

# Profiles of Food Security for US Farmworker Households and Factors Related to Dynamic of Change

Edward H. Ip, PhD, Santiago Saldana, MS, Thomas A. Arcury, PhD, Joseph G. Grzywacz, PhD, Grisel Trejo, MPH, and Sara A. Quandt, PhD

Farmworkers in the United States experience challenging living conditions and economic insecurity because of low-paying and contingent employment. Although an exact number of farmworkers is not available, estimates place the population at 900 000, plus dependents.<sup>1</sup> This includes migrant farmworkers, who establish temporary residences to do farm work, as well as seasonal workers who reside in one place and do farm work during the agricultural season.<sup>2</sup> Currently, most farmworkers are Latino and foreign-born,<sup>3</sup> which can limit their eligibility and access to food safety-net programs such as the Supplemental Nutrition Assistance Program. In addition, many reside in rural areas where access to healthy food retail stores may be limited by both availability and transportation, although home food production is sometimes possible.<sup>4</sup> Together, these create a situation in which farmworker households are likely to experience low food security (resulting from insufficient household resources), but this may be episodic. Children in farmworker households may be particularly vulnerable to the effects of low food security.<sup>5</sup>

Low food security is associated with negative developmental outcomes in infants and toddlers.<sup>6</sup> Persistently low food security in early childhood is associated with long-term lower health status.<sup>7</sup> For children at school age, this can adversely affect academic performance, weight gain, and social skills.<sup>8</sup> With the large population of farmworkers in the United States, food security among their families is an important public health issue.

Previous reports of food security for farmworker households have found 20% to 80% to be food insecure.<sup>9–14</sup> However, all of these reports have been cross-sectional, and most have used an extended recall period, asking respondents to recall whether their household was food insecure at any time during the past year. Such data provide no information on the duration of food security states or on factors associated with transitions in and out of low

**Objectives.** We recruited 248 farmworker families with preschool-aged children in North Carolina and examined food security indicators over 24 months to identify food security patterns and examine the dynamic of change over time.

**Methods.** Participants in the Niños Sanos study, conducted 2011 to 2014, completed quarterly food security assessments. Based on responses to items in the US Household Food Security Survey Module, we identified different states of food security by using hidden Markov model analysis, and examined factors associated with different states. We delineated factors associated with changes in state by using mixed-effect ordinal logistic regression.

**Results.** About half of the households (51%) consistently stayed in the most food-secure state. The least food-secure state was transient, with only 29% probability of this state for 2 consecutive quarters. Seasonal (vs migrant) work status, having immigration documents (vs not documented), and season predicted higher levels of food security.

**Conclusions.** Heterogeneity in food security among farmworker households calls for tailoring intervention strategies. The transiency and unpredictability of low food security suggest that access to safety-net programs could reduce low food security risk in this population. (*Am J Public Health*. 2015;105:e42–e47. doi: 10.2105/AJPH.2015.302752)

food security. Examining food security over time as a dynamic construct is necessary to understand its duration and to develop protective measures for low food security.

This repeated-measures study gathered data quarterly for 24 months, and examined different states of food security by using the 18-item US Household Food Security Survey Module.<sup>15</sup> Instead of constructing a single score, we used the full item set to form a food security profile. The approach allowed us to delineate several different states of food security within the food security profile, and examine the dynamic of change in food security over the 24-month period. The aims of the study were to (1) describe multiple states of food security of farmworker households, (2) identify factors associated with the different food security states, and (3) delineate the dynamic of change in food security states across a period of 24 months.

## METHODS

We used a sample of 248 families from the Niños Sanos study for the current analysis.

Niños Sanos is a longitudinal study designed to describe the dietary and physical activity patterns<sup>16</sup> of farmworkers' children across 8 consecutive quarters. We recruited Latino farmworker families with young children in North Carolina. Eligible participants were women who self-identified as Latino, had a 3-year-old (aged from 2.5 years to 3.5 years) coresident child, and had at least 1 member of the household that worked in farm work during the past year.

## Sampling

Because no sampling frame of Latino farmworker families exists and because the narrow child age range would require contacting a substantial fraction of the eligible population, we developed a site-based sampling plan<sup>17–20</sup> to provide as large a contact base as possible. This approach is appropriate for hard-to-reach populations, and has been used in the investigators' previous immigrant health research,<sup>21–23</sup> based on well-developed relationships with farmworker-serving institutions. "Sites" are organizations or locations with which members of the target community are

associated. All families are likely associated with at least 1 site and most with multiple sites. In this study, site categories (and number of sites within categories) were Head Start and Migrant Head Start Programs (n=7), migrant education programs (n=15), community health centers (n=4), Special Supplemental Nutrition Program for Women, Infants, and Children (n=1), community partner nonprofit organizations serving Latino immigrants (n=2), and stores, churches, and events serving predominantly farmworkers (n=7). In addition, community data collectors conducted door-to-door recruitment in multiple Latino neighborhoods and farmworker camps, and contacted families from previous Latino health studies and from personal networks.

For institutions subject to privacy regulations, such as Head Start, a staff member contacted the family, introduced the study, and obtained authorization to release contact information. In other cases, a trained data collector, who was a native Spanish speaker, attempted contact with individuals for whom contact information was available. Once contact was made, the data collector introduced and explained the study, including its requirements and incentives, screened for inclusion and exclusion criteria, and asked the family to participate. Those who agreed to participate were scheduled to complete enrollment and initiate the baseline data collection; in most cases, initiation of baseline data collection was completed at the time of recruitment. All participants provided signed informed consent.

Because of the multipronged nature of the site-based sampling, with organizations compiling lists of potential participants as well as study staff conducting direct recruiting, it was impossible to obtain precise figures to calculate refusal or participation rates. It was impossible to know whether those refusing to release information were eligible to participate. Organizations may have compiled incomplete lists from their participants, and potential participants could have avoided contact at events.

Nine trained interviewers conducted quarterly interviews in Spanish with each participant, in the participant's home or another location determined by the participant. The total data collection period was April 19, 2011, through July 30, 2014. The maternal interview was an interviewer-administered survey

questionnaire to collect information on demographic, family, and household characteristics; food security; and migration patterns.

### Measures

**Outcome.** We measured food security for each household by using a Spanish-language adaptation of the 18-item US Household Food Security Survey Module (HFSSM), which asks respondents to report for their household.<sup>15</sup> We used the Spanish-language version developed by Harrison et al.<sup>24</sup> This version is valid across different Hispanic populations. In the quarterly data analyzed here, we modified the questions to ask about conditions in the previous 3 months. At baseline only, the questions asked about the previous 12 months.

**Covariates.** Mothers reported their own age. Family migrant status was based on maternal characterizations of herself and another household member's involvement in farm work at baseline: if she classified either person as a "migrant worker who moves from place to place to do farm work," we classified the family as migrant. Otherwise, we classified the family as seasonal. Mothers reported whether they and their husband or partner had documents that allowed them to be in the United States legally. If either had documents, we classified the family as documented.

We measured food production and sourcing quarterly. Mothers were asked whether, in the previous 3 months, they had raised food in a garden; received food from a food pantry, a church, or other community agency; received food from employer, friends, or family (including taking home harvested produce without paying for it); and consumed wild game or fish that they caught or were given. Season was a dichotomized variable of warmer (May through October) and cooler (November through April) months. We treated time as a continuous variable.

### Statistical Method

For the first aim, we employed a hidden Markov model (HMM)<sup>25–28</sup> to identify a food security profile of farmworker households, using all 18 HFSSM items gathered at quarterly visits. The HMM can be viewed as a longitudinal extension of latent class analysis. On the basis of the responses to the items in the profile, the HMM analysis derived a number of states

summarizing food security. At each time point, we categorized each family into one of the hidden (latent) states. We selected the number of states by using the Bayesian Information Criterion.<sup>29</sup> A family could change state over the course of the study period, and we captured the likelihood that they stayed in the same state or transitioned into other states through a transition probability table that we estimated from the data.

For the second aim, we used the state as an outcome variable to determine the factors that were deemed predictive of food security states. Because the states were not necessarily ordered, we used a partial ordered model<sup>30</sup> in which the states were first partitioned into "weakly ordered" groups and then we applied a mixed-effects ordinal logistic model to the ordered groups. For states that could not be directly compared within a partition, we used multinomial logistic regression to compare the states. We introduced random effects into each model to account for correlation between observations within the same household. The HMM treated a missing quarterly survey from a family as missing at random.<sup>31</sup>

For the third aim, we first characterized change as 1 of 3 categories: transitioning into a poorer food security state, staying in the same state, and transitioning into a better state. We used ordinal logistic regression with mixed effects to delineate factors driving transition in food security state. We used a 2-sided test at the significance level of  $\alpha = 0.05$  for all statistical tests. We used Matlab-based HMM software,<sup>26,27,32</sup> which can be downloaded without fee, for HMM-based analysis and SAS version 9.3 (SAS Institute Inc, Cary, NC) for regression analyses.

## RESULTS

The number of completed HFSSM questionnaires varied across quarterly assessments. At baseline, 248 surveys were collected (100%); the average rate of survey completion across the following 8 quarters was 87% (range=76%–90%). There were no item-missing data for completed HFSSM questionnaires. Table 1 shows the characteristics of respondents at baseline.

In the HMM analysis, we selected the 4-state model, based on the Bayesian Information

**TABLE 1—Sociodemographic Characteristics of Latino Women Respondents (n = 248) in Farmworker Families: Niños Sanos Study, North Carolina, 2011–2014**

Characteristic	Total Sample, No. (%)
Age, y	
18–25	72 (29.0)
26–35	138 (55.7)
36–45	38 (15.3)
Educational attainment, y	
0–6	108 (43.6)
7–9	76 (30.7)
≥ 10	64 (25.8)
Marital status	
Married or living as married	224 (90.3)
Not married	24 (9.7)
Farmworker status	
Migrant	68 (27.4)
Seasonal	180 (72.6)
Household immigration status	
Any adult documented	38 (15.4)
Every adult undocumented	209 (84.6)
Household food security <sup>a</sup>	
High	97 (39.1)
Marginal	23 (9.3)
Low	87 (35.1)
Very Low	41 (16.5)

<sup>a</sup>Food security at baseline was reported for the previous 12 months.

Criterion. The characteristics of the 4 states were captured in Figure 1. The length of the dark bar for an item represented the likelihood of not being concerned about the specific item. The states were labeled (1) least secure, (2) concerned about balanced meal, (3) concerned about food quantity, and (4) most secure for the ease of discussion. The states were not, strictly speaking, linearly ordered, in that not all variables were higher or lower across the states concerned about balanced meal and concerned about food quantity. In the least-secure state, households reported, to various degrees, low security across all areas identified by the 18 items and especially expressed worries about running out of money for food and relying on only a few low-quality food items for the

children. In the concerned-about-balanced-meal state, households were most concerned about not being able to eat a balanced meal, especially for their children. In the concerned-about-food-quantity state, households were concerned about not having enough money to buy food, as well as about eating balanced meals. Compared with households in the least-secure state, those in the concerned-about-balanced-meal state had almost no concern that either adults or children would be hungry and would have to eat less. Finally, households in the most-secure state did not show concern about food security.

The least-secure state was a transient state, such that households in this state only had a 29% chance of staying in the same state across any 2 consecutive quarters (Figure 2). On the other hand, the most-secure state was relatively stable; households in this state tended to stay in the same state with 85% probability. If households in the most-secure state did transition to another state, they tended to transition into the concerned-about-balanced-meal state (10% probability), compared with the concerned-about-food-quantity state (3% probability). Over time, there was a general increase in the number of households in the most-secure state, from 68.8% to 75.3% in quarters 1 and 8, respectively.

The partial ordered model analysis suggested that the analysis of the state-based outcome be conducted in 2 stages under 2 respective submodels: (1) we combined the concerned-about-balanced-meal and concerned-about-food-quantity states into 1 category, and we treated the resulting 3 states (most secure, combined category, and least secure) as ordered and analyzed by the mixed-effects ordinal logistic regression (ordinal submodel in Table 2), and (2) we compared the concerned-about-balanced-meal and concerned-about-food-quantity states by using mixed-effect logistic regression (unordered submodel in Table 2). Several predictors showed statistical significance ( $P < .05$ ). Having a seasonal worker in the household and proper immigration documentations were associated with being in more-secure states for the ordinal submodel. In addition, cooler seasons were associated with lower food security ( $P < .05$ ). Compared with having a migrant worker in the household, having a seasonal worker mitigated

the effect. On the other hand, the unordered submodel suggested an increase in the concerned-about-balanced-meal state over time.

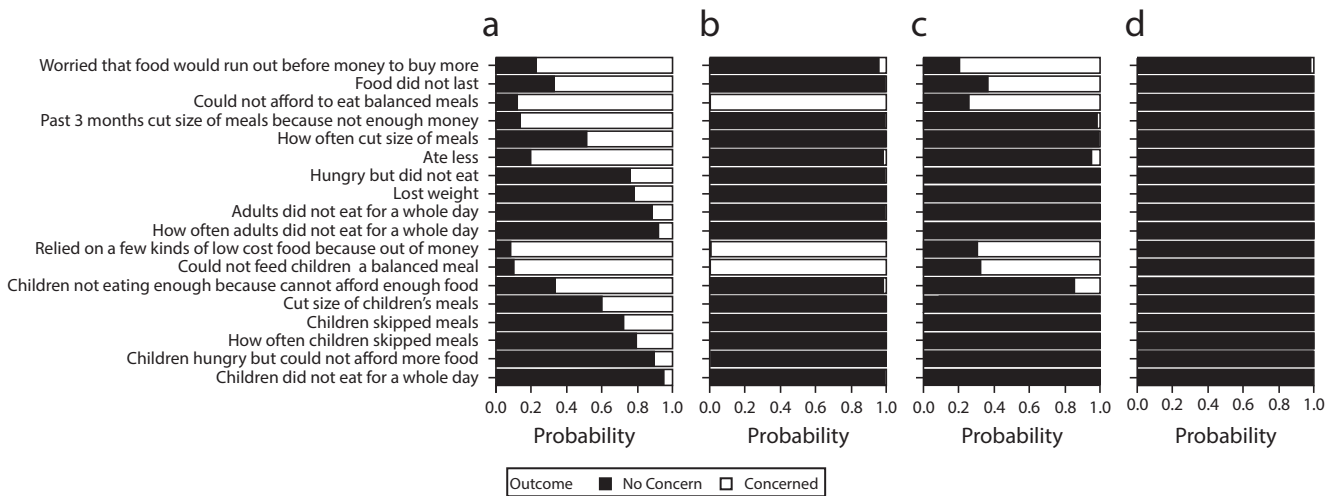
When we delineated factors that potentially drive changes in food security states, no statistically significant predictor was present. The details of the analysis are not included in this article.

## DISCUSSION

Food security is a multifaceted concept.<sup>33</sup> Instead of using the sum score from the HFSSM, which may not be adequate for capturing all facets of food security,<sup>34</sup> we adopted a hidden Markov analysis and delineated 4 distinct latent states of food security. Unlike the traditional sum score approach, the hidden Markov analysis used the response patterns in the data to derive distinct food insecurity states and revealed subtle conditions that were difficult to identify with traditional approaches. We found that the prevalence of farmworker households feeling food insecure was 28% at any time point, whereas 72% of households felt secure (in the most-secure state) at any time point.

Besides the 2 extreme states, there was a distinction between households concerned about food quality (indicated by balanced meals) and households concerned about food quantity. On average, households belonging to the concerned-about-balanced-meal state constituted 15% of the quarterly reports, and those belonging to the concerned-about-food-quantity state constituted 9%. Households that belonged to the least-secure state comprised only 5%. Over time, number of households in the most-secure state increased. This is consistent with findings from previous work that tracked rates of transition from lower to higher food security over a time interval of more than 2 years.<sup>35,36</sup>

One common feature of the several identified states is the shared anxiety and worry about children's food balance and quantity. This finding is consistent with other studies on similar populations.<sup>5</sup> Concerns about food security for adults often are mirrored in having concerns about food security for children. For the concerned-about-food-quantity state, strong concern existed about having to rely on a few low-cost foods for children before running out of money. In the least-secure state,



Note. Each dark bar represents the probability of not having a concern indicated by the item.

**FIGURE 1—Concern for 18 US Household Food Security Survey Module items by the 4 food security states (a) least secure, (b) concerned about a balanced meal, (c) concerned about food quantity, and (d) most secure: Niños Sanos study, North Carolina, 2011–2014.**

mothers expressed serious concern about food security for children, such as children not eating enough.

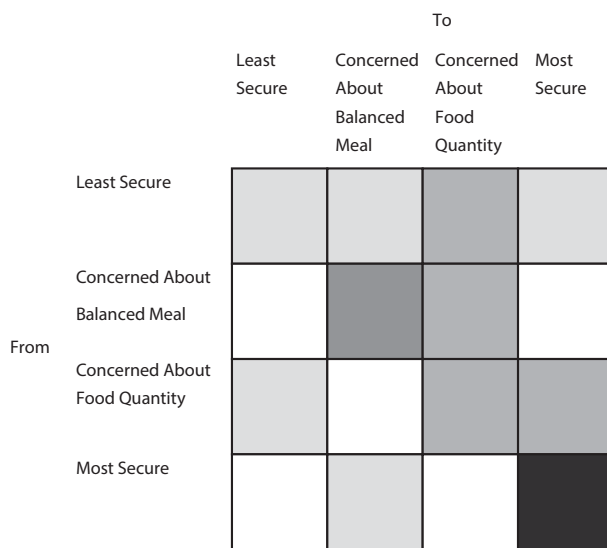
By analyzing longitudinal data, this analysis lends support to the notion that being food insecure, at least in some populations, is more episodic than chronic. This is reflected in the

relatively transient nature of the least-secure state; households had a low probability of staying in the same state over 2 consecutive time points (29%), as well as the concerned-about-balanced-meal state (56%) and concerned-about-food-quantity state (46%). These are in sharp contrast to the relatively stable

most-secure state; such households had an 85% chance of staying in the same state.

It was interesting that the concerned-about-balanced-meal state and the concerned-about-food-quantity state exhibited rather different dynamics. Households in the concerned-about-balanced-meal state had a high probability of transitioning into the concerned-about-food-quantity state (41%), but had minimal probability (0.0%) of transitioning into the most-secure state. On the other hand, households in the concerned-about-food-quantity state had a probability of 40% of transitioning into the most-secure state. This dynamic displayed in these 2 states appears to be somewhat counterintuitive. Judging from the profiles of the states, it could be concluded that, in general, households tended to compromise on quality and consume an imbalanced diet first and then compromise on quantity. Therefore, the concerned-about-balanced-meal state should be “closer” to the most secure group than the concerned-about-food-quantity state. However, this state tended to transition into all other groups except its closest “neighbor” (i.e., the most-secure state).

One possible explanation is that there existed households that tended to weigh balanced diet and food quality as an important factor in food security for both adults and children. This concern was more challenging



Note. Probability from state indicated by row to state indicated by color, with darker color indicating higher probabilities (from light to dark: <10%, 10%-29%, 30%-49%, 50%-79%, and ≥80%).

**FIGURE 2—Probability of transition from one food security state to another: Niños Sanos study, North Carolina, 2011–2014.**

**TABLE 2—Results From Partially Ordered Regression Model: Niños Sanos Study, North Carolina, 2011–2014**

Parameter	Ordinal Submodel, b (95% CI)	Unordered Submodel, b (95% CI)
Intercept	2.27** (0.64, 3.91)	-0.39 (-2.68, 1.89)
Mother's age	0.17 (-0.33, 0.65)	0.07 (-0.71, 0.85)
Time	0.05 (-0.01, 0.10)	0.32*** (0.21, 0.43)
Seasonal worker <sup>a</sup>	0.85* (0.08, 1.61)	-0.15 (-1.21, 0.91)
Any adult in family documented <sup>b</sup>	1.12* (0.16, 2.09)	-1.07 (-2.71, 0.57)
Food production <sup>c</sup>	0.48 (-0.16, 1.12)	0.29 (-0.57, 1.15)
Cooler seasons <sup>d</sup>	-1.11* (-2.12, -0.09)	-1.00 (-2.50, 0.49)
Cooler season × seasonal worker	0.29* (0.05, 1.19)	0.60 (-0.23, 1.45)

Note. CI = confidence interval. For the unordered model, concerned about food quantity is the reference category.

<sup>a</sup>Reference category: migrant worker status.

<sup>b</sup>Reference category: every adult in family undocumented.

<sup>c</sup>Reference category: no food production.

<sup>d</sup>Reference category: warmer seasons.

\* $P < .05$ ; \*\* $P < .01$ ; \*\*\* $P < .001$ .

to resolve because of financial and environmental constraints, rendering them not being able to feel confident in their status like those farmworker households belonging to the most-secure state. It is also possible that some farmworker households felt secure once the food-quantity issue was resolved. Under those circumstances, those households promptly transitioned into the most-secure state.

A trajectory analysis conducted by inspecting the patterns of states over all 8 quarters further revealed the episodic nature of being food insecure. Approximately 51% of farmworker households stayed in the most-secure group for at least 7 out of a total of 8 quarters. On the other hand, very few (<1%) farmworker households consistently stayed in the least-secure state for at least 7 quarters, suggesting that only a small proportion experienced food insecurity as a chronic problem. In addition, fewer than 1% of farmworker households consistently stayed in either the concerned-about-balanced-meal or concerned-about-food-quantity state for at least 7 quarters. Although low food security does not seem to be chronic, this analysis does reveal the extent to which migrant worker families feel insecure—almost half (49%) of the families did fall 1 or more times into an insecure state (concerned about food quantity, concerned about balanced meal, or least secure) during the 8 quarters of observation.

A significant increasing trend occurred over the 8 quarters for the concerned-about-balanced-meal state, compared with the concerned-about-food-quantity state. In addition, seasonal migrant status and proper documentation status were both significantly associated with higher levels of food security. These findings are not surprising because seasonal workers do not have to move and incur costs of moving.<sup>37</sup> Seasonal workers may have greater opportunities for off-farm employment, which may, unlike agriculture, be required to pay a minimum wage and overtime pay.<sup>38</sup> Having documentation may offer a better sense of control and security and eligibility for some safety net programs. On the other hand, the analysis of change in perception about food security did not identify any significant predictor, suggesting that the transitions between food security states were largely driven by random family-specific factors rather than systematic factors.

Our findings mirror results of studies focused on transition into and out of poverty.<sup>39</sup> This is not surprising, as food security is defined largely on the basis of ability to purchase food. Individuals in poverty tended to stay in poverty and approximately half of individuals who exited poverty would return to poverty in 5 years.<sup>39</sup> Like food security, transitions out of poverty are often driven by individual-specific factors such as temporary forms of income. Such findings indicate that more

detailed data for farmworkers, such as timing of income-related events (e.g., unexpected wage theft, weather events resulting in lost work time), might help explain farmworker food security transitions.

### Limitations

This study should be considered in light of its limitations and strengths. The sample is largely restricted to families from the south-eastern United States, and these findings should be confirmed among farmworkers in other parts of the country. Psychological and experiential factors specifically related to individual respondents may exist, but were not included in the analysis. For example, families' perceptions and beliefs about what is important about food for adults and children play a role in determining sensitivity to low food security. Experiences of income disruption may cause food security transitions.

Despite these limitations, this study represents one of the few longitudinal studies of food security that uses a widely accepted instrument in a vulnerable population in which considerable low food insecurity has been reported from cross-sectional studies.

### Conclusions

This study has several public health and policy implications. Educational programs for migrant farmworker families could help them better allocate resources to achieve better food balance with low-cost foods. Our findings suggest heterogeneity in how farmworker families perceive food security, implying that different intervention strategies may be needed for different population segments. For example, a small percentage of the population chronically feels insecure. General educational programs may not be highly effective in having an impact on families located at this state of food security. It is important to identify and reach out to these families, and offer targeted services to help them alleviate stress produced by serious concerns about food security. Our findings also provide evidence that low food security is episodic and unpredictable. Greater availability of safety-net programs, now unavailable to most immigrant families, could buffer the risk of low food security in farmworker households. ■

## About the Authors

Edward H. Ip and Santiago Saldana are with the Department of Biostatistical Sciences, Division of Public Health Sciences, Wake Forest School of Medicine, Winston-Salem, NC. Thomas A. Arcury is with the Department of Family and Community Medicine, Wake Forest School of Medicine. Joseph G. Grzywacz is with the Department of Human Development and Family Science, Oklahoma State University, Tulsa. Grisel Trejo and Sara A. Quandt are with the Department of Epidemiology and Prevention, Division of Public Health Sciences, Wake Forest School of Medicine. Thomas A. Arcury and Sara A. Quandt are also with the Center for Worker Health, Wake Forest School of Medicine.

Correspondence should be sent to Edward H. Ip, Department of Biostatistical Sciences, Wake Forest School of Medicine, Medical Center Blvd, Winston-Salem, NC 27157 (e-mail: eip@wakehealth.edu). Reprints can be ordered at <http://www.ajph.org> by clicking the "Reprints" link.

This article was accepted April 29, 2015.

## Contributors

S. A. Quandt, T. A. Arcury, J. G. Grzywacz, and E. H. Ip conceptualized and designed the study. S. A. Quandt, T. A. Arcury, J. G. Grzywacz, E. H. Ip, and G. Trejo designed the data collection and supervised the study implementation and data collection. S. Saldana and E. H. Ip carried out the initial analyses. S. A. Quandt and E. H. Ip developed aims for this specific analysis and drafted the initial article. All authors helped to conceptualize ideas, reviewed and revised the article, and approved the final article as submitted.

## Acknowledgments

This research was supported by grant R01HD059855 from the National Institute for Child Health and Human Development, grant 1R01HL101066 from the National Heart, Lung, and Blood Institute, and grant SES-1229549 from the National Science Foundation.

## Human Participant Protection

The Wake Forest School of Medicine institutional review board approved all sampling, recruitment, and data collection procedures. All participants provided signed informed consent. A Certificate of Confidentiality was obtained from the National Institutes of Health to protect the anonymity of study participants.

## References

- US Department of Agriculture. Farm labor. National Agricultural Statistics Service. 2013. Available at: [http://usda.mannlib.cornell.edu/usda/nass/FarmLabo//2010s/2013/FarmLabo-12-05-2013\\_revision.pdf](http://usda.mannlib.cornell.edu/usda/nass/FarmLabo//2010s/2013/FarmLabo-12-05-2013_revision.pdf). Accessed March 6, 2014.
- US Department of Labor. Who are migrant and seasonal farmworkers. Employment and Training Administration. 2013. Available at: [http://www.doleta.gov/programs/who\\_msfw.cfm](http://www.doleta.gov/programs/who_msfw.cfm). Accessed July 3, 2014.
- Carroll D, Samardick RM, Bernard S, Gabbard S, Hernandez T. Findings from the National Agricultural Workers Survey (NAWS) 2001–2002. A demographic and employment profile of United States farm workers. Washington, DC: US Department of Labor, Office of the Assistant Secretary for Policy, Office of Programmatic Policy; 2005. Research report no. 9.
- Carney PA, Hamada JL, Rdesinski R, et al. Impact of a community gardening project on vegetable intake, food security and family relationships: a community-based participatory research study. *J Community Health*. 2012;37(4):874–881.
- Chilton M, Black MM, Berkowitz C, et al. Food insecurity and risk of poor health among US-born children of immigrants. *Am J Public Health*. 2009;99(3):556–562.
- Rose-Jacobs R, Black MM, Casey PH, et al. Household food insecurity: associations with at-risk infant and toddler development. *Pediatrics*. 2008;121(1):65–72.
- Ryu JH, Bartfeld JS. Household food insecurity during childhood and subsequent health status: The Early Childhood Longitudinal Study—kindergarten cohort. *Am J Public Health*. 2012;102(11):e50–e55.
- Jyoti DF, Frongillo EA, Jones SJ. Food insecurity affects school children's academic performance, weight gain, and social skills. *J Nutr*. 2005;135(12):2831–2839.
- Kilanowski JF, Moore LC. Food security and dietary intake in Midwest migrant farmworker children. *J Pediatr Nurs*. 2010;25(5):360–366.
- Hill BG, Moloney AG, Mize T, Himelick T, Guest JL. Prevalence and predictors of food insecurity in migrant farmworkers in Georgia. *Am J Public Health*. 2011;101(5):831–833.
- Weigel MM, Armijos RX, Hall YP, Ramirez Y, Orozco R. The household food insecurity and health outcomes of U.S.–Mexico border migrant and seasonal farmworkers. *J Immigr Minor Health*. 2007;9(3):157–169.
- Kaiser LL, Melgar-Quinonez HR, Lamp CL, Johns MC, Sutherlin JM, Harwood JO. Food security and nutritional outcomes of preschool-age Mexican-American children. *J Am Diet Assoc*. 2002;102(7):924–929.
- Quandt SA, Arcury TA, Early J, Tapia J, Davis JD. Household food security among Latino farmworkers in North Carolina. *Public Health Rep*. 2004;119(6):568–576.
- Quandt SA, Shoaf JI, Tapia J, Hernandez-Pelletier M, Clark HM, Arcury TA. Experiences of Latino immigrant families in North Carolina help explain elevated levels of food insecurity and hunger. *J Nutr*. 2006;136(10):2638–2644.
- Bickel G, Nord M, Price C, Hamilton W, Cook J. Measuring food security in the United States. Guide to measuring household food security. Alexandria, VA: US Department of Agriculture, Food and Nutrition Service; 2000.
- Grzywacz JG, Suerken CK, Zapata-Roblyer MI, et al. Physical activity among preschool-aged Latino children in farmworker families. *Am J Health Behav*. 2014;38(5):717–725.
- Arcury TA, Quandt SA. Participant recruitment for qualitative research: a site-based approach to community research in complex societies. *Hum Organ*. 1999;58:128–133.
- Faugier J, Sargeant M. Sampling hard to reach populations. *J Adv Nurs*. 1997;26(4):790–797.
- Muhib FB, Lin LS, Stueve A, et al. A venue-based method for sampling hard-to-reach populations. *Public Health Rep*. 2001;116(suppl 1):216–222.
- Parrado EA, McQuiston C, Flippen CA. Participatory survey research. Integrating community collaboration and quantitative methods for the study of gender and HIV risks among Hispanic migrants. *Sociol Methods Res*. 2005;34(2):204–239.
- Grzywacz JG, Quandt SA, Chen H, et al. Depressive symptoms among Latino farmworkers across the agricultural season: structural and situational influences. *Cultur Divers Ethnic Minor Psychol*. 2010;16(3):335–343.
- Arcury TA, Grzywacz JG, Talton JW, et al. Repeated pesticide exposure among North Carolina migrant and seasonal farmworkers. *Am J Ind Med*. 2010;53(8):802–813.
- Quandt SA, Chen H, Grzywacz JG, Vallejos QM, Galvan L, Arcury TA. Cholinesterase depression and its association with pesticide exposure across the agricultural season among Latino farmworkers in North Carolina. *Environ Health Perspect*. 2010;118(5):635–639.
- Harrison GG, Stormer A, Herman DR, Winham DM. Development of a Spanish-language version of the US Household Food Security Survey module. *J Nutr*. 2003;133(4):1192–1197.
- MacDonald IL, Zucchini W. *Hidden Markov and Other Models for Discrete-Valued Time Series*. London, England: Chapman and Hall; 1997.
- Ip EH, Snow Jones A, Heckert DA, Zhang Q, Gondolf E. Latent Markov model for analyzing temporal configuration for violence profiles and trajectories in a sample of batterers. *Sociol Methods Res*. 2010;39(2):222–255.
- Zhang Q, Snow Jones A, Rijmen F, Ip EH. Multivariate discrete hidden Markov models for domain-based measurements and assessment of risk factors in child development. *J Graph Comput Stat*. 2010;19(3):746–765.
- Ip EH, Zhang Q, Rejeski J, Harris T, Kritchevsky S. Partially ordered mixed hidden Markov model for the disablement process of older adults. *J Am Stat Assoc*. 2013;108(502):370–380.
- Schwarz G. Estimating dimension of a model. *Ann Stat*. 1978;6(2):461–464.
- Zhang Q, Ip EH. Generalized linear model for partially ordered data. *Stat Med*. 2012;31(1):56–68.
- Little RJA, Rubin DB. *Statistical Analysis With Missing Data*. 2nd ed. Hoboken, NJ: Wiley; 2002.
- Ip EH, Zhang Q, Sowinski T, Saldana S, Barnard R. Software program: Dynamic Multichain Graphical Model. Available at: <http://dmgm.wfuhs.arsne.us>. Accessed October 30, 2014.
- Wolfe WS, Frongillo EA. Building household food-security measurement tools from the ground up. *Food Nutr Bull*. 2001;22(1):5–12.
- National Research Council. *Measuring Food Insecurity and Hunger: Phase 1 Report*. Washington, DC: The National Academic Press; 2005.
- Ribar DC, Hamrick KS. *Dynamics of Poverty and Food Sufficiency*. Washington, DC: US Department of Agriculture, Economic Research Service; 2003.
- Hofferth SL. *Persistence and Change in the Food Security of Families With Children, 1997–99*. Washington, DC: US Department of Agriculture, Economic Research Service; 2004.
- Quandt SA, Grzywacz JG, Trejo G, Arcury TA. Nutritional strategies of Latino farmworker families with preschool children: identifying leverage points for obesity prevention. *Soc Sci Med*. 2014;123:72–81.
- Wiggins MF. Farm labor and the struggle for justice in the eastern United States. In: Arcury TA, Quandt SA, eds. *Latino Farmworkers in the Eastern United States*. New York, NY: Springer; 2009:201–220.
- Stevens AH. Poverty transition. In: Jefferson PN, ed. *The Oxford Handbook of the Economic of Poverty*. New York, NY: Oxford University Press; 2012:494–518.