

FARMWORKER JUSTICE

HEALTH POLICY BULLETIN

Green Tobacco Sickness

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Winter 2019

Policy Update: Current and Proposed Policies to Mitigate Harm in Green Tobacco Sickness

By Iris Figueroa

Protecting Children from Exposure

There are an estimated half a million children working in agriculture in the U.S.¹ Although agriculture employs a small percentage of all children working in the U.S., it has the highest number of work-related child fatalities.² Compared to other industries, there are fewer workplace safety protections for children working in agriculture. The minimum age for most types of work is 16, with few exceptions, but in agriculture it is 14, with many exceptions. Furthermore, for tasks designated by the U.S. Department of Labor (DOL) as “hazardous,” the minimum age is 18 for all industries except agriculture, where the minimum age is 16.

Several recent policy proposals sought to improve the safety of children working in agriculture. In 2011, the DOL proposed a series of revisions to child agricultural labor protections, including updating the hazardous orders for agriculture, but ultimately withdrew the proposed regulations. The “Children’s Act for Responsible Employment” or “CARE Act,” most recently introduced in Congress in 2017,³ requires that hired farmworkers be at least 16 years old to work in agriculture (with some exceptions) and at least 18 years old to perform hazardous work. In a 2018 report, the Government Accountability Office (GAO) recommended that the DOL establish specific metrics and targets for child labor-related outreach in agriculture.

Some proposals sought to address the specific hazards encountered by children working in tobacco. As stated in the Quandt and Arcury article on page 2, the health effects of Green Tobacco Sickness (GTS) are even more severe in children, and exposure could have longterm adverse impacts for neurocognitive development. Among the DOL’s proposed revisions to the hazardous orders in 2011 was the prohibition of youth under age 16 from processing and packing tobacco. More recently, a 2017 bill entitled the “Children Don’t Belong on Tobacco Farms Act” was introduced in Congress but did not pass.⁴

Ensuring Adequate Field Sanitation

Quandt and Arcury also point to the importance of field sanitation practices in GTS prevention, particularly the availability of drinking water and facilities for hand washing. In 1987, the U.S. Occupational Safety and Health Administration (OSHA) issued the Field Sanitation Standard, a federal standard that requires agricultural employers to provide toilets, potable drinking water, and hand washing facilities to workers in the field.⁵ Small farms (those employing 10 workers or less) are excluded from its requirements.

Guarding Against Heat Stress

One of the measures for preventing GTS, wearing water proof clothing, can unfortunately also increase the risk of dehydration and heat stress. At the same time, high environmental temperature can increase nicotine absorption. Tobacco is usually harvested during August and September, when temperatures are high. Due to these factors, measures to guard against heat stress, including rest breaks, access to drinking water and shade could also be helpful for those
(Continued on page 2)

1. See Association of Farmworker Opportunity Programs (AFOP), CHILDREN IN THE FIELDS: THE FACTS YOU SHOULD KNOW (2018), <https://afop.org/wp-content/uploads/2018/04/CIFC-Publication-Final-1.29.18.pdf>.

2. See Government Accountability Office (GAO), “WORKING CHILDREN: FEDERAL INJURY DATA AND COMPLIANCE STRATEGIES SHOULD BE STRENGTHENED” (2018), <https://www.gao.gov/products/GAO-19-26>.

3. H.R. 2886 (115th Congress)

4. H.R. 2878 (115th Congress)

5. See Farmworker Justice and Migrant Clinician’s Network, Clinician’s Guide to OSHA’s Field Sanitation Standard for more information on this standard. <https://www.farmworkerjustice.org/sites/default/files/2016OSHA%27s%20Field%20Sanitation%20Standard%20Clinician%27s%20Guide.pdf>.

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at risk of GTS. There is currently no federal OSHA standard that specifically addresses heat stress. However, two states, California and Washington, have standards to protect outdoor workers from exposure to excessive heat.

The articles in this health bulletin provide further details on the prevalence and impact of GTS in farmworker communities. For more information about the federal policies detailed above, contact Iris Figueroa at ifigueroa@farmworkerjustice.org.

Green Tobacco Sickness: Epidemiology and Prevention

By Sara A. Quandt, PhD and Thomas A. Arcury, PhD

Farmworkers engaged in tobacco production are at risk for green tobacco sickness (GTS).^{6,7} GTS is acute nicotine poisoning, resulting from contact with nicotine while picking and handling green or uncured tobacco.⁸ Nicotine is an alkaloid, naturally occurring in the tobacco plant. Its chemical properties make it soluble in water that is in contact with the tobacco, such as dew, rainwater, and perspiration, and promote its absorption through the skin.

Symptoms of GTS usually start hours after exposure to the plants, so workers may not experience the symptoms until late afternoon or even in the evening after leaving work. These symptoms of GTS are unpleasant: dizziness, headache, nausea and vomiting.⁹ Because nicotine is a stimulant, GTS can also cause insomnia and lack of appetite (anorexia). While not life-threatening by themselves, these symptoms, in the heat of mid-summer when tobacco is harvested, can result in severe dehydration, which IS life-threatening. Farmworkers report that they are often forced to continue working while sick with GTS because they do not have paid sick leave; if they do not work, they do not get paid.

GTS is self-limiting. The body breaks down nicotine in the hours after exposure, and symptoms usually resolve within a day after contact with tobacco ends. Because GTS often happens after work and workers are well enough (though often weak and dehydrated) to return to work the next day, employers can be unaware of their workers' GTS. Medical care is rarely sought for GTS.

Although no clinical case definition or the level of nicotine that delineates GTS has been established, we established a working case definition in our research with North Carolina farmworkers: (1) having worked in tobacco in the past 48 hours; and (2) experiencing nausea or vomiting; and (3) experiencing headache or dizziness.

In our research we found the prevalence of GTS was high: 24% of farmworkers experienced GTS across an agricultural season.¹⁰ The incidence was also high. Farmworkers were sick with GTS two days for every 100 days they did any type of work in tobacco. They were sick with GTS for four days for every 100 days they harvested tobacco.¹¹

Farmworkers' level of nicotine poisoning is demonstrated by how much cotinine (a nicotine break-down product) can be detected in saliva. We found that, among non-smoking farmworkers, this increased 14-fold across 16 weeks of summer work, from an average of 6.6 ng/ml to 100 ng/ml; for farmworkers who regularly smoked, it almost doubled, from an average of 100 ng/ml to 180 ng/ml.¹² It was notable that, by the end of the summer of working in tobacco, non-smoking farmworkers had nicotine levels in the body equivalent to smokers.

(Continued on page 3)



A scene from *Learning about Green Tobacco Sickness: Juan's Experience*.
Published by the Wake Forest University School of Medicine.

6. Gehlbach SH, Williams WA, Perry LD, Woodall JS. Green-tobacco sickness. An illness of tobacco harvesters. *JAMA*. 1974 Sep 30;229(14):1880-3. PubMed PMID: 4479133.

7. Arcury TA, Quandt SA. Health and social impacts of tobacco production. *J Agromedicine*. 2006;11(3-4):71-81. doi: 10.1300/J096v11n03_08. PubMed PMID: 19274899.

8. Arcury TA, Quandt SA, Preisser JS, Bernert JT, Norton D, Wang J. High levels of transdermal nicotine exposure produce green tobacco sickness in Latino farmworkers. *Nicotine Tob Res*. 2003 Jun;5(3):315-21. PubMed PMID: 12791526.

9. Arcury TA, Quandt SA, Preisser JS, Norton D. The incidence of green tobacco sickness among Latino farmworkers. *J Occup Environ Med*. 2001 Jul;43(7):601-9. PubMed PMID: 11464390.

10. IBID.

11. IBID.

12. Quandt SA, Arcury TA, Preisser JS, Bernert JT, Norton D. Environmental and behavioral predictors of salivary cotinine in Latino tobacco workers. *J Occup Environ Med*. 2001 Oct;43(10):844-52. PubMed PMID: 11665453.

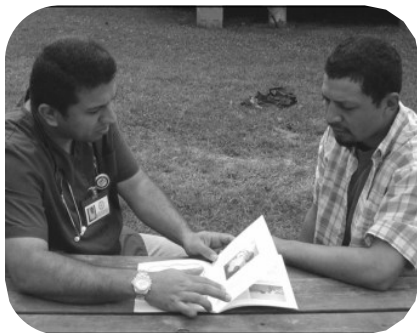
Factors that increase the risk for GTS are harvesting and topping tobacco (compared to planting or burning), working in wet clothing and wet conditions, and having limited work experience in tobacco.¹³ Although smoking reduces the risk of GTS, it does not completely protect workers from experiencing GTS.

Work that causes contact with tobacco, or the water on tobacco, is essential for developing GTS. This is demonstrated by comparing the very low GTS rates found in farmworkers harvesting cigar wrapper tobacco in Connecticut with the high rates of those harvesting flue-cured tobacco in the Southeast.¹⁴ Wrapper tobacco is harvested one leaf at a time, and leaves are placed on a conveyor belt to keep them from being damaged. In contrast, workers in the Southeast break off leaves and hold them in their underarm as they move through the rows; by day's end, their underarms are sticky with tobacco juice.¹⁵ Underarm skin is extremely efficient at absorbing chemicals, thus promoting the high rates of cotinine and GTS in these workers.

There is no information on the long term health effects of GTS for adult farmworkers. It is unlikely that it causes the best-known effects of smoking (e.g., lung cancer or emphysema) because those result from components of smoke, but the effects of high levels of nicotine as a stimulant deserve further study.

Educational materials on GTS are available on the Wake Forest School of Medicine [website](#). Click on the links below to view their *fotonovela* and brochures on green tobacco sickness.

- [Spanish](#)
- [English](#)
- [Bilingual](#)



The immediate health effects of GTS for child farmworkers are similar to those of adults, but more severe. Because children have a greater surface to volume ratio, less mature metabolic processes, and less mature nervous systems than adults, they can absorb more nicotine than adults but are less able to process it. The long term health effects of GTS for child farmworkers are unknown, but studies of non-work related nicotine exposure among adolescents indicate that this exposure affects their neurocognitive development.

The best way to protect farmworkers from GTS is for farmworkers to wear waterproof clothing that protects them from direct contact with tobacco and the water on tobacco.¹⁶ Farmworkers should change clothes after they become wet from contact with tobacco. They should also wash their work clothes before re-wearing to remove any nicotine. Farmworkers and their employers should be aware that wearing water proof clothing in the heat will increase the risks of dehydration and heat stress. Farmworkers will also need adequate work clothes and clothes washing facilities. For preventive measures to be adopted, farmworkers and their employers need to be educated about the actual causes and nature of GTS. Employers will need to ensure that current field sanitation and housing regulations are observed.

Clinicians and outreach workers need training and materials to educate farmworkers about GTS. Clinicians should question farmworker patients about tobacco work and consider GTS in their differential diagnosis, as symptoms are similar to pesticide poisoning and food-borne illness. All of those providing services to tobacco workers should know the actual causes of GTS. They should support farmworkers in using safe procedures to reduce tobacco exposure, including using waterproof clothing, changing from wet clothing, and washing contaminated clothing. They should ensure that field safety and sanitation rules are followed, particularly the availability of safe drinking water and facilities for hand washing. They should discourage the use of unsafe and unproven preventive

practices, including smoking or chewing tobacco, taking motion-sickness medications, and using traditional remedies.¹⁷ With basic information and training, clinicians, outreach workers and employers can help farmworkers to prevent GTS.

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13. *IBID.*

14. Trapé-Cardoso M, Bracker A, Grey M, Kaliszewski M, Oncken C, Ohannessian C, Barrera LV, Gould B. Shade tobacco and green tobacco sickness in Connecticut. *J Occup Environ Med.* 2003 Jun;45(6):656-61. PubMed PMID: 12802219

15. For more information on contact dermatitis among tobacco harvesters, see <https://onlinelibrary.wiley.com/doi/pdf/10.1111/j.1600-0536.2007.01148.x>

16. Arcury TA, Quandt SA, Garcia DI, Preisser JS Jr, Norton D, Rao P. A clinic-based, case-control comparison of green tobacco sickness among minority farmworkers: clues for prevention. *South Med J.* 2002 Sep; 95(9):1008-11. PubMed PMID: 12356099.

17. Rao P, Quandt SA, Arcury TA. Hispanic farmworker interpretations of green tobacco sickness. *J Rural Health.* 2002 Fall;18(4):503-11. PubMed PMID: 12380893.

Clinic Spotlight: Addressing GTS Among Agricultural Worker Children in Kinston, North Carolina

By Melissa Bailey Castillo, Community Outreach Director, Kinston Community Health Center



A child working in a tobacco field. Photo credit: Melissa Bailey Castillo.

Addressing Green Tobacco Sickness (GTS) and other occupational injuries among child agricultural workers requires a concerted effort among local migrant education programs, enabling services providers in the Outreach Department, and clinical providers. Chemical exposure is at once the most pervasive medical challenge we encounter in our outreach and clinical work, and the most difficult to address. In the case of tobacco, we know that a child's size is directly proportional to the degree of illness as a result of nicotine poisoning during tobacco topping and harvesting. Kinston Community Health Center tailors its interventions to child workers' specific health and emotional needs, and is sensitive to the vulnerability of this population.

Anecdotally, we know that most child workers in our community come from seasonal agricultural worker families and newly arrived immigrant families. Parents and working children are often under a great deal of emotional and economic stress, and misinformation is rampant in agricultural worker communities. Most families are told from the beginning to hide the fact that their child works, convinced that a child worker and parent may be in danger of child protective services interventions or even law enforcement interactions. For this reason, the manner in which outreach workers approach working children and their parents is extremely important. We make great efforts to ensure that our

outreach workers are sensitive and prepared to deal with the fear, unique medical challenges, and economic stressors the parents and children in these communities face. At Kinston Community Health Center, our providers and outreach team alike are well aware that pediatric patients may be accompanying parents to the fields for lack of appropriate child care, or to help the family earn money.

Our outreach process typically begins in January of each year, when health educators conduct individual home visits with newseasonal and migratory agricultural worker families. Children are often included in the discussion as outreach workers provide education on crops and the particular occupational health risks involved with their planting, care, and harvest. Children most frequently work in cut flower fields during Spring Break, blueberry crops in the early summer, and tobacco during the topping season. We also have encountered children working in watermelon fields and packing, as well as sweet potato fields.

During and after these visits, health educators gather occupational health information using the [WHACS occupational health survey](#). Based on the responses that families provide, our outreach workers may perform additional screenings, such as the RHS-15,¹⁸ to obtain more information about the type of risk particular families may face and to best assess follow-up options. Outreach workers also perform a PRAPARE assessment for every agricultural worker family or individual. Clinical providers are then able to access some or all of this information in a patient's medical records in order to better understand, screen, and treat these patients.

Health educators and care coordinators make every effort to accurately identify or document the possibility that children may be actively participating in agricultural labor environments. This information is an invaluable asset to clinical providers for the identification of an occupational illness or injury. Screening tools and efforts to convince a family to delay or forego a child's participation in agricultural labor is a priority for our clinic's devotion to health prevention and wellness.

At Kinston Community Health Center, non-judgmental attitudes are a requirement. Many of our outreach workers have some experience with agricultural work. We understand the social determinants that can lead to the need for children to work in agriculture. Our efforts ensure all children receive appropriate care.



*A child worker getting water.
Photo credit: Melissa Bailey Castillo.*

18. Refugee Health Screener-15 is a tool developed by Pathways to Wellness to detect the range of emotional distress common across refugee groups.

EYE ON FARMWORKER HEALTH

A summary of important recent developments in research on issues affecting the health and safety of agricultural workers.



The Impacts of Pesticide and Nicotine Exposures on Functional Brain Networks in Latino Immigrant Workers

Authors: Mohsen Bahramia, Paul J. Laurientia, Sara A. Quandt, Jennifer Talton, Carey N. Pope, Phillip Summers, Jonathan H. Burdette, Haiying Chen, Jing Liu, Timothy D. Howard, Thomas A. Arcury, and Sean L. Simpson

Source: *Neurotoxicology* (2017) 62: pp. 138-150. doi: 10.1016/j.neuro.2017.06.001

Tobacco farmworkers are exposed to both nicotine and pesticides in the course of their work, and chronic exposure to these substances might affect workers' health. Cholinesterase-inhibiting pesticides, such as organophosphates and carbamates, have been shown to have deleterious effects on cognitive functioning. Nicotine also has an effect on cholinergic neurotransmission: while small doses of nicotine may improve cognitive functioning, large doses are proven to be toxic. Each of these substances on their own has been shown to have deleterious health effects. Researchers in this study decided to investigate in tandem the effects of nicotine and pesticides on farmworkers' cognitive functioning due to the double exposure that workers on tobacco farms face.

This study used resting-state functional magnetic resonance imaging (rs-fMRI) to identify fluctuations in blood oxygenation in the brain over time and across multiple scans as well as a mixed-effects modeling framework to control for confounding factors. The rs-fMRIs allowed researchers to evaluate functional connectivity from one area of the brain to another. By conducting brain network analyses based on graph theory, researchers were able to trace broad connectivity patterns across the brain. The researchers used whole blood acetylcholinesterase (AChE) and butyrylcholinesterase (BChE) activities as a metric for pesticide exposure and urinary cotinine levels as a measure of nicotine exposure.

This research was part of a larger project, "Pesticide Exposures and Neurological Outcomes for Latinos: PACE4," with 447 male Latino farmworkers and non-farmworkers. All participants were Latino, male, and working in North Carolina. For this particular study, data was collected from 74 of the participants in the PACE4 study; of these, 48 participants were farmworkers and 26 were non-farmworkers. In order to qualify as a farmworker, participants had to have been employed in agricultural work for the previous three years and currently employed in the same line of work. Researchers collected a brain image, one urine sample, and one blood sample from each worker.

Researchers controlled for smoking status, noting a high incidence of cigarette use among the farmworkers. They also controlled for age and education in their modeling framework.

Results showed that there was indeed a difference in both connection probability and strength between non-farmworkers and farmworkers. Farmworkers had networks that were more clustered and modular than non-farmworkers. This is important as lower

modularity and higher integration is associated with enhanced performance in complex tasks. Farmworkers' functional modules were denser and had more internal connections while connections between discrete functional modules were weaker than in non-farmworkers. Non-farmworkers generally had stronger brain connections that increased more rapidly. This implies that farmworkers may have segregated neural processing and less communication between brain regions and could indicate that farmworkers may have lower performance outcomes when completing complex cognitive tasks compared to non-farmworkers. When the factor of occupational exposure to pesticides (using the metric of AChE and BChE measurements) and nicotine (using the metric of cotinine measurements) were removed from the model, researchers noted that the differences in modularity between farmworkers and non-farmworkers were eliminated, suggesting that occupational exposure to pesticides and nicotine has a negative effect on the cognitive abilities of farmworkers.

The study was constrained by a number of limiting factors. Researchers were not able to include the number of years exposed to pesticides in the network model, and the model's output wasn't able to relate information about the differences in connections between specific brain regions and subnetworks (this study offers a more general view of connections). The authors further mentioned that, due to regional preferences for other pesticide types than the ones used by workers in North Carolina, studies in other locations may yield different results). Finally, although longitudinal studies have shown farmworkers to have decreased AChE activities, there was no difference in AChE activities between the farmworkers and non-farmworkers who participated in this study.

The authors suggest a number of future research topics including: studies that perform brain scans on participants while they perform cognitive tasks instead of during a resting state; studies that place an emphasis on understanding the relationship between years of exposure, cognitive processes, and network organization by surveying a larger group of farmworkers; and studies that look at connectivity patterns in specific brain subnetworks and track changes in functional connections and brain networks over the course of the agricultural season. While the authors highlight multiple opportunities for future research, this paper provides a necessary preliminary demonstration of the particular detrimental cognitive effects that farmworkers may incur from being exposed to pesticides and nicotine in their work.



Benefits, Facilitators, Barriers, and Strategies to Improve Pesticide Protective Behaviors: Insights from Farmworkers in North Carolina Tobacco Fields

Authors: AnnMarie Lee Walton, Catherine E. LePrevost, Laura Linnan, Ana Sanchez-Birkhead, Kathi Mooney

Source: International Journal of Environmental Research and Public Health (2017) 14 (7): 677. doi: 10.3390/ijerph14070677

Farmworkers are exposed to pesticides in the course of the agricultural season. Pesticide exposure has been shown to have negative health outcomes, and previous studies have shown that Latino farmworkers feel that they have little control over the extent to which they're exposed to pesticides during their work cycle. Using the [Health Belief Model](#), the authors surveyed North Carolina-based Latino farmworkers employed in tobacco fields to understand attitudes around pesticide protective behaviors and how best to increase adherence to those protective behaviors.

The 72 self-identifying Latino farmworkers who took part in the research all worked at farms that had previously participated in a safety program aimed at reducing farm injuries. The workers were at least eighteen years old, with an average age of thirtythree. Ninety-seven percent of the workers surveyed were male, 96% were Mexican, and the vast majority had received a limited education, with 36% having completed less than middle school and an additional 53% having completed middle school. Ninety percent were H2A workers. Workers spoke either Spanish or English. The workers surveyed had recently been involved in tasks that included weeding, topping and suckering, and harvesting tobacco. Research data, including demographic information, was collected during structured interviews in Spanish conducted by a native Spanish speaker whose parents had been agricultural workers. Incentives for participating in this study were a \$25 Walmart gift card and a hat. The questions selected for the structured interviews were piloted beforehand with two non-participating farmworkers. The study used REDCap electronic data capture tools and ATLAS.ti software to assign and code values to factors anticipated by the researchers.

Researchers found that workers spoke of the short-term effects of pesticide protective behaviors rather than long-term benefits and risks. Respondents understood that pesticide protective behaviors carried benefits, including keeping workers healthy, preventing "intoxication" or "poisoning," and preventing dizziness or skin irritation. Two workers explicitly mentioned that pesticide protective behaviors, such as wearing ponchos, could prevent green tobacco sickness.

They also volunteered information about barriers and facilitators to adopting pesticide protective behaviors. Twentytwo percent of workers said that protective behaviors were effective, and mentioned training, watching others in the fields, and having necessary equipment (such as gloves and glasses) as important facilitators. The most frequently mentioned barrier to adoption of pesticide protective behaviors was wetness, including dampness from dew, rain, the tobacco plants, and sweat. Workers understood the danger of interacting with wet tobacco and that sweat could increase the risk of experiencing adverse effects from pesticide exposure. Workers also mentioned heat as an impediment to using protective clothing.

When workers were asked about strategies to improve pesticide protective behaviors, 64% of respondents said they did not know what to suggest or had no suggestions. Some suggestions included changing clothing during the work day, having protective clothing on hand, communicating with other workers, and reducing or eliminating the use of pesticides as strategies for improvement.

Researchers came to a number of conclusions about how best to educate workers about the risks of pesticide exposure and how to increase the adoption of pesticide protective behaviors by workers in the future. They concluded that training should emphasize longterm risks, as workers currently seem primarily preoccupied with the short-term risks of pesticide exposure. They recommended that training materials geared towards tobacco workers educate workers about the health risks of pesticide and tobacco exposure alike, with explicit mention of the long-term risks of pesticide exposure. Researchers noted the utility of discussion-based training led by more experienced farmworkers. Pesticide protective behavior training should more strongly emphasize washing behaviors that can keep workers healthy and the dangers of dermal exposure to pesticides. Researchers noted a popular belief that ointments and suero (an electrolyte powder frequently consumed in the fields) could protect against the effects of exposure to pesticides. The authors suggest that more research be done on suero as well as the efficacy of other strategies mentioned by the interviewed farmworkers to protect against pesticides.



Green Tobacco Sickness Among Tobacco Harvesters in a Korean Village

Authors: Sung-Jun Park, Hyun-Sul Lim, Kwan Lee, Seok-Ju Yoo

Source: Safety and Health at Work (2018) 9(1): 71-74. doi: <https://doi.org/10.1016/j.shaw.2017.06.007>

Farmworkers who handle tobacco face the risk of green tobacco sickness. Workers may absorb unhealthy amounts of nicotine through the skin in the process of handling wet tobacco plants and experience acute intoxication, the symptoms of which can include dizziness, headache, nausea, vomiting, and seizures.

Because green tobacco sickness shares symptoms with a number of other conditions and illnesses, including occupational hazards like pesticide poisoning and heat stress that are also associated with agricultural work, the condition is frequently misdiagnosed. The study aimed to observe tobacco harvesters and the temporal change in urine cotinine during harvesting and non-harvesting seasons to propose an accurate diagnostic method for green tobacco sickness. Researchers obtained urine samples from forty workers involved in the tobacco harvest in Cheongsong-gun, Korea, and also administered a survey to all study participants. They collected four urine samples per worker per day from July 20, 2008 to July 30, 2008, collecting the samples immediately after waking up, completing morning work, completing afternoon work, and eating dinner. Additional samples were collected the next year during the off-season when workers were not handling tobacco.

Half of the workers surveyed were men and half were women. Thirty-six of the workers were fifty years old or older. The workers provided demographic information such as age, sex, smoking status, harvesting time, symptoms, and were also asked to disclose whether they had taken motion-sickness pills. Researchers used high performance liquid chromatography to estimate the concentration of cotinine, an accurate biomarker of nicotine exposure, in urine samples.

Researchers found that the incidence of green tobacco sickness among surveyed workers was 37.5%. Fifty-five percent of women experienced green tobacco sickness as did 20% of men. Non-smokers experienced green tobacco sickness at a higher rate than smokers. There was no significant difference in the incidence of green tobacco sickness between the age categories surveyed (younger than fifty years old, age fifty to fifty-nine, and older than sixty). Concentration of cotinine was found to be highest at dawn during the harvesting season and lowest during the non-harvesting period. There was no major variation in cotinine concentration during the course of the workday during the harvesting period.

Researchers were limited by the age of the participants, given that green tobacco sickness tends to occur at a higher rate among young people. Their study was also limited by regional specificity, namely that tobacco-growing regions in Korea may grow different types of tobacco which may produce different results. The authors suggest that future research could build on this study's data to develop a prevention plan and diagnostic criteria for green tobacco sickness among workers in Korea.