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# Stress and Cognitive Function in Latino Farmworkers

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## Abstract

**BACKGROUND—**Job stress has been associated with cognitive function, but the relationship is often overlooked when considering occupational health and safety issues of farmworkers. This study examined the relationship between stress and change in stress with change in cognitive function in a representative sample of 123 Latino farmworkers. METHODS: A prospective study design was used in which stress and cognitive function data were collected at baseline and at 3-month follow-up. Linear regression models were used for analyses. Potential confounders included baseline gender, age, education, number of years worked in U.S. agriculture, ever smoking status, self-rated health, and depressive symptoms.

**RESULTS—**Baseline stress was significantly correlated with baseline cognitive function ($r = -.27$; $p < .001$). Adjusting for confounders, increased baseline stress was associated with greater decline in cognitive function ($p = .024$). Short-term changes in stress were not associated with cognitive change in this cohort.

**CONCLUSIONS—**Stress at work is an important risk factor for poor cognitive function. This analysis suggests several implications for the provision of health care and for the organization of work for farmworkers.

### Keywords

stress; cognitive function; occupational health; farmworkers

Farming is one of the most dangerous industries in the United States [NIOSH 2010]. Stress in farmworkers has emerged as an important public health concern, with nearly 40% of farmworkers studied having significant levels of stress [Hiott et al. 2008]. Farmworkers face numerous stressors, including occupational hazards, poverty, nature of rural life and social isolation, health and safety concerns, and separation from family [Arcury and Quandt 2007;Hovey and Seligman 2005;Magana and Hovey 2003]. Stressors inherent in farm work

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and the farmworker lifestyle are associated with poor physical [Gregoire 2002;Walker and Walker 1988] and mental health outcomes [Hiott et al. 2008;Hovey and Magana 2002;Magana and Hovey 2003].

Stress has been documented to have deleterious effects on brain structure and cognitive function [Crowe et al. 2007;McEwen 2000;Sapolsky 1996]. Hippocampal atrophy is associated with cognitive dysfunction in humans and in animal models [de Quervain et al. 2003;McEwen et al. 1999]. Studies have shown that acute stressors can cause short-term but reversible deficits in tasks of memory, while chronic stress could lead to irreversible loss of hippocampal neurons and cognitive impairment [Lupien et al. 2005;Lupien et al. 2009;McEwen 2000]. Stress-related outcomes including cognitive impairment may lead to poor work performance or even injury [NIOSH 2009]. In view of the evidence of the adverse effect of stress on cognitive function, it is important to examine the potential impact of stress on cognitive function. However, stress-related cognitive function is rarely examined in farmworkers.

About 85% of migrant and seasonal farmworkers in the United States are Latinos [Carroll et al. 2005]. Most of these Latino farmworkers experience numerous stressors inherent in farmwork [Hiott et al. 2008;Hovey and Magana 2000;Magana and Hovey 2003]. This study examined the role of stress in predicting change in cognitive function (e.g., cognitive decline) over an agricultural season in a sample of Latino farmworkers. Longitudinal approaches were used to provide information as to the dynamic or reversible effects as a function of changes in exposure. The relationship between stress and cognitive function was explored in three ways: (1) cross-sectional relationship between baseline stress and baseline cognitive function (2) baseline stress as a predictor of subsequent cognitive function; and (3) change in stress as a predictor of change in cognitive function. We first hypothesized that baseline stress would be associated with baseline cognitive function, and with subsequent cognitive function. Secondly, we hypothesized that changes in stress would be associated with changes in cognitive function. Understanding these associations will be helpful in understanding mechanisms and planning interventions to reduce stress-related disorders including cognitive impairment.

## Materials and Methods

The data used in this analysis were collected in 2008 as part of an ongoing program addressing the health of Latino farmworkers and their families in eastern North Carolina. This study used a prospective design in which data were collected at baseline (June) and at 3-month follow-up (August). The Wake Forest School of Medicine Institutional Review Board approved the study protocol and instruments, and each participant provided written informed consent.

### Sample

The baseline survey included 128 farmworkers who were recruited from 29 farmworker camps in the 11 counties. For the sample selection, farmworker camps were visited in random order until the target sample size of at least 120 was reached. The final sample in these analyses included 123 who participated in both baseline and 3-month follow-up data collections.

### Data Collection

The study obtained data on cognitive function and personal characteristics such as age, gender, and education. Questionnaires were administered by Spanish-speaking interviewers who traveled to the farmworkers' residences. Interviewers were required to complete an

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intensive course of training, including a thorough review of camp and participant selection, recruitment procedures, and data collection procedures.

## Measure of Stress in Farmworkers

Stress was assessed at baseline and at 3-month follow-up. Stress was measured with the brief Migrant Farmworker Stress Inventory (MFWSI), a 17-item self-report instrument that assesses exposure to stressors inherent in migrant farm work for adults [Magana and Hovey 2003]. Items tap aspects of migrant farm work, such as perceived discrimination, acculturative stress, poor working conditions, and physically demanding work. Respondents rate each item that they have experienced on a 5-point scale ("Have Not Experienced" to "Extremely Stressful"). Scores were obtained by summing the scores for the 17 items (Cronbach's alpha = .70). Higher scores reflect a higher level of stress.

## Measures of Cognitive Function

Two well-validated and widely-used tests that draw on tasks of visual memory and psychomotor speed were used at baseline and at 3-month follow-up. The cognitive tests were chosen in accordance with previous conventions in the literature and have been used in other studies to examine cognitive function among farmworkers [Baldi et al. 2001;Farahat et al. 2003]. Visual memory was assessed using the Benton Visual Retention Test (BVRT) [Sivan 1992]. Participants were presented with 10 cards depicting geometric designs. The first two cards contained one figure per design and the rest contained two major figures and one peripheral figure per design. Each card was exposed for 10 seconds. Immediately after its removal, participants attempted to reproduce the designs from memory on a blank ½ sheet of paper. BVRT scores were recoded, with higher scores indicating better performance in tasks of visual memory. Psychomotor speed was assessed using the Trailmaking Test B [Reitan and Wolfson 1985]. In Trails B, randomly arranged letters and numbers appear on a single page and participants are required to draw a line connecting them sequentially in alternating order (i.e., 1-A-2-B, etc.). Trails B scores were recoded, with higher scores indicating better performance on psychomotor speed.

To avoid floor and ceiling effects and the significant correlation between the two cognitive tests ($r = .45$; $p < .001$), composite scores of both tests were used. As previously described [Nguyen et al. 2007;Wilson et al. 2005], the composite measure was constructed by transforming the raw score of each test into z-scores, using the sample mean and standard deviation. The z-scores were then averaged to produce the composite score of cognitive function.

## Covariates

We adjusted the analyses for baseline characteristics including gender, age, education, number of years worked in U.S. agriculture, and ever smoking status (yes/no). Self-rated health**,** a standard and very predictive measure of health status [Idler and Benyamini 1997], was based on one question "In general, how would you rate your health?" (good health vs. poor health). Depression was assessed with a 10-item version of the Center for Epidemiologic Studies Depression (CES-D) scale assessing depressive symptoms in the past week [Kohout et al. 1993]. A standard cutoff score of 10 has been reported as indicative of significant depressive symptoms [Andresen et al. 1994]. The scale has acceptable internal consistency ($\alpha$ = .73, 95% CI = .70 - .76) and it accounts for 78.3% of the variance in scores from the full CES-D [Grzywacz et al. 2009].

### Statistical Analysis

Descriptive statistics were used to describe baseline characteristics of study population. All data analyses accounted for the study's clustered within camps. Linear regression models were used to examine the relationships between stress and cognitive function. First, we examined the baseline cross-sectional relationship between stress and cognitive function. Next, mixed effects models (SAS Proc Mixed) were used to assess whether baseline stress score predicted subsequent cognitive function (3-month follow-up). Lastly, the associations of changes in stress (predictor) with changes in cognitive function over time (outcome) were examined with an additional mixed effects model. Two levels of covariate adjustment were used in each approach: (1) a reduced adjustment model that included gender, age, education, and number of years worked in U.S. agriculture as covariates; and (2) a full model that further added ever smoking status, self-rated health, and depressive symptoms. Statistical analysis was performed using SAS 9.1 (SAS Institute, Inc., Cary, NC).

## Results

Baseline descriptive statistics are reported in Table I. About 90% of farmworkers in this study are men. They have a mean age of 36.9 years (SD 9.7) and a mean education of 6.9 years (SD 3.1). All farmworkers speak Spanish, with 7.0% speaking some English. The mean BVRT (10.9 errors) and Trails B (224.7 seconds to complete task) scores indicate low cognitive function in this group. Farmworkers reported an average of 6.8 ($SD = 4.2$) depressive symptoms at baseline, and 22% (n = 27) of the sample had scores above the cut-off for significant depressive symptoms. Overall, the mean scores for stress slightly decreased over the 3 months (24.8 ± 8.7 vs. 23.5 ± 8.2), but mean z-scores for cognitive function did not change (0 ± 0.72 vs. 0 ± 0.85).

Baseline stress was significantly correlated with baseline cognitive function ($r = -.27$; $p < .001$). In the reduced adjustment model, a 1 point higher stress score was associated with a 0.02 point lower cognitive z-score ($p < .05$). The cross-sectional relationship between baseline stress and baseline cognitive function was marginally significant ($p < .10$) after full adjustment. As shown in Table II, baseline stress significantly predicted change in cognitive function. In the full adjustment model, increased stress was associated with greater decline in cognitive function. Baseline cognitive score, age, and education level were also significantly associated with change in cognitive function. The relationship between change in stress and change in cognitive function is also shown in Table II. The relationship for change in stress was in the same direction as baseline stress; over time, increased stress seemed to be related to more decline in cognitive function. However, the relationship was not statistically significant in either the reduced or full adjustment models.

## Discussion

The present study assessed stress in a sample of Latino farmworkers in eastern North Carolina. We found (1) a cross-sectional relationship between baseline stress and baseline cognitive function, but the association became marginally significant after full adjustment; (2) baseline stress level independently predicted subsequent cognitive function, and (3) changes over time in stress seemed to be related to changes over time in cognitive function, but the relationship was not statistically significant. The association between baseline stress and subsequent cognitive function could not be attributed to known risk factors of cognitive dysfunction including age, education, health status, smoking status, and depressive symptoms [Lee et al. 2003;Schaie and Willis 2002;Scuteri et al. 2005;van Hooren et al. 2005] in the previous 3 months. The relationship was essentially unchanged, suggesting that these covariates could not account for the findings. Although short-term changes in stress did not statistically predict subsequent cognitive function, the direction of association suggests that reduced stress may help to reduce cognitive decline. The non-significant relationship could be due to multiple factors, including minimal changes in the average stress scores across the two data points. Perhaps other designs such as day-to-day stressor models might better capture how daily changes in stress relate to cognitive function. Several studies have found relationships between daily fluctuations in stress and cognitive performance variability [Neupert et al. 2006;Sliwinski et al. 2006;Vedhara et al. 2000], and some of this evidence suggests that stress may have particularly deleterious effects for more vulnerable populations like recent immigrants [Hovey and Magana 2000;Magana and Hovey 2003]. Examining these relationships in a larger sample would be informative.

Our results are consistent with earlier work in the area of stress and cognitive function [Crowe et al. 2007;Lupien et al. 2005;Lupien et al. 2009;McEwen 2000;McEwen and Sapolsky 1995]. A critical review of stress research by Lupien and associates [Lupien et al. 2007] suggests the significant negative impact of stress and stress hormones on cognitive function in young and older adults. Our findings also strengthen the conclusion that stresses in farm working are associated with mental health-related outcomes [Gregoire 2002;Hiott et al. 2008;Hovey and Magana 2002;Magana and Hovey 2003;Walker and Walker 1988] including cognitive function.

These findings have important implications both for the provision of health care and for the organization of work for farmworkers. Limitations in the availability of mental health care in rural communities and the spatial distribution of farmworkers limits direct therapeutic interventions for most farmworkers [Arcury and Quandt 2007]. However, clinical and outreach programs of migrant health programs should consider farmworker stress and programs that can help farmworkers better accommodate and cope with experienced stressors. Such programs could include the discussion of stress at outreach visits to farmworker camps, and the organization of recreational activities for farmworkers. For example, Grzywacz and colleagues [2006] suggest improving the ability of farmworkers to communicate with their families. Changes in the organization of work for farmworkers should be considered that will reduce the causes of stress. Such changes could include providing workers with safer working conditions and safer housing. Any alleviation of stressor exposure by farmworkers has the potential of significant implications for enhanced cognitive function, considering the 40% of farmworkers who report significant levels of stress and other mental health conditions [Hiott et al. 2008;Hovey and Magana 2000;Hovey and Magana 2002]. Initiatives designed to minimizing exposure to stressors or that provide resources to promote adaptive coping could generate meaningful reductions in occupational health disparities borne by this vulnerable group of workers. This is an important area for research and program development. Screening for stress is warranted in this population; such screening can promote the most efficient use of limited health service resources by delivering appropriate interventions to those most at risk [Arcury and Quandt 2007].

These findings also have implications for occupational justice and health [Arcury and Quandt 2009]. This analysis indicates that the work in which farmworkers are engaged exposes them to stressors that reduce their cognitive capacity. Farmworkers receive very little compensation for these exposures or for the potential affects of these exposures for their quality-of-life. Little has been done to ameliorate physical or psychosocial stressors for farmworkers; in fact, few regulations to protect the health of farmworkers exist, and those that do exist are not well-enforced [Arcury et al.;Robinson et al. 2011;Wiggins 2009]. Improved regulation and monitoring of farmworker exposures are required to provide a just work environment.

This study has several strengths, including a representative sample of farmworkers, baseline and follow-up stress and cognitive assessments using validated measures, and a number of relevant covariates. To date, studies of stress and cognitive function have examined the general population or clinical samples. The study's sample involved Latino farmworkers that have not been well-represented in previous studies. This population faces numerous stressors inherent in farmwork. Study of relatively high risk populations can be particularly important to provide potential mechanisms by which stress influences cognition. To our knowledge, this is the first study that uses short-term longitudinal approaches to investigate the relationship between stress and change in stress and subsequent cognitive function in farmworkers. Longitudinal approaches are necessary for observing the impact of stress on cognitive function, and are essential to provide information as to the dynamic nature or reversibility of cognitive effects as a function of changes in stress level.

This study also has several limitations. Although the study employed sampling techniques that provided a representative sample, the sample size was relatively small. However, farmworker and other immigrant Latino communities are "hard-to-reach" populations for health research [Heckathorn 1997;McQuiston et al. 2005] in that no sampling frame for these communities exists, and the members of these communities have compelling reasons (e.g., lack of documentation, experience of discrimination) not to be found. A community-based participatory research approach (CBPR) was used to allow communities and universities to conduct research collaboratively. Our conceptual model of CBPR as translational science delineates four domains of community participation: consultation, strategic planning, implementation, and dissemination [Arcury et al. 1999]. Such a model improves recruitment in these hard-to-reach populations to address consequences of work-related stress and cognitive health. Future studies including other types of stressor (e.g., limited social mobility, acculturative stress, and geographical isolation) and cognitive function in Latino farmworkers are necessary to examine the effects more thoroughly. The study did not include other confounders such as diet, medical conditions, and pesticide exposure that may also contribute to the association between stress and cognitive function.

In summary, this study examined the association between stress and cognitive function. The findings suggest that stress and short-term changes in stress are related to changes in cognitive function. This information can be used to guide effective provision of health care and organization of work aimed at reducing stress in farmworkers. More research is needed to explore the role of stress in the risk of cognitive impairment and because of its practical value for preventing poor cognitive function.

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**Table I**

Baseline Characteristics of Farmworkers, Eastern North Carolina (N = 123).

| Characteristic | Mean±SD or % |
|---|---|
| Male | 89% |
| Age | 36.9±(9.7) |
| Education (years) | 6.9±(3.1) |
| Number of Years Worked in U.S. Agriculture | 11.8±(8.6) |
| Ever Smoking Status | |
| No | 58% |
| Self-rated Health | |
| Good health | 57% |
| Depressive Symptoms | 6.8±4.2 |
| Composite cognitive function, z-score | 0±0.84 |
| BVRT errors | 10.9±6.2 |
| Trails B total seconds | 224.7±76.2 |
| Stress | 24.8±8.7 |

**Table II**

Relationship Between Baseline Stress Score and Change in Stress with Change in Cognitive Function Over 3-Month Follow-up.

| | **Estimated coefficient of baselines stress for change in cognitive function** | |
|---|---|---|
| | **Reduced adjustment** | **Full adjustment** |
| | **Coefficient (SE)** | **Coefficient (SE)** |
| Male | −0.063 (0.175) | −0.168 (0.177) |
| Age | −0.011 (0.006) | −0.014 (0.006) ** |
| Education | 0.037 (0.019) * | 0.038 (0.018) * |
| Number of years worked in U.S. agriculture | 0.003 (0.006) | 0.003 (0.006) |
| Ever smoking status (No) | | −0.173 (0.110) |
| Self-rated health (Good) | | −0.196 (0.100) * |
| Depressive symptoms | | −0.212 (0.145) |
| Baseline stress | −0.014 (0.006) * | −0.016 (0.006) * |
| | Estimated coefficient of change in stress for change in cognitive function | |
| | Reduced adjustment | Full adjustment |
| | Coefficient (SE) | Coefficient (SE) |
| Male | 0.042 (0.175) | −0.073 (0.173) |
| Age | −0.010 (0.006) | −0.014 (0.006) * |
| Education | 0.041(0.019) * | 0.044 (0.019) * |
| Number of years worked in U.S. agriculture | 0.005(0.006) | 0.006 (0.006) |
| Ever smoking status (No) | | −0.227 (0.110) * |
| Self−rated health (Good) | | −0.197 (0.101) |
| Depressive symptoms | | −0.210 (0.141) |
| Change in stress | −0.003 (0.012) | −0.001 (0.012) |

* $p < .05$

** $p < .01$