Eighty-three percent of US-hired crop labor force is of Hispanic ethnicity, the majority of which are Mexican-born (7). They experience higher risks of food insecurity and hunger compared to the general population (8). Thirty percent of farmworkers live below the federal poverty level (7), which increases the risk for nutrition-related health problems (9). Although Hispanic farmworkers play an important role in food production in the United States, they are at a greater risk than other groups of consuming inadequate amounts of fruits and vegetables; Kowalski and colleagues (9) reported that 89% of farmworkers have inadequate consumption of fruits and vegetables.

In this study, we analyzed dietary data from a community research project that is part of the Centers for Child Environmental Health Risks Research at the University of Washington. The project's primary aim was to examine the multiple pathways of pesticide exposure among farmworker and non-farmworker adults and children; one pathway it explored was the dietary pathway. Our analyses had two goals: the first was to describe the fruit and vegetable consumption patterns (and purchasing behavior) of rural Hispanics across agricultural seasons, the second was to examine the difference in consumption patterns between farmworkers and non-farmworkers. We also sought to describe the sources of locally grown produce across season. We hypothesized that the variation in fruit and vegetable consumption is high in this agricultural region, particularly among farmworkers.

METHODS

Between December 2004 and October 2005, a longitudinal cohort study was carried out in the Lower Yakima Valley of Washington State. The Lower Yakima Valley, which is the lower part of Yakima County, as well as part of neighboring Benton County, contains many small agricultural communities and has the greatest percentage of Hispanics in Washington State. An estimated 50,000 people work in agriculture in the region. The Lower Yakima Valley leads the nation in its production of apples and sweet cherries. Other major agricultural crops include pears, peaches, grapes, and hops.

Types of fruits and vegetables that were examined in this study can be grown locally, although data do not distinguish between local and imported produce. In the Yakima Valley, produce is harvested during the months of April through October. Specifically, the asparagus harvest begins in April and peaches, apricots, and cherries are harvested beginning in June. Several vegetables are harvested beginning in July, including tomatoes, cucumbers, squash, and corn. In August, peppers, carrots, plums, pears, and apples are harvested, and in September onions and pumpkins begin harvest. For the purposes of the parent study, farmworkers who only worked in apples and pears were eligible to participate.

The aim of the study was to recruit 100 Hispanic farmworker families and 100 Hispanic non-farmworker families. Eligibility criteria included having a child between the ages of 2 and 6 years (because the parent study emphasized children's protection from pesticide exposure). To be considered eligible for the farm-worker group a parent must have worked in apple or pear crops during the previous 2 weeks. A convenience sample of farmworkers and non-farmworkers was recruited. Trained bilingual, bicultural study staff recruited participants at retail outlets, churches, and through door-to-door solicitation in the Lower Yakima Valley. Flyers announcing the study were posted in community organizations and commercial outlets. Informed consent was obtained from all participants.

Data were collected at three different time periods, which corresponded to agricultural growing seasons and that roughly corresponded to three seasons of the year. The first survey period, corresponding to the thinning season for apples and pears, was between June and July 2005 (summer). During the thinning season, farmworkers remove, by hand, small buds and shoots from the limbs of trees to allow the remaining buds to produce larger fruit. The second survey period took place between September and October 2005 (fall), which was the harvest season for apples and pears, among other crops. The third survey was conducted between December 2005 and January 2006 (winter). This period was considered the nonspray period in which few if any pesticides are applied to the fields. Agricultural tasks common during this period include pruning and tying branches to maximize sun exposure.

At each period, trained research staff interviewed participants using a questionnaire reviewed by the Institutional Review Board at Fred Hutchinson Cancer Research Center. Each participant family (one adult and one child) was compensated $160 for participating in the data collection for all three seasons. Through structured interviews, participants were asked whether in the past month they had consumed a given fruit or vegetable and whether it was purchased fresh, dried, canned, or frozen. An additional question asked about the source of produce (regardless of whether it was grown locally). Response categories for this question included grocery store, fruit stand, work, own or friend's garden, and other, which was self-specified. All dietary questions were asked of the same adult participants at each sampling period. Demographic questions asked about sex, age, marital status, annual household income, birthplace, and language spoken.

To determine whether there was a statistically significant difference in the proportion of the total study population who consumed fruits and vegetables between agricultural task seasons, we used the method of generalized estimating equations with a binomial family and a logit link. Multivariable logistic regression models were performed using agricultural season and occupational position reported during the first survey administration (thinning season) as main effects. An exchangeable correlation structure among measurements for the three agricultural seasons was assumed. Odds ratios comparing consumption during the harvest and nonspray season to the thinning season; and the consumption of farm-

Table 1. Demographic characteristics of Hispanic farmworkers and non-farmworkers enrolled in the Community-Based Participatory Research Project (2004-2006)

Characteristics	Farmworkers (n=101)		Non-farmworkers (n=100)		*P* value[b]
	n	%[a]	n	%[a]	
Sex					
Male	21	20.8	19	19.0	0.750
Female	80	79.2	81	81.0	
Age (y)					
17-24	12	11.9	15	15.1	0.093
25-29	20	19.8	27	27.3	
30-34	46	45.5	28	28.3	
35 and older	23	22.8	29	29.3	
Mean±standard error	31.5±5.7		31.3±7.1		
Household income (US$)					
≤10,000	22	21.8	18	18.2	<0.001
10,001-15,000	18	17.8	13	13.1	
15,001-25,000	40	39.6	32	32.3	
25,001-35,000	21	20.8	19	19.2	
>35,000	0	0.0	17	17.2	
Marital status					
Married/partnered	92	91.1	76	76.0	0.004
Other	9	8.9	24	24.0	
Language spoken at home					
More Spanish	94	94.0	51	51.0	<0.001
More or equal with English	6	6.0	49	49.0	
Birthplace					
Mexico	98	98.0	64	64.0	<0.001
United States	2	2.0	36	36.0	

[a]Sum of percentages may not total to 100% due to rounding.
[b]*P* values correspond to χ^2 tests of homogeneity between farmworker and non-farmworker cohorts.

workers to non-farmworkers were calculated. Associated 95% confidence intervals were computed using robust variance estimates. We computed global score statistics to compare whether the proportions of the study population who consumed each fruit and vegetable were significantly different ($P<0.05$) between agricultural seasons and between occupations. The sample size of this study was insufficient to adequately test whether occupational position (farmworker vs non-farmworker) was an effect modifier of agricultural season. Data analysis for this article was performed using SAS/STAT software, version 9.1.3 of the SAS System for Windows (2005, SAS Institute Inc, Cary, NC).

RESULTS

One-hundred one farmworker families and 100 non-farmworker families participated in the study. The majority of participants were female (Table 1). Thirty-two percent of farmworkers and 42% of non-farmworkers were younger than 30 years old. Household income distribution varied by occupational status, with 40% of farmworkers and 31% of non-farmworkers earning $15,000 per year or less. Notably, no farmworkers and 17.2% of non-farmworkers reported earning >$35,000 per year. Compared to non-farmworkers, farmworkers were more likely to be married or living with a partner. Nearly all farmworkers were born in Mexico and reported only speaking Spanish at home; this compared to one half and two thirds of non-farmworkers, respectively.

When we examined the sources of fruits and vegetables by agricultural seasons we observed that for all seasons the grocery store and work were the most common places where fruits were obtained (Table 2). Sources for obtaining fruits varied across agricultural season. Eighty-six percent of respondents reported having purchased fruit in the grocery store during the thinning season, and this percentage dropped in the harvest season (60%), and rebounded in the nonspray season (87.4%) ($P<0.001$). Few respondents purchased fruit at a fruit stand and the percentage was highest in the harvest season (7.1%) ($P<0.01$). Nearly one half of respondents in the thinning season reported obtaining fruit from their workplace, and this percentage rose to more than two thirds in the harvest season and dropped to 40% in the nonspray season ($P<0.001$). Obtaining fruits from one's garden was reported by 7.5% of respondents in the thinning season, 17.3% of respondents in the harvest season, and only 3.8% of respondents in the nonspray season ($P<0.001$). Non-farmworkers were more likely than farmworkers to obtain their fruits from a grocery store, fruit stand, or

Table 2. Sources for obtaining fruits and vegetables among participants in the Community-Based Participatory Research Project by agricultural task season and by occupation

	Agricultural Season										Worker Occupation[a]				
	Thinning[b] (n=201) (referent)		Harvest[c] (n=196)				Nonspray[d] (n=182)					Farmworker (n=101)	Non-farmworker (n=100) (referent)			
Sources of:	n	%	n	%	OR[ef]	95% CI[fg]	n	%	OR	95% CI	P value[h]	%	%	OR	95% CI	P value[h]
Fruits[i]																
Grocery	173	86.1	118	60.2	0.2	0.1, 0.4	159	87.4	1.1	0.6, 1.9	***	72.5	82.9	0.5	0.3, 0.8	**
Fruit stand	11	5.5	14	7.1	1.3	0.6, 3.0	3	1.6	0.3	0.1, 1.0	**	2.8	6.8	0.4	0.2, 0.9	*
Work	90	44.8	135	68.9	3.8	2.5, 5.9	73	40.1	0.8	0.5, 1.2	***	74.6	28.8	9.0	5.8, 14.0	***
Garden	15	7.5	34	17.3	2.6	1.3, 5.1	7	3.8	0.5	0.2, 1.2	***	7.7	11.6	0.6	0.4, 1.1	†
Other	33	16.4	39	19.9	1.3	0.8, 2.1	12	6.6	0.4	0.2, 0.7	***	9.8	19.2	0.4	0.3, 0.7	**
Vegetables[j]																
Grocery[k]	200	99.5	188	95.9	—	—	182	100	—	—		97.9	99.0	—	—	†
Fruit stand	13	6.5	49	25.0	4.8	2.6, 8.9	8	4.4	0.7	0.3, 1.6	***	10.1	14.0	0.7	0.4, 1.2	†
Work	81	40.3	37	18.9	0.3	0.2, 0.5	10	5.5	0.1	<0.1, 0.2	***	22.6	21.6	1.1	0.7, 1.6	†
Garden	14	7.0	94	48.0	12.2	6.9, 22.0	7	3.8	0.5	0.2, 1.2	***	19.9	19.9	1.0	0.6, 1.7	†
Other	20	10.0	7	3.6	0.3	0.1, 0.8	4	2.2	0.2	0.1, 0.6	**	4.5	6.2	0.7	0.3, 1.5	†

[a]Five farmworkers at the harvest season, and 11 farmworkers and eight non-farmworkers at the nonspray season, were lost to follow-up.
[b]Thinning season for apples and pears (June-July). Buds and shoots are removed from trees.
[c]Harvest season for apples and pears (September-October).
[d]Nonspray season for apples and pears (December-January). Limited pesticides are applied to crops.
[e]OR=odds ratio.
[f]OR estimates and 95% confidence interval limits are computed from logistic regression models using the method of generalized estimating equations for correlated responses, modeling source of fruit (or vegetable) with agricultural season and worker occupation as main effects.
[g]CI=confidence interval.
[h]*P* values for test of main effects are represented by: †($P \geq 0.05$), *($0.01 \leq P < 0.05$), **($0.001 \leq P < 0.01$), and ***($P < 0.001$).
[i]Includes apples, pears, plums, grapes, peaches, apricots, and cherries.
[j]Includes asparagus, green beans, carrots, peppers, corn, pumpkin, squash, cucumbers, tomatoes, and onions.
[k]Logistic regression model not performed due to lack of variability in response to grocery stores as a source for vegetables.

other source and less likely to obtain them from work. There were no statistical differences in the proportions of farmworkers and non-farmworkers who obtained their fruit from gardens.

When we examined sources of vegetables across agricultural seasons, we observed that nearly all respondents in all seasons reported obtaining vegetables from grocery stores. The frequency with which respondents reported purchasing vegetables at fruit stands varied across seasons, with 6.5%, 25.0%, and 4.4% of respondents reporting having done so at the thinning, harvest, and nonspray seasons, respectively ($P<0.001$). Significant differences were observed across season in the proportion of respondents who reported having obtained vegetables from work ($P<0.001$), having obtained vegetables from gardens ($P<0.001$), and having obtained vegetables from other sources ($P<0.01$). When we examined difference in sources of vegetables among farmworkers and non-farmworkers, we found no statistical differences.

When we examined differences in consumption of fruits and vegetables across agricultural season, we found statistically higher consumption in the harvest season than the other two seasons for apples, pears, plums, peaches, and apricots (Table 3). Consumption of cherries was highest in the thinning season (for apples and pears), which corresponds to the harvest season for cherries. When we examined differences in fruit consumption between farmworkers and non-farmworkers, we found that farmworkers were more likely in the past month to have consumed peaches, apricots, and cherries.

Vegetable consumption also varied across agricultural season and occupational task. Significant differences were observed across growing seasons for asparagus, carrots, peppers, corn, pumpkin, squash, and cucumbers; consumption of peppers, corn, and cucumbers was highest in the harvest season. Asparagus consumption was highest in the thinning season for apples and pears, which is the harvest season for asparagus. Consumption of carrots and pumpkins were highest in the nonspray season, while consumption of squash was similar in the harvest and nonspray seasons and lowest in the thinning season. Farmworkers were more likely than non-farmworkers to report having eaten in the past month green beans, carrots, peppers, corn, pumpkin, squash, and onions. Consumption of green beans, tomatoes, and onions were similar across agricultural season.

While our sample size was too small to allow for statistical comparisons within occupational groups across agricultural season, Table 4 reports proportions of respondents within these subgroups.

DISCUSSION

The seasonal variation in consumption of fruits and vegetables has been reported in a limited number of previous investigations. Our study contributes to this literature by reporting on the seasonal variation in locally grown fruits and vegetables in a sample of Hispanic farmworkers and non-farmworkers living in an agricultural community. Our findings document substantial variation in fruit and vegetable consumption, with the greatest consumption generally occurring during the harvest season. Similarly, sources of fruits and vegetables varied by season, with a substantial share of respondents during the fall harvest

Table 3. Reported consumption of fresh fruits and vegetables over the past month among participants in the Community-Based Participatory Research Project by agricultural task season and by occupation

Respondents who had consumed:	Thinning[b] (n=201) (referent)		Agricultural Season									Worker Occupation[a]				
			Harvest[c] (n=196)				Nonspray[d] (n=182)					Farmworker (n=101)	Non-farmworker (n=100) (referent)			
	n	%	n	%	OR[e]	95% CI[e]	n	%	OR	95% CI	*P* value[f]	%	%	OR	95% CI	*P* value[f]
Fresh fruits																
Apples	140	69.7	179	91.3	4.7	2.7, 8.1	150	82.4	2.1	1.3, 3.2	***	85.0	77.1	1.6	1.0, 2.6	†
Pears	20	10.0	127	64.8	17.0	10.2, 28.5	34	18.7	2.1	1.2, 3.7	***	33.8	28.8	1.4	0.9, 2.2	†
Plums	16	8.0	49	25.0	3.9	2.1, 7.0	10	5.5	0.7	0.3, 1.4	***	15.7	10.3	1.6	0.9, 2.8	†
Grapes	142	70.6	128	65.3	0.8	0.5, 1.1	130	71.4	1.0	0.7, 1.6	†	68.3	69.9	0.9	0.6, 1.4	†
Peaches	48	23.9	135	68.9	7.4	4.8, 11.2	19	10.4	0.4	0.2, 0.6	***	39.4	30.5	1.8	1.1, 2.7	*
Apricots	21	10.5	39	19.9	2.2	1.3, 3.8	6	3.3	0.3	0.1, 0.7	***	15.3	7.6	2.3	1.3, 4.1	**
Cherries	102	51.0	20	10.3	0.1	<0.1, 0.2	6	3.3	<0.1	<0.1, 0.1	***	31.0	13.4	5.1	2.9, 9.1	***
Fresh vegetables																
Asparagus	114	56.7	6	3.1	<0.1	<0.1, 0.1	5	2.7	<0.1	<0.1, 0.1	***	20.6	22.6	0.8	0.5, 1.3	†
Green Beans	37	18.5	46	23.5	1.4	0.9, 2.1	35	19.2	1.1	0.7, 1.7	†	25.9	15.1	2.0	1.2, 3.3	**
Carrots	161	80.5	161	82.1	1.1	0.8, 1.7	163	89.6	2.0	1.2, 3.5	*	88.5	79.4	2.0	1.2, 3.6	*
Peppers	159	79.1	171	87.2	1.9	1.2, 2.9	152	83.5	1.4	0.9, 2.1	*	93.4	73.3	4.9	2.7, 9.1	***
Corn	103	51.5	162	82.7	4.8	3.0, 7.6	51	28.0	0.4	0.2, 0.5	***	62.7	46.7	2.3	1.5, 3.4	***
Pumpkin	49	24.4	58	29.9	1.4	0.9, 2.0	69	37.9	2.0	1.3, 3.1	**	41.3	19.9	2.8	1.8, 4.5	***
Squash	96	47.8	120	61.2	1.8	1.3, 2.5	110	60.4	1.8	1.3, 2.5	***	68.3	44.5	2.7	1.7, 4.3	***
Cucumbers	141	70.5	160	81.6	1.9	1.2, 2.9	119	65.4	0.8	0.5, 1.1	***	75.9	69.5	1.4	0.9, 2.1	†
Tomatoes	199	99.0	189	96.4	0.3	0.5.1.3	176	96.7	0.3	0.1, 1.5	†	97.2	97.6	0.8	0.3, 2.7	†
Onions	190	94.5	179	91.3	0.6	0.3, 1.2	171	94.0	0.9	0.5, 1.7	†	96.9	89.7	3.2	1.4, 7.4	*

[a]Five farmworkers at the harvest season, and 11 farmworkers and eight non-farmworkers at the nonspray season, were lost to follow-up.
[b]Thinning season for apples and pears (June-July). Buds and shoots are removed from trees.
[c]Harvest season for apples and pears (September-October).
[d]Nonspray season for apples and pears (December-January). Limited pesticides are applied to crops.
[e]Odds ratio (OR) estimates and 95% confidence interval (CI) limits are computed from logistic regression models using the method of generalized estimating equations for correlated responses, modeling fresh fruit (or vegetable) consumption over the past month with agricultural season and worker occupation as main effects.
[f]*P* values for test of main effects are represented by: †($P \geq 0.05$), *($0.01 \leq P < 0.05$), **($0.001 \leq P < 0.01$), and ***($P < 0.001$).

season receiving fruit from their workplaces. Differences in both consumption practices and sources of fruits and vegetables were observed between farmworker and non-farmworker groups. Our findings provide potentially important information for the timing of data collection for epidemiologic studies that link dietary exposure to health outcomes and for intervention studies that aim to evaluate dietary consumption across time.

Our finding that consumption of fruits and vegetables was highest in the fall harvest seasons was consistent with some previous investigations. Subar and colleagues (10) used data from the National Health Interview Survey to assess seasonal differences in the consumption of 59 food items. They reported differences in the proportion of individuals with consumption greater than the median yearly intake for a number of foods. For oranges, the proportions of individuals consuming greater than the median annual intake was greatest in the winter and spring compared with the summer and fall for both men and women. Differences ranged from 6% to 12%. Differences >5% were also documented for grapefruit, tomatoes, and cantaloupes. Median servings per week of tomatoes varied by greater than one-half serving for both men and women comparing summer to winter months. The median servings per week of oranges was stable across seasons for women, but dropped in the summer and fall months for men (10). Our study did not examine quantities of fruits and vegetables consumed, instead, our analyses report on consumption patterns for specific locally grown produce.

Notably, the magnitude of the differences across seasons was much higher in our study than that reported in previous studies. Data from the National Health Interview Survey documented that the proportion of respondents who consumed apples differed by <5% across seasons (10); our data show a 21.6% difference in consumption proportions when summer thinning and fall harvest seasons are compared. These differences were even greater for pears, which were consumed by 10% of our sample in the summer and 64.8% in the fall (a difference of 54.8%). Similarly, peaches were consumed by 10.4% of our sample in the winter, and 68.9% in the fall (a difference of 58.5%). The change in consumption of cherries differed by 47.7%, when proportions in the summer thinning and winter nonspray seasons were compared. These findings are consistent with our hypothesis that the variation in consumption is higher in our agricultural sample than in the general US population.

The relatively high variability in consumption of fruits and vegetables in our sample may be explained, in part, by changes in purchasing practices across seasons. While the majority of farmworkers and non-farmworkers relied on the grocery store as the primary source of fruits and vegetables in all seasons, the proportions in each group that reported obtaining fruits and vegetables from local markets and personal gardens rose in the fall harvest season. In addition, the proportion of fruit from work increased in the fall. The rise in the proportion of respondents who obtained produce from local markets may reflect the success of programs that provide vouchers to low-income individuals to be redeemed at farmers' markets (11,12).

Table 4. Reported consumption of fresh fruits and vegetables over the past month among Hispanic farmworkers and non-farmworkers in the Community-Based Participatory Research Project by agricultural task season[a]

Respondents who had consumed:	Thinning[b] (n=201)				Harvest[c] (n=196)				Nonspray[d] (n=182)			
	Farmworkers		Non-farmworkers		Farmworkers		Non-farmworkers		Farmworkers		Non-farmworkers	
	n	%	n	%	n	%	n	%	n	%	n	%
Fresh fruits												
Apples	68	67.3	72	72.0	94	97.9	85	85.0	82	91.1	68	73.9
Pears	12	11.9	8	8.0	68	70.8	59	59.0	17	18.9	17	18.5
Plums	11	10.9	5	5.1	26	27.1	23	23.0	8	8.9	2	2.2
Grapes	64	63.4	78	78.0	65	67.7	63	63.0	67	74.4	63	68.5
Peaches	33	32.7	15	15.0	68	70.8	67	67.0	12	13.3	7	7.6
Apricots	15	14.9	6	6.1	24	25.0	15	15.0	5	5.6	1	1.1
Cherries	79	78.2	23	23.2	7	7.3	13	13.1	3	3.3	3	3.3
Fresh vegetables												
Asparagus	54	53.5	60	60.0	3	3.1	3	3.0	2	2.2	3	3.3
Green beans	20	20.0	17	17.0	29	30.2	17	17.0	25	27.8	10	10.9
Carrots	86	85.1	75	75.8	85	88.5	76	76.0	83	92.2	80	87.0
Peppers	89	88.1	70	70.0	92	95.8	79	79.0	87	96.7	65	70.7
Corn	61	60.4	42	42.4	88	91.7	74	74.0	31	34.4	20	21.7
Pumpkin	32	31.7	17	17.0	40	42.1	18	18.2	46	51.1	23	25.0
Squash	56	55.4	40	40.0	72	75.0	48	48.0	68	75.6	42	45.7
Cucumbers	70	70.0	71	71.0	83	86.5	77	77.0	64	71.1	55	59.8
Tomatoes	100	99.0	99	99.0	92	95.8	97	97.0	87	96.7	89	96.7
Onions	99	98.0	91	91.0	89	92.7	90	90.0	90	100.0	81	88.0

[a]Five farmworkers at the harvest season, and 11 farmworkers and eight non-farmworkers at the nonspray season, were lost to follow-up.
[b]Thinning season for apples and pears (June-July). Buds and shoots are removed from trees.
[c]Harvest season for apples and pears (September-October).
[d]Nonspray season for apples and pears (December-January). Limited pesticides are applied to crops.

Our data showed that for most fruits, consumption proportions were highest during the harvest season. For certain vegetables, such as green beans, carrots, and pumpkin, consumption proportions were highest during the winter nonspray season, and asparagus during the summer (when asparagus is harvested). These findings are consistent with previous research that documents increased vegetable consumption during the winter and increased fruit consumption during harvest months (3,4).

Seasonal variation in consumption is an important consideration in studies that seek to measure fruit and vegetable intake. As previous studies have documented, increased daily consumption corresponds to an increase in the variety of fruits and vegetables available (13). A rise in the proportion of individuals who consumed several local fruits, such as apples, pears, peaches, and cherries, corresponds with the season in which the crops were harvested; and a similar pattern was observed for vegetables, such as asparagus, corn, pumpkin, squash, and cucumber. Thus, accurate measurement of consumption patterns and dietary behaviors is important for research examining associations between dietary intake and health status as well as the time of data collection for intervention studies with dietary outcomes.

Differences in fruit and vegetable consumption associated with agricultural season, as documented in this study, contribute to the limited available research regarding dietary habits of Hispanic farmworkers and residents of a rural agricultural community. The US Hispanic population has greater rates of chronic disease attributed to nutrition (14). A survey of farmworkers in Michigan State documented high prevalences of nutritional related disease (9). For example, 60% of the population was obese; 54% of male farmworkers were diagnosed as diabetic; and 23% of female farmworkers were anemic. The risk of food insecurity has been documented to be extremely high among several populations of farmworkers, particularly during winter months or changes in crop season, when work is limited (8). Our data suggest that interventions as well as social services that encourage adequate fruit and vegetable consumption may be most effective by taking into account the variation in fruit and vegetable intake that is associated with agricultural season.

This study had several limitations that should be considered. Due to multiple comparisons, results from this study should be carefully interpreted. In this study, we modeled the differences in proportions of individual fruits and vegetables consumed across agricultural seasons. By subjecting each individual fruit and vegetable to the same acceptance criterion ($P<0.05$), we greatly increased the probability of a type 1 error (yielding P value <0.05 due to chance alone). Nevertheless, many of our statistical tests produced P values that were <0.001, reducing the likelihood of a type I error.

Our participant selection method relied on a conve-

nience sample of individuals with a child aged 2 to 6 years. It is possible that individuals who are willing to participate in research or that have a young child are more likely to consume fruits and vegetables. Notably, the majority of participants were female. Thus, our findings have limited generalizability to the general US Hispanic population and even less for the overall US population. Even so, the demographic characteristics of the Hispanic farmworker cohort in our study are similar to the US farmworker population, which is predominantly low-income and Mexican-born (7).

As with any self-reported questionnaire, there is a potential for information bias. Our survey asked participants to recall dietary habits within the last month. In a study of middle-aged adults, Dwyer and colleagues documented that dietary recall in the distant past was not correlated with dietary habits reported at the time in question, although it was correlated to recent dietary habits (15). Thus, participants are prone to report foods that they have most recently consumed. Although we asked participants to recall dietary habits looking back upon a much smaller time period (1-month intervals), it is possible that both random and systematic errors may be present. While we think it is unlikely, there is a possibility that farmworkers' ability to recall dietary habits is different from the non-farmworker cohort. Nevertheless, our data-collection method that relied on in-person interviews at three points during the year is susceptible to less bias compared to methods that rely on report of dietary intake at one time point.

We found an overall higher proportion of farmworkers than non-farmworkers reported having eaten several fruits and vegetables. Given the small sample size of our study, we were unable to adjust for potential confounding factors. Furthermore, our study did not collect data on the number of servings of fruits and vegetables consumed. Thus, it is unknown to what extent our study findings may be biased by differences in quantities consumed. Our research team has administered food frequency questionnaires in these communities in the past, and has reported 4.96 servings of fruits and vegetables per day among Hispanics and 3.85 servings per day among non-Hispanic whites ($P<0.001$) (16). Notably, our previous analysis show higher consumption of fruits and vegetables among individuals having lower levels of acculturation, compared to those having higher levels of acculturation (5.07 vs 4.70; $P<0.05$). Given that the farmworkers in our study were, overwhelmingly, born in Mexico and spoke Spanish at home, and presumably had lower levels of acculturation than the non-farmworkers, it is plausible that they consumed higher quantities of fruits and vegetables.

Despite these limitations, the longitudinal design of this study is one of its strengths. Our study was one of the few that collected information on the sources of fruits and vegetables, which helps to more accurately describe behaviors regarding fruit and vegetable consumption.

CONCLUSIONS

This study also contributes to the much-needed research regarding health behaviors of Hispanic farmworkers and residents of a rural agricultural community. This exploratory study of longitudinal dietary behaviors among a rural agricultural community is consistent with previous studies, which have documented a seasonal variation in fruit and vegetable consumption. Moreover, our data appear to suggest that, compared to the general US population, seasonal variation in consumption patterns is much greater in agricultural communities in general and among farmworkers in particular.

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