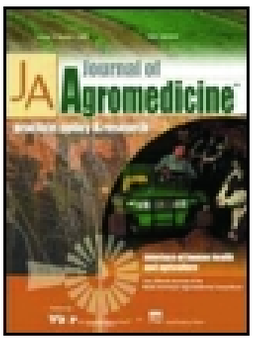

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ORIGINAL RESEARCH

Cotinine Levels and Green Tobacco Sickness Among Shade Tobacco Workers

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ABSTRACT. *Study Objective*: Symptoms consistent with Green Tobacco Sickness (GTS) were found in 4% (13/331) to 15% (45/303) of the migrant, mostly Latino, Shade tobacco workers who sought medical care at a Connecticut clinic. The objective of this study was to determine whether or not Shade tobacco farm workers absorb nicotine from the tobacco leaves and have a corresponding increase in both salivary cotinine levels (a breakdown product of nicotine) and symptoms consistent with GTS.

Methods: The study utilized a prospective cohort design to evaluate salivary cotinine and

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symptoms consistent with GTS in a population of Shade tobacco farm workers compared to a control group of nursery workers. The workers were assessed at two points in time, the early tobacco planting season and the harvest season.

Results: There was not a significant increase in salivary cotinine levels among Shade tobacco workers. Salivary cotinine levels over the work season did not significantly increase in Shade tobacco workers when compared with nursery workers. During the harvest season, none of the tobacco workers reported symptoms consistent with GTS.

Conclusions: Migrant workers in Connecticut who harvest Shade tobacco appear to have a low risk of occupational nicotine dermal absorption and a low incidence of GTS. The work practices associated with harvesting Shade tobacco, in addition to the fact that Shade tobacco may actually have a lower level of nicotine than either burley or flue cured tobacco, may explain these results. Our study appears to reinforce the GTS prevention recommendations made by investigators in other tobacco growing regions, specifically the importance of minimizing close skin contact with tobacco leaves and avoiding dermal contact with the plants when they are wet.

KEYWORDS. Green tobacco sickness (GTS), salivary cotinine levels, migrant farm workers, Shade tobacco

INTRODUCTION

Green Tobacco Sickness (GTS) is an occupational syndrome that has been diagnosed in farm workers who harvest tobacco. This self-limiting condition has been attributed to acute nicotine poisoning following dermal contact with mature tobacco plants.[1] GTS symptoms include headache, nausea, dizziness, abdominal pain, diarrhea, palpitations, and increases in blood pressure. In severe cases, GTS patients have been hospitalized for dehydration, cardiovascular instability, and seizures.[1-3] The impact of GTS on farm workers' morbidity, utilization of health care, and loss of productivity is an important public health issue.[3-5] Prevalence rates of GTS range from 8-41% among farm workers who harvest tobacco.[6-12] In our retrospective study of Shade tobacco farmers, we estimated a lower prevalence rate (4-15%) of GTS.[13]

Connecticut Valley Shade Grown and Connecticut Broadleaf/Havana Seed are the primary tobacco varieties grown in the Connecticut River Valley. The workers in this study harvested Shade tobacco. Selected cultivars of *Nicotiana tabacum* are grown in fields shaded by polypropylene fabric (23-26% shade). In the continental United States, the Connecticut River Valley is the only region that currently uses this method to grow tobacco. (Thomas Rather, Soil Scientist and Diagnostician, Connecticut Agricultural Experiment Station; EB Whitty, PhD, Professor of Agronomy, University of Florida; and Alex Csinos, PhD, Professor of Plant Pathology, University of Georgia College of Agricultural and Environmental Sciences; pers. comm.). The method used to grow Shade tobacco is designed to mimic the climate of Sumatra. During the 2001 growing season, Connecticut's tobacco farms employed approximately 7,000 migrant and seasonal workers (Walter Montes, State of Connecticut Department of Labor, Equal Opportunity Monitoring Unit, pers. comm.). Connecticut Shade tobacco is a high-value crop used as wrappers for premium cigars. It is harvested with extraordinary care to prevent tears or blemishes that could diminish crop value. These careful harvesting practices may limit farm workers' exposure to nicotine, and explain Shade tobacco farm workers' lower GTS prevalence rate. We conducted this follow up study to determine whether or not workers who harvest Shade tobacco absorb nicotine from the tobacco leaves.

METHODS

This study utilized a prospective cohort design to evaluate salivary cotinine concentra-

tions and symptoms of possible GTS in a group of Shade tobacco farm workers compared to a group of nursery workers in Connecticut. Questionnaire surveys and exposure assessments were completed at two points in time: Time 1, at the beginning of the tobacco planting season when there was a low risk of nicotine absorption because of minimal dermal contact with the plants (May-June); and Time 2, during the tobacco harvesting season when the workers harvested the leaves and transferred them to curing sheds (late July-August). Although there is no firm established diagnostic criteria for GTS, Arcury et al. recently developed a clinically useful case definition of GTS based on the following criteria: nausea or vomiting plus dizziness or headache reported after a day of working in tobacco.[9] We used this case definition for GTS in our study.

During training sessions held at the beginning of the planting season an outreach worker recruited participants from two Shade tobacco farms and a nursery. Workers interested in participating in the study were informed about the nature of the study and written informed-consent was obtained. The consent form and the questionnaire, written in English and Spanish, had been approved by the Institutional Review Board (IRB) of the University of Connecticut Health Center. During Time 1 and Time 2 the participants were interviewed in either Spanish or English. We had access to workers from the tobacco farms in the evening. We interviewed workers from the nursery during their lunch hour. Nursery workers were assessed at Time 2 during the lunch hour at their annual picnic, the only day the research team had access to the workplace.

The interview questionnaires were modified from Arcury et al. (with Dr. Arcury's permission) to capture Shade tobacco harvesting tasks. The interview questionnaire had been pilot-tested and validated among migrant tobacco farm workers in North Carolina.[9] Our outreach worker pilot-tested our modified version of the questionnaire before we began our interviews in Connecticut. Questions asked during the planting season interview included age, gender, place of origin, marital status, length of residence in the United States, type of housing, height and weight. Questions asked at both the planting and harvest season interviews addressed recreational tobacco use (cigarettes, cigars, chewing tobacco), exposure to second-hand smoke, and whether or not the participant had experienced any symptoms consistent with GTS (headache, dizziness, nausea or vomiting) during the previous work week. Participants were asked to describe the type of tobacco harvesting task they had been involved in during the week preceding the interview. During Time 2 Tobacco workers who reported any symptom consistent with GTS were asked whether or not they used a tobacco product or a nicotine patch/gum to control their symptoms. With the exception of the questions concerning tobacco-harvesting tasks and the use of a nicotine patch/gum, the nursery workers answered the same questions as the tobacco harvesters.

In addition to the questionnaire interview, at both time points during the study, participants were asked to provide the investigators with salivary samples to be analyzed for cotinine and exhaled breath for a carbon monoxide level. Each participant was instructed to keep a sterile cotton dental roll (Veratex, Troy, MI) in his or her mouth until the roll was thoroughly saturated (5-10 minutes). Without touching the rolls with their fingers, the participants returned the saliva-saturated roll to a sterile tube (Evergreen, Los Angeles, CA).[14-15]

Two samples were obtained from each participant at each interview session. The tubes were labeled and immediately placed in a cooler with ice packs for transport to a laboratory freezer where they were stored at minus −70° C until analysis. Cotinine samples were analyzed at the University of Minnesota by Gas Chromatography.[16] The laboratory's lower limit of detection (LOD) for cotinine is 10 nanogram/milliliter (ng/mL). All levels below the LOD were considered negative results.

Carbon monoxide (CO) measurements in exhaled breath have been shown to correlate well with smoking status.[17-22] Participants performed a measurement of CO in exhaled breath test during both the planting and the harvest season interviews. Carbon monoxide in exhaled breath was measured with a Vitalograph (Lenexa, KS) portable machine. Validated data collected with this instrument suggest that exhaled CO levels less than or equal to 8 parts per million (ppm) are consistent with smoking abstinence.[20]

Tobacco user status was defined by combining information from the self-report in planting and harvest seasons with information from the CO measurements. We classified an individual as a tobacco user if they self-reported using tobacco products (cigars, cigarettes, chewing tobacco) within the seven days before either interview. Individuals who self-reported not using tobacco products but who had a higher than 8 ppm exhaled CO level at either planting or harvest season were classified as tobacco users as well.

To maximize compliance and completion of the study, incentives were given to the participants after completion of the initial interview ($10) and after completion of the follow-up interview ($40).

DATA ANALYSIS

The study used a combination of analytical techniques. Chi-square (χ^2) goodness-of-fit, t-test analyses and Mann-Whitney U test were used to assess differences in demographic characteristics and tobacco use histories between tobacco farms and nursery groups. The Wilcoxon signed-ranks test was used to compare differences in cotinine levels between nonparametric, paired pre- versus post-data. Next, a multivariate repeated measures analysis was conducted to measure the effect of Shade tobacco worker versus nursery worker on salivary cotinine levels. The repeated measures analysis predicted change in cotinine levels from planting season to harvest season. The equation controlled for demographics (age, gender), body mass index (BMI), and tobacco use status. Lastly, to examine the effect of dermal exposure to tobacco on the harvest cotinine levels, a multivariate analysis of variance was performed.

Our modeling approach included the following: (1) exclusion of all cases missing relevant data, (2) exclusion by sequencing to account for covariance of previous predictors, (3) judgments of significance based on the standard significance criteria (i.e., $\alpha < 0.05$), (4) square-root transformed salivary cotinine levels to reduce positive skewness.

Our power calculations were based on the GTS literature from other tobacco growing regions. In these studies both smokers and nonsmokers had an 80 ng/mL increase in cotinine levels between the planting and the harvesting seasons.[5] We concluded that at least 20 control subjects were needed to detect this difference in cotinine levels. Because of the high attrition rate (45%) we considered that the healthy worker effect may be selecting for individuals without symptoms consistent with GTS. Consequently, we analyzed the characteristics of the tobacco workers who left before completing the study and compared them with the tobacco workers who stayed until the end of the study.

RESULTS

Fifty-three Shade tobacco workers enrolled in the study at the beginning of the planting season (Time 1). Fifty-nine workers from the nursery enrolled in the study at Time 1. Characteristics of the two cohorts are presented in Table 1. The subjects who worked in the tobacco and nursery farms were similar with respect to two important characteristics, tobacco use and BMI. Slightly more than one-third of the nursery workers reported exposure to Environmental Tobacco Smoke (ETS). Although nearly all of

TABLE 1. Demographic characteristics of initial prospective cohort Shade tobacco workers (exposed) and nursery workers (unexposed).

	Tobacco Workers N = 53	Nursery Workers N =59	P Value
Mean Age (SD)	44 (13.1)	33 (13.3)	< 0.001
Body Mass Index-BMI-(SD)	26.7 (3.8)	26.2 (5.4)	0.177
Tobacco Users (%)	28 (52.8%)	30 (50.8%)	0.834
Female (%)	0 (0.0%)	14 (23.7%)	< 0.001
Place of Origin			< 0.001
US (%)	2 (3.8%)	3 (5.1%)	
Mexico (%)	26 (49.1%)	6 (10.2%)	
Puerto Rico (%)	15 (28.3%)	25 (42.4%)	
Honduras (%)	1 (1.9%)	0 (0.0%)	
Jamaica (%)	7 (13.2%)	1 (1.7%)	
Guatemala (%)	0 (0.0%)	23 (39.0%)	
Other (%)	2 (3.8%)	1 (1.7%)	
Exposed to second hand smoke (%)	53 (100%)	21 (35.6%)	< 0.001

the tobacco workers reported exposure to ETS, it is noteworthy that smoking inside the barracks was not permitted, thus limiting their actual exposure to ETS. None of the tobacco workers used a nicotine patch or nicotine gum during Time 2. All of the Shade tobacco workers were males. In the control group, 24% of the workers were female. All the Shade tobacco workers were migrant farm workers who lived in barracks provided by the growers. Workers in the comparison group were migrant and seasonal farm workers who did not live in company housing. The mean age for the tobacco workers was 10 years older than the mean age of the nursery workers. Mean height and weight were significantly different between the two cohorts and probably reflect gender and place of origin differences.

Twenty-nine (55%) of the tobacco workers and 44 (75%) of the nursery workers returned for the harvest season follow-up assessment (Time 2). Because of a fight between two workers at one of the tobacco farms, one worker was hospitalized with severe injuries and the other was incarcerated. In response, a significant percentage of the tobacco workers quit their jobs and left the country. In addition, one tobacco worker with no recreational tobacco use who did return for follow-up was excluded from the study because an explanation for his Time 1 elevated cotinine level (309 ng/ml) could not be ascertained. The cotton dental rolls submitted by one nursery worker at both Time 1 and Time 2 contained a quantity of saliva insufficient for analysis.

When we compared the group of tobacco workers who left the farm after Time 1 with the group of workers who stayed, we found statistically-significant differences. The farm workers who left before Time 2 used less tobacco, were mostly from Mexico, and had lower cotinine levels during the planting season. The majority of the 28 tobacco workers from both farms who did return for follow-up during Time 2 were employed in tobacco handling tasks during the week before the interviews. Thirteen (46%) of the workers had worked in the fields picking tobacco; one (4%) had worked in the curing sheds sewing and/or racking the leaves; seven (25%) had worked in both settings and seven (25%) had been involved in miscellaneous tasks.

TABLE 2. Salivary cotinine levels (ng/ml) of the tobacco and nursery farm workers with both Time 1 and Time 2 salivary cotinine data.

	Planting season (Time 1)	Harvest season (Time 2)	
	Mean salivary cotinine ± SD Median	Mean salivary cotinine ± SD Median	P value†
All tobacco workers (n = 28)	93.6 ± 114.4 35	87.9 ± 107.8 39.5	0.868
Tobacco workers with tobacco use (self report) (n = 19)	137.9 ± 114.7 114.0	124.3 ± 113.0 67.0	0.570
Tobacco workers with exhaled CO > 8 ppm (n = 8)	196.13 ± 116.5 216.5	162.4 ± 125 165.5	0.398
Tobacco workers with no tobacco use (self report) (n = 9)	0.0 0.0	11.33 ± 27.6 0.0	0.18
Tobacco workers with exhaled CO ≤ 8 ppm (n = 20)	52.55 ± 85.91 0.0	58.2 ± 86.59 15.00	0.575
All Nursery workers (n = 43)	71.7 ± 107.3 15.0	98.5 ± 136.4 25.0	0.002
Nursery workers with tobacco use (self report) (n = 23)	124.2 ± 122.1 56.0	157.6 ± 143.3 92.0	0.004
Nursery workers with exhaled CO > 8 ppm (n = 12)	179.4 ± 131.44 198	251.9 ± 139.6 251.5	0.008
Nursery workers with no tobacco use (self report) (n = 20)	10.0 ± 28.8 0.0	30.5 ± 90.8 0.0	0.138
Nursery workers exhaled CO ≤ 8 ppm (n = 31)	29.13 ± 57.1 0.0	39.06 ± 76.4 10.0	0.095

†Wilcoxon Signed Ranks Test

There was a small change in mean salivary cotinine concentrations over time among the 28 Shade tobacco workers for whom we had planting and harvest season data. As shown in Table 2, this change was not statistically-significant. There was a significant increase in mean cotinine levels over time for the 43 nursery workers with both planting and harvest season salivary cotinine data (P = 0.002). In the nursery population there was also a significant change over time between the tobacco users and non-

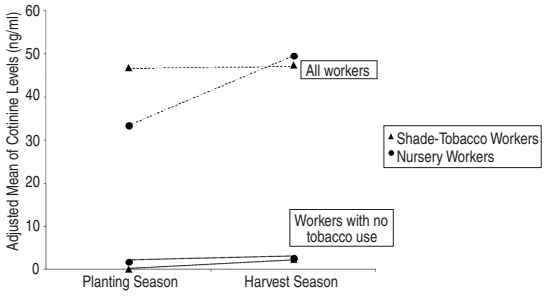
users (F (1,41) = 4.10, P = .049). Simple main effects omnibus tests indicate that only tobacco users in the nursery setting were significantly changing over time (Mean Difference (I−J) = −2.038, P = .001), with Bonferroni's adjustment for multiple comparisons.

When nursery workers and tobacco farm workers for whom we had planting and harvest season cotinine data were combined, we observed a significant change in salivary cotinine levels from planting season to harvest season when controlling for tobacco use and type of farm (F (1,67) = 4.564, P = 0.036). There was no statistically-significant Time by Tobacco User Status difference or Time by Farm/Nursery group difference. There was a significant time by Tobacco User Status by Farm/Nursery group difference (F (1,67) = 6.140, P = 0.016) (Figure 1).

There was no correlation between either the planting season or harvest season salivary cotinine levels and the day of the week the sample was collected (Spearman's Rho = 0.076, P = 0.285).

As shown in Table 3, during Time 1, two tobacco workers (4%) reported symptoms consistent with GTS. Neither of these workers could have had significant dermal exposure to nicotine because they had not begun handling tobacco leaves. During Time 1, four nursery workers (7%), without occupational exposure to nicotine, reported the same constellation of symptoms. The two workers with symptoms consistent with GTS (one tobacco, one nursery) who did not use tobacco recreationally did not have detectable salivary cotinine levels.

FIGURE 1. Salivary cotinine concentrations for all workers (N = 71) with data collected at the two times, subdivided into workers who do not use tobacco (N = 28). Salivary cotinine concentrations obtained at Time 1 and Time 2, during planting and harvest seasons, respectively.



During the harvest season none of the 28 tobacco workers enrolled in our study met the case definition for possible GTS. One nursery worker, without occupational nicotine exposure, had symptoms consistent with the GTS case definition used in the study. This worker had reported the same constellation of symptoms during Time 1. None of the tobacco workers reported using nicotine patches or nicotine gum during Time 2.

DISCUSSION

Our data suggest that Shade tobacco farm workers do not have significant occupational exposure to nicotine. When compared to workers from other tobacco-growing regions, Shade tobacco farm workers have a lower incidence of GTS. Workers enrolled in our study who had symptoms consistent with GTS did not have any evidence of dermal exposure to nicotine; either they were not occupationally exposed or they did not have a corresponding elevation of salivary cotinine. This finding suggests that another etiology (i.e., viral illness, heat exhaustion, pesticide exposure, etc.) may have been responsible for symptoms in these farm workers. To avoid the misdiagnosis of GTS in future research, the GTS case definition used in our region should include both symptoms and the documentation of an increase in salivary cotinine above baseline for smokers and above detectable levels for non-smokers. In addition, clinicians in our region should be encouraged to explore the possibility of a sentinel case of pesticide poisoning or heat exhaustion when tobacco or nursery workers present with headache, dizziness, nausea or vomiting.

Our results are in contrast to other studies in the literature that have shown that tobacco workers have significant dermal exposure to nicotine.[5,9,12] In both smokers and nonsmokers Quandt et al. documented a significant increase in mean cotinine levels as the season progressed. The threshold of salivary cotinine for the development of GTS consistent symptoms has not been established. Gehlbach et al. documented that tobacco harvesters with levels of urinary cotinine up to 35 microgram/100 mg

TABLE 3. Tobacco and nursery farm workers' self-reported symptoms during Time 1 and Time 2 (number and percent). For workers with symptoms consistent with GTS, tobacco use and salivary cotinine levels (ng/ml) for each worker are presented.

Time 1	Headache	Dizziness	Nausea	Vomiting		Symptoms Consistent with GTS*		
							Tobacco Use	Salivary Cotinine
Tobacco	12 (23%)	6 (11%)	3 (6%)	3 (6%)		2 (4%)	No	0
							Yes	16
Nursery	12 (20%)	6 (10%)	4 (7%)	2 (3%)		4 (7%)	Yes	194
							No	0
							Yes	12
							Yes	24

Time 2	Headache	Dizziness	Nausea	Vomiting		Symptoms Consistent with GTS			
							Tobacco Use	Salivary Cotinine	Change in Salivary Cotinine Level from Time 1
Tobacco	4 (14%)	1 (4%)	0	0		0			
Nursery	5 (11%)	0	3 (7%)	0		1 (2%)	Yes	25	+1

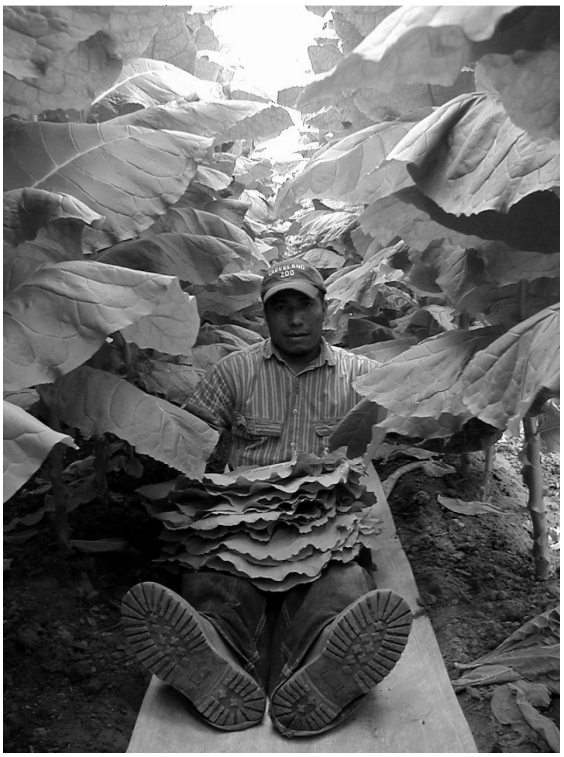
* Nausea or vomiting *plus* dizziness or headache reported after a day of working in tobacco.[9]
Although nursery workers did not handle tobacco, those nursery workers who reported the same constellation of symptoms are presented here.

creatinine did not develop GTS symptoms.[1] In an earlier study he had documented that GTS occurred in workers who had a urinary cotinine level of 89 microgram/100 mg creatinine.[6]

Shade tobacco workers may have less dermal exposure to nicotine because they use different harvesting methods than the workers who harvest tobacco in other regions of the country. Shade tobacco is harvested (primed) six to seven times throughout the season with extraordinary care to prevent tears or blemishes on the leaves. At each harvest, starting at the base of the plant, workers carefully pick two to three mature leaves and place them on bicycle-powered conveyor belts. The conveyor belts bring the leaves to the field edge where coworkers place them in bins. The workers transfer the bins to sheds. In the sheds, workers "sew" 20-30 tobacco leaves onto "bents." They hang ("rack") these "bents" of tobacco in the sheds to air cure. Shade tobacco workers wear both long sleeved and short sleeved shirts. Some Shade tobacco workers wear work gloves. Although Shade tobacco workers do not wear raincoats when they harvest tobacco, we observed that some workers covered their torsos with plastic bags. Figures 2 and 3 present some images of the Shade tobacco harvesting process.

GTS has been reported in populations of workers who harvest both flue-cured and burley tobacco.[2,4] When these workers handle green leaves and stalks they have more dermal exposure to tobacco leaves that the workers who harvest Shade tobacco. Workers who prime or hand crop flue-cured tobacco collect the leaves in large bundles that are held close to the body, underneath the arm or against the chest.[12] The moisture of the axilla has been shown to increase absorption more than 100% of the reference standard (ventral forearm).[23] Workers

FIGURE 2. Shade tobacco is primed (picked) with extraordinary care to prevent blemishes on the leaves. Starting with the base of the plant, workers carefully pick the mature leaves.



who harvest burley tobacco handle the entire stalks when they impale them on stakes.

Shade tobacco workers may have less dermal exposure to nicotine because they do not harvest the tobacco when it is wet with dew or rain. Flue-cured and burley tobacco may be harvested when the plants are wet.[2] Handling wet tobacco is a risk factor for GTS.[2,12]

Lastly, Shade tobacco workers may have less dermal exposure to nicotine because Shade tobacco plants are not topped and may consequently have a lower concentration of nicotine.[24] Topping, the removal of the terminal flower from the tobacco plant, limits the height of the plant and increases the size of the leaves. Topping increases the amount of nicotine in the plants' upper leaves.[24-26] Both flue-cured and burley tobacco are topped. Very few publications have documented the nicotine concentration of Shade tobacco. One publication reports that flue-cured, burley, Cuban and Connecticut cigar wrapper tobacco are generally medium in nicotine content (1.87-3.65%).[25] In this report, the Connecticut cigar wrapper tobacco discussed may have been Broadleaf/Havana Seed, not Shade tobacco. However, another study documented a relatively low concentration of nicotine (0.33-1%) in Shade tobacco leaves.[23] Future research in Connecticut should include studies that document the nicotine content of Shade tobacco at various leaf positions. In addition, studies of workers' exposure to nicotine when they harvest Broadleaf/Havana Seed tobacco should be initiated because this variety of tobacco appears to be higher in nicotine content than Shade tobacco. Unlike Shade tobacco, Broadleaf/Havana Seed is topped and cured on the stalk.

This study had several limitations. The first was the unanticipated attrition rate at one of the tobacco farms. Other studies involving migrant and seasonal workers have had similar attrition problems.[10] However, even with the high attrition rate we observed in our study, we had adequate power to detect differences in cotinine similar to what had been observed in previous studies.[9] Only 20 subjects per group (90% power) were needed to detect a difference in cotinine levels, significant differences in cotinine levels over time, and significant group by time interactions.

Secondly, the language barrier made it difficult to obtain a clear description of symptoms and harvesting practices even though we had several bilingual (English/Spanish) researchers on our team. Because of the unique characteristics of this migrant workforce, future questionnaire development would benefit from the use of focus groups and forward and backward translations.[27]

A third potential study limitation was the sensitivity of our salivary cotinine assay. The assay we used was unable to detect levels of cotinine that were less than 10 ng/mL. However, sensitivity analyses of the data checking for extreme cotinine values showed identical results making this limitation a moot point.

A fourth limitation was our inability to evaluate the significance of the tobacco workers' exposure to environmental tobacco smoke. Because the tobacco workers lived collectively, they all indicated that they had exposure to ETS. Consequently, we were unable to control for ETS in our data analyses.

FIGURE 3. After the leaves are picked, workers place them on bicycle-powered conveyor belts. Co-workers place the harvested leaves in bins.

During Time 2 we asked tobacco workers about the use of nicotine patches and nicotine gum because researchers have documented that some tobacco workers report using tobacco products or nicotine patches to prevent GTS.[5] Although we did not ask nursery workers the same question we are very confident that the nursery workers enrolled in our study did not use nicotine patches. Outreach workers who have worked intimately with this population told us unequivocally that none of the workers who participated in this study used nicotine patches because poverty and minimal access to health care would have made the use of nicotine patches cost prohibitive for both populations.

Lastly, the timing of our data collection was an additional study limitation. It is unlikely that the timing of the harvest season saliva sample collection influenced our results significantly. We collected the Time 2 samples in late July and early August. The summer we collected our samples, the harvest season ended within two weeks after our study ended. However, future studies should be continued until the end of the harvesting season to take into account potential nicotine exposures associated with tasks that occur later in the season. Multiple sampling for salivary cotinine levels every 2 to 3 weeks may be necessary to avoid the possibility of missing peaks that may reflect higher exposure throughout the season.[3] Although we collected the control group's saliva samples at the same time of day during Time 1 and Time 2, nursery workers enrolled in the study at Time 2 had attended a mid-day employee picnic. As a result, the tobacco users in our control group may have used more tobacco products before the samples were collected during Time 2.

CONCLUSION

Our non-random study of farm workers in Connecticut suggests that Shade tobacco workers do not have the prevalence of GTS and the corresponding seasonal increase in salivary cotinine that has been reported in the literature for workers in other tobacco growing regions. The specific work-practices unique to the harvesting of Shade tobacco may reduce the workers' dermal absorption of nicotine. The introduction of these harvesting techniques in other tobacco growing regions may prevent GTS. Our study reinforces the GTS prevention recommendations made by investigators in other tobacco growing regions, specifically the importance of minimizing close skin contact with tobacco leaves and avoiding dermal contact with the plants when they are wet. Tobacco farm workers in other regions could be instructed to avoid placing the tobacco leaves under their arms or directly next to the chest. Postponing tobacco-handling tasks until the leaves are dry may reduce harvesters' nicotine exposure. Lastly, growers could be encouraged to look at alternative leaf transport options (tubs, manual and/or bicycle powered conveyors) to minimize handling.

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