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To cite this article: Ioana Albu, Lisa Elon, Nezahualcoyotl Xiuhtecutli, Linda McCauley & Roxana Chicas (2024) Retention of Agricultural Workers Participating in a Renal Longitudinal Study, Journal of Agromedicine, 29:1, 26-33, DOI: [10.1080/1059924X.2023.2246966](https://doi.org/10.1080/1059924X.2023.2246966)

To link to this article: <https://doi.org/10.1080/1059924X.2023.2246966>

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 Published online: 13 Aug 2023.


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## Retention of Agricultural Workers Participating in a Renal Longitudinal Study

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### ABSTRACT

**Objectives:** The relationship between heat stress, chronic kidney diseases and acute kidney injury has been documented in cross-sectional studies with agricultural workers. However, only a few international studies have assessed renal function in agricultural workers longitudinally. Our research study, Occupational Heat Exposure and Renal Dysfunction (OHEaRD) is the first longitudinal study in the U.S. that monitored renal function in agricultural workers five times over the course of 32-months. The main objectives of this study were to evaluate the rate of retention and identify predictors associated with retention in a longitudinal study with agricultural workers.

**Methods:** In January 2020, we enrolled 119 Florida agricultural workers to observe on 5 workdays over 32 months. Retention was defined by the number of follow-up visits that a participant attended, the consistency of visit attendance, and attendance at the last visit. Participants were provided hemoglobin A1C, lipid panel, creatinine measurement, glomerular filtration rate (eGFR), blood pressure, and body mass index results and an incentive gift card were handed out to participants at each visit.

**Results:** Four enrollees did not participate on any workday, thus analysis concentrated on the remaining 115 participants. The majority of participants (64%) completed the 32-month study, 78% completed at least 4 visits, and 55% completed all 5 visits. The statistically significant predictors of higher retention among this study were being older in age ( $p=0.02$ ), Mexican nationality ( $p=0.004$ ), working in ferneries ( $p=0.009$ ), more years working in agriculture ( $p=0.02$ ), and higher total cholesterol ( $p=0.02$ ). Appreciation for the health tests was associated with greater participation at the final visit ( $p=0.01$ ).

**Conclusion:** Retention in longitudinal studies is crucial to better understand kidney disease among agricultural workers, an understudied population. Participants reported valuing the access to health results, indicating that implementing point-of-care health screenings and providing the health results to each participant is a good retention strategy. There was some evidence that a participant living with or being related to a fellow co-participant could impact retention as they either showed up or missed visits together, suggesting recruiting from the same household may reduce retention.

### KEYWORDS


Agricultural Workers;  
Longitudinal Study;  
Retention; Kidney


## Introduction

It is estimated that there are 4 million agricultural workers in the United States (U.S.)<sup>1</sup> that are at an increased risk of hazardous occupational exposures and experience significant health disparities.<sup>2–5</sup> Agricultural workers are primarily Latino immigrant workers, and it is estimated that 50% lack immigration status, and have limited access to health care<sup>6,7</sup> Studies have found agricultural workers face health disparities, including obesity, elevated blood pressure, prediabetes, heat stress, heat-related illness, and musculoskeletal problems, and that their working conditions contribute to health inequities.<sup>3,4,8–12</sup> Furthermore, agricultural workers are at increased risk for renal dysfunction that is associated with occupational heat exposure.<sup>13,14</sup> Chronic kidney disease of unknown

etiology (CKDu)<sup>15</sup> has plagued agricultural workers in Latin America, and recent studies in the United States (U.S.) have documented acute kidney injury (AKI) among agricultural workers over the course of one work shift.<sup>11,13</sup> The combination of demanding physical labor, exposure to high temperatures and chronic dehydration are risk factors for renal dysfunction among agricultural workers.<sup>11,13–16</sup> A focus of the National Institute for Occupational Safety and Health research is to conduct studies to better understand kidney disease among agricultural workers who are working at high ambient temperatures.

In the U.S., studies on the health status of agricultural workers have often been cross-sectional studies or survey studies.<sup>11,17–19</sup> Studies on renal dysfunction among agricultural workers have also

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 Supplemental data for this article can be accessed online at <https://doi.org/10.1080/1059924X.2023.2246966>.

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been limited to cross-sectional studies in the U.S.<sup>11,13</sup> While chronic dehydration and heat exposure have been frequently described as the potential factor affecting renal function, there are no published biomedical longitudinal studies conducted in the U.S with agricultural workers.

Longitudinal studies are essential to assess the change over time of renal function and to identify risk factors.<sup>20</sup> Retention rates in longitudinal studies are critical to the research design, to reduce bias, and to maintain power for statistical analysis.<sup>20</sup> Retention in research studies is defined as the measure of participants that continue and/or complete a given research study. Agricultural workers are a vulnerable population, and recruiting workers to participate in research studies is challenging due to multiple issues, including mistrust, logistical factors, concerns about privacy and confidentiality due to their immigration status and fear of employer retaliation for participating in research.<sup>21</sup> However, in our studies with agricultural workers, we have partnered with the Farmworker Association of Florida (FWAF), to conduct community-based participatory research and have been successful at enrolling workers in cross-sectional studies. FWAF is a grassroots organization that has been part of the agricultural community of Florida for over 20 years and has developed a strong relationship with that community. They have been our community partners for over a decade and have been successful at reducing barriers to agricultural workers' willingness to participate in research. However, the studies have all been cross-sectional studies.

Our research study, Occupational Heat Exposure and Renal Dysfunction (OHEaRD | R01OH011782), is the first longitudinal study in the U.S. that monitored agricultural workers five times over the course 32-months to measure changes in markers of renal injury and diminishing renal function over time. The purpose of this paper is to report the rate of retention of agricultural workers in a longitudinal study and to identify predictors associated with retention.

## Methods

The OHEaRD study was a longitudinal study of agricultural workers in Florida designed to investigate renal dysfunction related to occupational

heat exposure. The study was conducted by Emory University researchers in partnership with FWAF. Consent was given by 119 workers, 4 of whom dropped out immediately and did not provide any workday data; this analysis concentrates on the remaining 115 participants. We monitored the participants at five time points: January August 20, 2020, January July 20, 2021, and September 2022. At each visit, participants were assessed pre- and post-work shifts. At the pre-work shift visit, participants were equipped with a Zephyr bioharness to monitor heart rate and physical activity, and estimated core body temperature and the bioharness was removed at the post-work shift visit. We obtained blood samples via a fingerstick at the pre- and post-work shift visits for point-of-care measurements (hemoglobin A1C, lipid panel, and creatinine). Based on each participant's work hours, we quantified exposure to temperature and relative humidity by extracting weather data summaries from the Florida Automated Weather Network (FAWN). A more detailed methods section will be described in a manuscript that is forthcoming for the larger study that investigated renal dysfunction related to occupational heat exposure.

## Recruitment, eligibility, and retention efforts

The FWAF recruited a convenience sample of agricultural workers who worked in the north-central Florida towns of Pierson and Apopka. Agricultural workers were recruited from a roster of FWAF members, during FWAF community events, workplace site outreach for other FWAF programs, and by word-of-mouth. Workers in these two areas primarily worked in ferneries and plant nurseries. Inclusion criteria for agricultural workers to be eligible to participate in the study were that they were 18–49 years of age and working in ferneries, nurseries, or crops, including the 4 weeks prior to enrollment in the study. Both male and female agricultural workers were eligible to participate. Exclusion criteria at baseline included: 1) currently pregnant; 2) Type 1 or 2 diabetes; 3) under treatment for hypertension; or 4) reported history of glomerulonephritis, pyelonephritis, renal calculi, or snake bite. In between data collection visits, the FWAF personally invited

each participant to various community events. Two-weeks before each data collection appointment, participants were called or texted to remind them of the upcoming data collection day. A day before their data collection date, a FWAF community health worker called and/or sent reminder text of their scheduled date. Lipid panel and the hemoglobin A1C were added to the study design at the request of community members during previous collaborative studies between FWAF and Emory School of Nursing. At each post-workday data collection visit, each participant was given by the study nurse their individual point-of-care results (height and weight, body mass index (BMI), blood pressure, hemoglobin A1C, lipid panel, and creatinine measurements). Participants were also counseled on how to improve elevated values and/or referred to a local clinic as needed. At each data collection visit, participants received gift cards for a total incentive of \$270 if all five visits were completed.

### Data collection

All data were collected from participants in the FWAF field offices. During the first baseline visit, participants had their height and weight recorded, body mass index (BMI) was calculated, and blood pressure measured. Study personnel orally queried participants about socio-demographic and general work-related information, entering the responses in the RedCap platform.<sup>22</sup> Before and after their data collection workday, participants had a fingerstick to collect blood for analysis of hemoglobin A1C (A1CNOW®, pts Diagnostics, Whitestown, IN), creatinine (Abbott Laboratories, Abbott Park, IL), and lipid panel (CardioChek® Plus, pts Diagnostic, Whitestown, IN). The lipid panel included total cholesterol, high-density lipoprotein (HDL), and low-density lipoprotein (LDL). The blood was analyzed with the iSTAT Handheld Blood Analyzer Point of Care system with a Chem8+ cartridge (Abbott Laboratories, Abbott Park, IL). The creatinine measurement was used to estimate glomerular filtration rate (eGFR),<sup>23</sup> and the change in creatinine from pre- to post-work shift was used to determine acute kidney injury (AKI) status.<sup>24</sup> Participants were queried about heat-related illness (HRI) symptoms (heavy sweating, headache, nausea, dizziness,

confusion, muscle cramps, fainting, and dysuria) experienced during that workday.

### Retention predictors

Retention in this study was defined in three ways: by the number of data collection dates that a worker participated in, the consistency of participation, and whether a worker remained in the study until the last (fifth) visit.

The variables analyzed for their relationship to the retention included socio-demographic factors at baseline, the health status of participants at baseline, work-related factors at baseline, workday health at baseline, and whether the participant lived in the same household or was family with a co-participant. Socio-demographic factors at baseline were self-reported and included the age of the participant at the first visit, sex, years of education, marital status, and nationality. Health status of participants at baseline was determined by a basic self-assessment of their general health (excellent/good/average/poor), BMI, A1C, cholesterol, HDL, LDL, and blood pressure. Work-related factors at baseline consisted of the location/primary work (Pierson/ferneries vs. Apopka/nurseries), payment method (by the piece/by the hour/combo or other method), age they started working in agriculture, length of time working in agriculture, length of time working in Southern U.S. agriculture. Work-health at baseline factors included the number of HRI symptoms reported, AKI status, and post-work shift eGFR. Additionally, at the fourth visit participants were asked what they liked most about study participation; the most commonly given answer, “provision of health test results”, was used as a predictor of returning for the fifth visit 1 year later.

### Statistical analysis

Descriptive statistics were reported as median and quartiles and percent and sample size. Simple generalized linear mixed models were used to evaluate baseline and fourth year predictors of retention, with alpha set at 0.05. Mixed models are adjusted for the clustering effects due to some participants living with or being related to other participants; the intraclass correlation

**Table 1.** Baseline predictors of retention in a 32-month (5-visit) study of Florida agricultural workers. January 2020 to August 2022.

Baseline Characteristic	Overall N = 115 <sup>1</sup>	Completed Visit 5		p-value <sup>2</sup>
		No N = 41 <sup>1</sup>	Yes N = 74 <sup>1</sup>	
<b>Demographics</b>				
Age, yrs	38.9 (33.4, 44.5)	36.7 (30.0, 41.0)	40.9 (34.7, 45.0)	<b>0.02</b>
Education, yrs	8(6, 10)	8 (6, 10)	8(6, 9)	0.6
Female	77% (88)	73% (30)	78% (58)	0.5
Married/Coupled	68% (78)	71% (29)	66% (49)	0.7
Nationality				<b>0.004</b>
Mexican	72% (83)	49% (20)	85% (63)	
Guatemalan	14% (16)	24% (10)	8% (6)	
Other	14% (16)	27% (11)	7% (5)	
Lives with/related to co-participant	44% (51)	46% (19)	43% (32)	0.7
<b>Work</b>				
Location (primary work type)				<b>0.009</b>
Pierson (Ferneries)	42% (48)	22% (9)	53% (39)	
Apopka (Plant nurseries)	58% (67)	78% (32)	47% (35)	
Payment				0.07
By the piece	30% (35)	15% (6)	39% (29)	
By the hour	64% (74)	80% (33)	55% (41)	
Other	5% (6)	5% (2)	5% (4)	
Age started in agriculture	20 (17, 26)	19 (15, 25)	20 (17, 27)	0.9
Agricultural work, yrs	11 (4, 18)	6 (2, 16)	13 (6, 19)	<b>0.02</b>
Southern agriculture, yrs	10 (3, 18)	4 (1, 16)	11 (5, 18)	0.05
<b>Health status</b>				
General Health				0.6
Excellent	8% (8)	11% (4)	6% (4)	
Good	47% (50)	47% (17)	47% (33)	
Average/Poor	45% (48)	42% (15)	47% (33)	
Hypertension				0.9
SBP<120 and DBP<80	53% (61)	51% (21)	54% (40)	
SBP 120–139 or DBP 80–89	37% (42)	37% (15)	36% (27)	
SBP 140+ or DBP 90+	10% (12)	12% (5)	9% (7)	
BMI	29 (26, 34)	28 (25, 31)	30 (27, 34)	0.7
A1c	5.1 (4.8, 5.5)	5.1 (4.9, 5.5)	5.1 (4.8, 5.5)	0.8
Total Cholesterol	163 (142, 194)	147 (127, 178)	172 (151, 199)	<b>0.02</b>
HDL Cholesterol	52 (46, 58)	53 (49, 59)	52 (44, 58)	0.6
Triglycerides	162 (115, 215)	145 (88, 182)	172 (128, 228)	0.1
<b>Workday Health</b>				
Heat-Related Symptoms, #				0.3
none	64% (72)	52% (21)	70% (51)	
one	29% (33)	38% (15)	25% (18)	
two or more	7% (8)	10% (4)	5% (4)	
Acute kidney injury	15% (16)	19% (7)	13% (9)	0.3
eGFR post-workday	116 (109, 127)	116 (106, 125)	116 (109, 128)	0.9

<sup>a</sup>Median (IQR); % (n)<sup>2</sup>Generalized linear mixed model.

<sup>b</sup>Symptoms include heavy sweating, headache, nausea, dizziness, confusion, muscle cramps, fainting, dysuria.

Missing (no/yes): education (0/1), years working in agriculture (0/1), general health (5/4), A1c (1/0), HRI (1/1), eGFR pre-workday (4,3), eGFR post-workday (1/1)

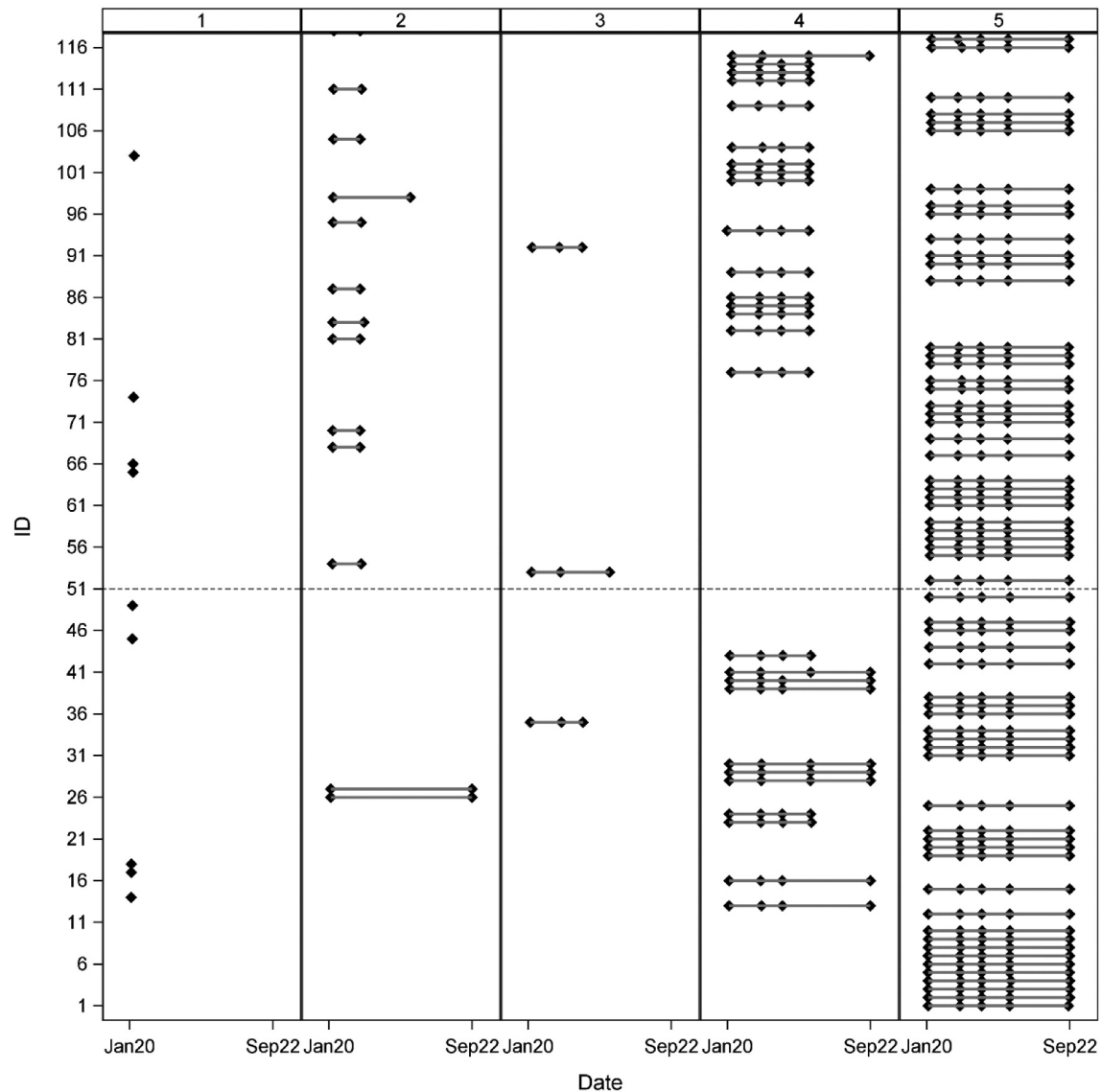
Abbreviations: SBP, systolic blood pressure; DBP, diastolic blood pressure; HDL high-density lipoprotein; eGFR, estimated glomerular filtration rate

coefficient for this term is reported. Analyses were performed using SAS® 9.4 software [SAS Institute Inc., Cary, NC, USA].

## Results

Among the 115 participants, all identified as Hispanic (Table 1). At baseline the median age was 39, with low educational attainment

(median 8 years). The group was primarily female (77%), married or coupled (68%), and the distribution of nationalities was 72% Mexican, 14% Guatemalan, and 14% other. Nearly half were living with or related to a co-participant. The study recruited more nursery workers (58%) than fernery workers, and all Guatemalans were nursery workers. The median age they started working in agriculture was 20,



**Figure 1.** OHEaRD study retention patterns. The majority of participants (64%) completed the 32-month study, 78% had at least four visits, and 55% had five visits. As seen in columns 2, 3, and 4, most participants consistently showed up for follow-up visits until they dropped out of the study. The dotted line demarks the two locations (below=primarily fernery workers, above=primarily plant nursery workers).

and they had commonly been working in this sector for over a decade. They tended to report their general health status as good or average (only one person said “poor”). Almost half had elevated blood pressure (SBP  $\Rightarrow$  120 or DBP  $\Rightarrow$  80), their median BMI was high (median 29), and 15% had elevated A1c ( $\geq$ 5.7%). Post-workday, one-third reported having symptoms of heat-related illness and 15% had AKI.

The majority of participants (64%) completed the 32-month longitudinal study, 78% had at least four visits, and 55% had five visits. [Figure 1](#)

displays participation patterns. Twenty-two percent completed three or fewer data collection sessions, but the remainder complete four or more sessions. As seen in plot columns 2, 3, and 4, most participants working in nurseries (upper half of the graph) consistently showed up for follow-up visits until they dropped out of the study, while fernery workers were more likely to have intermittent participation.

[Table 1](#) reports baseline predictors of remaining in the study until the final visit. Older age, Mexican nationality, working in ferneries, more years

working in agriculture, and higher cholesterol were associated with higher retention. While living with or being a relative of a coparticipant was not associated with retention to study end point, there is some evidence that coparticipants showed up or missed visits together (intraclass correlation coefficient = 0.24), leading to somewhat fewer co-participants coming to all visits (Table S1).

At visit 4, 87 participants were asked what they liked most about the study. The most common answer (56%) was “provision of health test results”, with response increasing with age (20% if <30 years old, 50% 30–39, and 69% 40–49;  $p = .02$ ). Appreciation for the health tests was associated with greater participation at the final visit 1 year later (90% v 63%,  $p = .01$ ).

## Discussion

This study aimed to identify the predictors associated with participant retention in the OHEARD longitudinal study. Such research has significant implications towards the improvement of retention in the future research of agricultural workers, a currently understudied population. In studies where kidney function is being studied, retention in these longitudinal studies is crucial to better understand kidney disease among agricultural workers and its progression.

The statistically significant predictors of higher retention in this study were being older in age. Mexican nationality, working in ferneries, more years working in agriculture, and higher cholesterol were associated with higher retention. This is suggestive that participants may have been more concerned with continuing to see their health results and thus stayed in the study, highlighting the lack of access to health care that agricultural workers face.<sup>3,25</sup> Furthermore, participants reported that health results were the most liked aspect of participating and were strongly predictive of showing up for the final study visit. This indicates that implementing point-of-care health screening and providing individual health results to each participant is a good retention strategy as workers value health screenings and learning about their laboratory values. In future, it would be worthwhile to explore retention strategies that would appeal to younger workers.

Participants who were from Guatemala (all at Apopka, younger and therefore lower cholesterol, and fewer years in age) were most likely to drop out before visit 5. Several of the Guatemalan participants were indigenous workers and were in a relationship and/or co-habited with another participant. We had some barriers preventing us from fully gaining their trust, and therefore it was more difficult for us to maintain their trust. Three of the Guatemalan participants expressed concerns that we were collecting too much blood from the fingerstick. They continued in the study without providing blood samples, but ultimately on their last visit they decided to not participate. Language access and a history of abuses from governments and researchers with indigenous communities in the past may have played a role in those reservations.<sup>26</sup> Thus, it is important for collaborations between community organizations and research institutions to plan for a more efficient inclusion of indigenous agricultural workers that includes indigenous community health workers who can speak to indigenous participants' worries. Furthermore, it may be beneficial prior to starting a research study for community health organizations and academic institutions to begin working with indigenous communities to gain their trust, accomplished by having indigenous speaking staff providing community outreach activities that are culturally tailored to indigenous communities. With time, trust may be built, and indigenous communities may be more inclined to participate in biomedical research. A recent systematic review of research with farmworker populations pointed to this need for more studies of indigenous agricultural workers and also investigations of health promotion activities (in this case, integrating health screening in a research protocol).<sup>27</sup>

The study found some evidence that when a participant was related to or was living with a fellow co-participant, missed visits together. This suggests that recruiting participants from the same household may reduce retention as participants tend to attend/not attend collectively.

This study has limitations. The convenience sample, recruited through FWA community health workers at community outreach events they either showed up or and word of mouth, may not be representative of agricultural communities. The study included the point-of-care

tests of hemoglobin A1C, lipid panel, creatinine, and blood pressure, which could have caused agricultural workers who are interested in obtaining their health results or concerned about their health to participate in and stay in the study. However, the elevated point-of-care results we saw are characteristics of medically underserved minority populations, as are agricultural communities. Our community-engaged approach allowed us to provide contextual interpretation of their health results in a linguistically and culturally appropriate manner to each participant for their review and use and helped maintain cohort retention.

## Conclusion

To our knowledge, this is the first longitudinal study to follow agricultural workers for more than one harvest season to assess the change over time of renal function and to identify risk factors in agricultural workers working in the U.S. There are a few studies in Latin American that have tracked renal function progression for more than one harvest period but are retrospective studies based on data gathered by employers during preemployment health screenings.<sup>28–30</sup> Studies that enrolled agricultural workers to monitor renal function in Latin American range from 3 to 5 months.<sup>16,31–35</sup> Unlike our study, which is a collaboration with community partners, published longitudinal studies from Latin America have been done with the support of agricultural companies. Thus, the cohort is formed by the employees of such companies, and workers are only followed for one harvest season, which results in a very high retention rate. Our study does not count on agricultural company support, yet we were successful at following a cohort of agricultural workers for 32 months – the longest agricultural worker cohort followed to date assessing renal function in the U.S. Implementing point-of-care health screening and providing health results to each participant is a good retention strategy for agricultural workers, a population that is medically underserved.

## Disclosure statement

No potential conflict of interest was reported by the author(s).

## Funding

This work was supported by the CDC/NIOSH under Grant R01OH011782; and NIH/NINR under Grant K23NR020356.

## Ethical considerations

The Institutional Review Board at Emory University provided approval (IRB00112681) for the study, and all participants provided informed consent.

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