

EXAMINING THE RELATIONSHIP BETWEEN PESTICIDE EXPOSURE AND NEGATIVE  
HEALTH OUTCOMES AMONG FARMWORKERS

by

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## DEDICATIONS

To my partner, Erika Nacim, who has been a major inspiration through the entire process and continues to support and encourage me when times are tough. To my familial lineage of migrant and seasonal farmworkers.

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## ABSTRACT

Farmworkers in the agriculture sector work in one of the most dangerous occupations in the country. Farmworkers are highly exposed to occupational pesticides that can result in various negative health outcomes. Drawing on the National Agricultural Workers Survey (NAWS), this thesis examines the relationships between lifetime asthma diagnoses, pain/discomfort, pesticide exposure, occupational factors, and socio-demographic factors. Logistic regression results suggest that farmworkers who handled pesticides within the past 12 months preceding the survey have higher odds of having received a lifetime health care provider diagnosis of asthma, as well as higher odds of reporting experiencing pain and discomfort during the prior year. The findings produced in this research provide further knowledge to farmworkers, employers, and society about occupational health disparities and exposure to pesticides.



## INTRODUCTION

Agricultural work is one of the three most dangerous occupations in the nation and farmworkers are a key component to the economic system in the United States (Davis, 2001). The agricultural sector is a vital element, contributing a massive amount of revenue to the capitalistic economy in the United States (Wilkerson, 2005; Kandel, 2008).

Farmworkers spend hours planting, growing, cultivating, and processing many of the products that are consumed and exported globally (Preibisch and Binford, 2008). Besides being systematically exploited and having to work under extreme conditions, farmworkers experience high rates of occupational health illnesses and injuries, as they are exposed to various occupational hazards (Hansen and Donohoe, 2003). Being from a marginalized sector of the community and considered a vulnerable population, farmworkers experience many health disparities (Arcury and Quandt, 2017).

Asthma and other respiratory illnesses are some of the most common negative health outcomes that occur in the agricultural sector (Linkar and Smedley, 2002). There is a limited amount research that thoroughly examines the association between occupational pesticide exposure and asthma among the farmworker community. In the US, approximately 80% of pesticides are used in the agricultural sector (Kasner et al. 2012; US Environmental Protection Agency EPA, 2011). Research has shown that pesticide exposure is associated with asthma or asthma like symptoms (Faria et al. 2005). Scientific metabolite testing has also shown that farmworkers experience high rates of pesticide exposure (Arcury et al. 2014; Arcury et al. 2009). As a farmworker, I personally have experienced the effect that occupational exposures have on my body. I have experienced body pain and was

once hospitalized due to a respiratory issue. Given the precarious nature of farmwork, the current study addresses the following questions: 1) What socio-demographic factors increase farmworkers' likelihood of having received an asthma diagnosis sometime during their lives by a health care provider (HCP)? 2) Does handling pesticides increase the likelihood of having received a lifetime HCP-diagnosis of asthma among farmworkers?

The purpose of this study is to further expand the current knowledge of occupational pesticide exposure and the negative health disparities presented in the farm work agricultural sector. Specifically, this study examines the relationship between lifetime asthma diagnoses, pesticide exposure, occupational factors, and socio-demographic factors. Providing social justice-based knowledge for future changes in the agricultural sector is also a central aim of this project. Further, this research contributes contemporary knowledge to the literature that could inform socially just policies to reduce occupational incidents, illnesses, and increase occupational educational programs to farmworkers. The knowledge produced in this research provides additional information to farmworkers, employers, and society about occupational health disparities and exposure to pesticides.

The current study draws on national data from U.S. Department of Labor's National Agricultural Workers Survey (NAWS) (<https://www.doleta.gov/naws/public-data/>), as it includes a measure of asthma diagnosis and pesticide exposure. The present analyses use logistic regression to explore the relationship between an asthma diagnosis and socio-demographic characteristics such as documentation status, education, race/ethnicity, and gender. I also examine how occupational factors such as pesticide exposure, years of farm work experience, type of employment, and work task affect people's likelihood of having

received an asthma diagnosis. Due to limitations in the NAWS question on pesticide exposure, I am only able to examine the association between having handled pesticides in the 12 months preceding the survey and self-reported asthma diagnosis by a health care provider (HCP) during a farmworker's lifetime. Due to the temporal ordering of these events, I am unable to establish a direct causal relationship between pesticide exposure and an asthma diagnosis. Moreover, having received a lifetime asthma diagnosis by a HCP is predicated upon having seen a physician or nurse as well as having access to healthcare. Given these limitations, I conducted a validity check by examining the relationship between farmworkers' self-reports of having experienced pain or discomfort within the past 12 months and the same factors associated with a lifetime asthma diagnosis, including handling pesticide within the preceding year.

From the first analytic sample (N= 30,553) and logistic regression Model 4, the association between handling pesticides and the likelihood of having received a lifetime HCP-diagnosis of asthma was examined. Findings suggest that Female, Puerto Ricans, and farmworkers who work in packing houses have higher odds of having received an asthma diagnosis, while migrant farmworkers, farmworkers whose dominant language is Spanish, Indigenous, or Other, and farmworkers who are Legal Permanent Residents or Unauthorized have lower odds. Most important, and central to the aim of this thesis, the findings also suggest a positive association between handling pesticides and the likelihood of having received a lifetime HCP-diagnosis of asthma when controlling for all other factors.

As noted, I also conducted a supplement analysis (validity check) examining the relationship between farmworkers' self-reported pain or discomfort within the past 12

months and the same factors used to explain an asthma diagnosis. The findings suggest that handling pesticides is positively associated with farmworkers' having experienced pain/discomfort within the preceding 12 months, net all other factors. Additionally, farmworkers who self-identify as Black/African American, Native American, or Other have higher odds of reporting pain/discomfort relative to farmworkers who identify as White. Finally, farmworkers with unauthorized immigration status have lower odds of reporting pain/discomfort relative to farmworkers who are US citizens.

## **LITERATURE REVIEW**

### ***Respiratory Conditions among Farmworkers***

Over the past few years, there has been a growing literature examining the importance of occupational health and the social determinants of health among farmworkers in the U.S. agricultural sector. In particular, the number of studies examining occupational respiratory illnesses among the farmworker community have increased. In a qualitative analysis, Flocks et al. (2002) found that female farmworkers reported feeling respiratory problem that included sneezing, coughing, nose pain, throat irritation, and breathing difficulties during the process of applying pesticides (Flocks et al. 2002). There is a clear understanding throughout the literature that farmworkers present high levels of respiratory symptoms, but only a few have examined the prevalence of asthma among farmworkers. A recent study, which examined data from the Behavioral Risk Factor Surveillance System (N=107,327), found that the prevalence of asthma was of 4.2% among agricultural workers in 21 states, and 8.5% of the sample currently had asthma in the state of Washington (Dodd and Mazurek, 2016). Through the *Mexican Immigration to California:*

*Agricultural Safety and Acculturation* study of 702 farm worker participants, 6% had asthma, 5% experienced a chronic cough, 3.1% had chronic bronchitis, and 6.7% experienced a persistent wheeze (Stoecklin-Marois et al. 2015).

Studies have linked respiratory illnesses to the occupational exposure of fumes, diesel exhaust, chemical fertilizers, pesticides, and dust (Dodge et al. 2007). In a cross-sectional study Faria et al. (2005) examined the association between pesticide exposure and the risk of respiratory conditions among farmers. Through a multivariate logistic regression analysis, this study found that 60% of the farmers worked at least two days a month with pesticides, and 12% reported that they had experienced pesticide poisoning during their lifetime (Faria et al. 2005). The study employed the American Thoracic Society/Division of Lung disease to characterize respiratory symptoms. Specifically, asthma symptoms were defined as whether, an individual had experienced two or more episodes of wheezing or shortness of breath at any point of their lifetime. Overall, occupational pesticide use was associated with a higher rate of respiratory symptoms specifically, asthma symptoms (Faria et al. 2005).

### ***Farm Work Other Health Outcomes***

Due to the intensity of labor, long workdays, and being over worked, farmworkers experience various adverse health issues, such as injuries, body pain, and musculoskeletal problems (Swanberg et al. 2017). Musculoskeletal issues and body pain are a result of extreme heavy handling, repetitive body motions, and working in painful or awkward postures and positions (Vyas, 2012). Many studies utilize numeric scales to measure the overall pain or discomfort for respondents and specifically targeting section of the body. In

a quantitative study, Vyas (2012) found that both men and women self-reported high levels of discomfort during the harvest season, and discomfort was highly present in the neck, shoulders, palms/fingers, upper back, thighs, and lower leg (Vyas, 2012). With specific on-farm job/tasks forcibly being gender specific, pain or discomfort varied between men and women when studies specifically analyzed the association between pain or discomfort on task. Xiao et al. (2013) found that women were more likely to work in packing/sorting tasks and men were more likely to work in picking, pruning, machine operation, and supervision (Xiao et al. 2013). In a cross-sectional study administered in North Carolina, Kearney et al. (2016) found that 79% of farmworkers overall reported any type of pain or discomfort (Kearny et al. 2016).

### ***Occupational Pesticide Exposure in Farm Work***

The agricultural sector is the prime consumer of pesticides, leading farmworkers and their families to be highly exposed to dangerous and fatal chemicals (Levesque et al. 2012). Among many of the occupational health hazards, pesticide exposure is considered the most common occupational hazard for agricultural farmworkers (Sakala, 1987). Scholars have been examining the effect of occupational pesticide exposure through various methodological processes. In a cross-sectional study, Arcury et al. (2009) examined measures of biomarkers among 287 farmworkers in North Carolina during 2007 (Arcury et al. 2009). Urinary metabolites were utilized to measure the concentration of various types of pesticides. Drawing on 939 urinary samples, the study found high levels of insecticides among those farmworkers. Nevertheless, Acury et al. (2009) have suggested the

importance of longitudinal studies to further understand the effect that pesticides have on the farm working community (Arcury et al. 2009).

Farm workers are exposed to pesticides daily and contact with these toxic chemicals occur through various forms. Pesticide exposure can be “dermal, oral, and respiratory and occurs through direct contact with pesticides during application, contact with pesticide residue on plants, upon entering a recently treated area, or through drift from nearby applications” (Flocks et al. 2012). A common association with pesticide exposure is the on-job of mixing, loading and the application of pesticides. Kandel and Donato (2009) show that males, citizens, and legal permanent residents who characteristically had higher levels of education and English proficiency were more likely to handle pesticides than male unauthorized farmworkers (Kandel and Donato, 2009). The study provided a demographic overview of who is more likely to handle pesticides among farmworkers. This does not suggest that other farmworkers are not as highly exposed to pesticides or are in less danger because, as noted above, exposure to pesticides presents itself in other forms. Although high occupational exposure is significantly linked to the application of pesticides, an on-site job that is highly administered by males, women are also highly exposed through “other” on-site jobs, such as planting, weeding, and picking (Bell, 2006; Barbour and Gutham, 2018).

### ***Documentation Status Among Farmworkers and Health Access***

According to the most recent report from the National Agricultural Workers Survey (Hernandez and Susan, 2018), 69% of the agricultural population are from Mexico. Because farm work has never been a desired occupation by white Americans, the Agricultural sector

in the U.S. has had an extensive history of exploiting racial and ethnic individuals. The agricultural sector has always been comprised by minority individuals, such as Black farmworkers during slavery, migrant Japanese farmworker in the early 1900's, and migrant Mexicans during the Bracero program (Rausa and Lloyd, 2012). These are just some of the many other migrant populations who have been the backbone of the U.S agricultural sector.

People have been migrating to the US throughout the country's history, and employment patterns continue to show that many of these individuals are employed in the agricultural sector (Kandel, 2008). As migration continues to be an ongoing process, there are high rates of farmworkers who do not have the proper legal status to reside or work in the U.S. From 2007 through 2009, almost 70% of the farmworkers in the U.S were foreign-born, and among this population 55% did not have the proper legal status to reside or for employment (Martin, 2016). In the past few decades, the criminalization of migrant farmworkers and the simple act of seeking employment has increased discrimination and enhanced exploitation (Horton, 2016). Further, the criminalization of a farmworkers' everyday existence could limit their ability to seek healthcare and healthcare services and could be potentially undercounted in adverse health outcomes.

Additionally, as a result of it being immensely difficult to acquire legal status in the U.S., many agricultural workers lack proper legal status and are further marginalized. The majority of farmworkers lack healthcare coverage and are unable to seek adequate health care services (Davis, 2001). Unfortunately, not having proper legal status deprives agricultural workers from occupational rights and further segregates them from receiving



the necessary protection and crucial benefits. Drawing on the National Agricultural Worker Survey between 2009- 2014, Ghimire et al. (2018) Found that Legal Permanent Residents (LPRs: also commonly referred to as Green Card holders), H2-A visa holder, and Unauthorized farmworkers had lower probabilities of having health insurance when compared to U.S citizens (Ghimire et al 2018). Other studies estimated that 40% of farm workers do not have health insurance coverage, and migrant and seasonal farmworkers are twice as likely not to have health insurance coverage (Kandilov and Kandilov, 2010).

There are many socio-demographic factors that impede farmworkers from having adequate health care coverage, such as low income and poverty, low levels of formal education, and language barriers. Programs such as Medicaid have been enacted in order to provide assistance to people who are either low income, pregnant women, elderly, or disabled. However, since the enactment of the Welfare Reform Act, there has been a decline in the number of farm working households that receive Medicaid benefits (Davis, 2001). Medicaid has excluded a high percentage of farmworkers because of the criterion of eligibility, excluding undocumented and H-2A workers, who make up for over half of the farm working population. Fortunately, Medicaid and The Immigrant Children's Health Improvement Act of 2001 has provided female farm working mothers the ability to access the necessary health services for themselves and their progeny (Davis, 2001; Flocks et al. 2012). In a recent study Chung and Leigh, (2015) showed that having a child highly increased the odds of receiving Medicaid and that females and married farmworkers were more likely to report Medicaid use (Chung and Leigh, 2015). This has led female

farmworkers to have higher rates of health care visits when compared to male farmworkers.

Although, there is ample amount of scholarship examining occupational risk factors and the multiple negative health outcomes that farmworkers experience, there is a limited amount of research that assess the occupational risk factors of female farmworkers (Habib, 2014). According to the most current household data from 2019, 26.7% of agriculture crop producers are females (U.S. Bureau of Labor Statistics, 2020). Habib et al., (2014) has brought to attention that because women constitute a smaller percentage of the farm working sector, studies have under sampled women and are mostly reflective of the male farm working population (Habib, 2014). Farm work is a structurally violent occupation that perpetuates negative health outcomes for both men and women, as well for children. The systematic and structural factors of a capitalistic society such as mass production through labor exploitation, the inaccessibility of health access by hegemonic governmental policy, and the criminalization of undocumented legal status. These are some but not exhaustive forms of structural violence perpetrated towards farmworkers in the agricultural sector.

With previous research elaborating that occupational health outcomes are presented differently and are associated by biological gender differences, Dodge et al. (2007) analyzed data from the California Cancer Registry from 1988-2001 and found that Farmworker men had higher rate of prostate cancer when compared to the other California Hispanic men, and women had higher rates of breast, cervix, corpus uterus cancers (Dodge et al. 2007). A crucial biological difference presented through the literature was the negative health outcomes that farm working women experience, due to systemic maternal

and child health disparities related to childbearing. Recent studies show that occupational hazards among pregnant farm working women are associated with adverse health effects such as infertility, high level of still births, premature births, and developmental issues of the child (Flocks et al. 2012). Not forgetting additionally there are the physiological and emotional stress that these farm working women endure as they feel solely responsible for the occupational exposure they experience during pregnancy (Barbour and Guthman, 2018). Despite utilizing all the precautionary methods, the only real option for the protection of farmworker pregnant women, would be for them to stop working, which is systematically impossible and does not negate the long years they worked prior to pregnancy (Del Savio et al. 2015; Flocks et al. 2012).

### ***Indigenous Farmworkers***

Although, occupational health and the social determinants of health among farmworkers in the U.S has vastly been studied, there is lack of research specifically when it pertains to Indigenous farmworkers (Farguhar et al. 2008). Through the creation of identities placed onto specific populations by nationalism rather than ethnic and racial identity, Indigenous identities are often embedded into the larger conventional identities (i.e., Latinos, Mexican, Mexican-American) which fail to recognize the experiences of the Indigenous population. In the context of farmworkers, the Indigenous identity often gets overlooked by the process of labeling all individuals as simply farmworkers. Having been raised in this community, the self-identity of Latino, Mexican, and Mexican American seems to be the overarching identity that distinguishes this specific population. It is important to note that in the farmworker community there are individuals who do not identify as

Mexican or Mexican-American. There are many farmworkers who come throughout Latin America and other global countries. Moreover, there are indigenous farmworkers who come from pre-Columbian communities that are mostly self-governing and the Indigenous language is primary (Farquhar et al. 2008). There is a growing literature that further expands the importance of indigenous identity among farmworkers and the social determinants of health that affects this specific community.

A recent study estimates that approximately 40% of the farmworker population in the state of Oregon are Indigenous from Mexico and Guatemala (Farguhar et al. 2008). With the majority of previous research examining occupational health and other health issues among Indigenous farmworkers through community-based participatory research, a recurring theme is presented in the literature as Indigenous farmworkers experience greater systematic, institutional, occupational, and cultural discrimination due to varying linguistic and cultural differences. Isolation was identified as a key factor as many Indigenous farmworkers who have low proficiency in both English and Spanish could not understand crucial occupational safety information, such as pesticide exposure information and or other information that derives from this dangerous occupation. The literature suggests the importance of community-based strategies and actions to develop educational and health outreach programs that are accessible in Indigenous languages and would assist the access to economic, health, and social services (Farguhar et al. 2008).

Notably, most of the recent literature focusing on the importance of Indigenous occupational health has been conducted through the qualitative research process. Providing a vast amount of pivotal knowledge for governmental healthcare policies,

occupational and safety policies, and for further research. The current study through quantitative statistical analysis also incorporates the Indigenous identity as a socio-demographic outcome variable. As a way to bring more attention into discussion at the macro level on the importance of indigenous farm workers, who often get overlooked during quantitative statistical analyses.

## **HYPOTHESES**

Guided by findings from prior research, the current study proposes five testable hypotheses regarding the possible associations between various socio-demographic characteristics and the likelihood of having received a lifetime health care provider (HCP)-diagnosis of asthma among farmworkers.

*Hypothesis 1: "Occupational Pesticide Exposure"; Farmworkers who handled pesticides within the past 12 months are more likely to report having received a lifetime HCP-diagnosis of asthma than those who have not.*

*Hypothesis 2: "Access to healthcare"; Farmworkers with health access to health care are more likely report having received a lifetime HCP-diagnosis of asthma than those who do not have access to health care.*

*Hypothesis 3: "Legal status"; Unauthorized farmworkers are less likely to report having received a lifetime HCP-diagnosis of asthma than authorized farmworkers.*

*Hypothesis 4: "Gender differences in Access to health"; Female farmworkers are more likely to report having received a lifetime HCP-diagnosis of asthma than male farmworkers.*

*Hypothesis 5: “Dominant Language”; Farmworkers whose Dominant language is not English are less likely report having received a lifetime HCP-diagnosis of asthma than those who are Dominant language English.*

The National Agricultural Workers Survey is the only national representative survey of demographic employment and health characteristics of hired crop workers (Hernandez and Susan, 2018). The public data-set focuses on a variety of topics crucial for the current research such as education, work-type and working conditions, income and wages, self-reported health outcomes and accessibility to healthcare. Most important, for the current study, it also contains information on the mixing and application of pesticides.

## **DATA AND METHODS**

The present study draws on publicly-available data gathered through the U.S. Department of Labor’s National Agricultural Workers Survey (NAWS) (<https://www.doleta.gov/naws/public-data/>). The survey has been administered yearly since 1989 and consists of employment-based, random sample surveys, conducted through face-to-face interviews. The NAWS focuses and presents extensive demographic, employment, and health data on crop farmworkers at a national level (Hernandez and Susan, 2018). The survey is administered to participants who, at the time of each survey, are hired as crop workers or who work in crop-related occupations such as greenhouses, nurseries, operating machinery, and packing houses. Due to seasonal variation in work, the survey is administered three times a year to account for the large number of migrant farmworkers who follow the crops (Rodriguez et al. 2008; Kandel and Donato, 2009).

By conducting a multi-stage sampling procedure, NAWS is able to randomly select major farm working counties representative to each state and employers. In the fiscal year of 2009, 66% of the randomly selected employers agreed to cooperate in the survey and interviews were conducted in 59% of eligible work establishments (The National Agricultural Workers Survey, Part B). During the same year, 92% of the approached workers agreed to participate in the survey (The National Agricultural Workers Survey, Part B). It is important to note that potential participants are ineligible to participate in the survey if they had already been interviewed by NAWS during the same year and employment location. The sample also excludes H-2A visa workers and individuals who directly work with livestock such as bees, cows, fishes, etc. Since 1989, when the survey began, nearly 66,000 workers have been interviewed (Hernandez and Susan, 2018).

For the current study, two specific CSV files were downloaded in order to access the dataset. Both public CSV files were opened in Stata 13 version for further analyses (StataCorp LP, College Station, TX). Once the data were accessible in Stata, a close examination of the data was conducted by comparing the information that was provided in the public data codebooks (The National Agricultural Workers Survey, Codebook). The Stata datasets from 1989 through 2016 were then merged into a large individual dataset consisting of 66,553 cases. To protect respondents' anonymity, all NAWS data were completely deidentified.

Though the NAWS consists of 66,553 cases, the number cases vary according to specific questions posed in the survey across the study period. For instance, there were several questions that have been discontinued since the survey began in 1989, while-other

have been added throughout the years. Take for example, the question used to construct the dependent variable in the present study; “Have you ever in your whole life been told by a doctor or nurse that you have the following conditions: asthma?” This question was integrated into the survey in the fiscal year of 1999 and has remained in use through the most recent years for which NAWS data is publicly available (2016).

### ***Dependent Variables***

The current study examines the association between different socio-demographic factors and the likelihood of having received a lifetime HCP-diagnosis of asthma among farmworkers, with a primary interest in examining the association between handling pesticides and HCP-diagnosis of asthma. Table 1 provides the specific question wording and the proportions of the dependent variables examined in this study. The study’s dependent variable -- whether a farmworker has ever had an asthma diagnosis by a healthcare provider -- is represented as a dichotomous indicator (0 = “no”; 1 = “yes”). From the analytic sample of (N= 30,533), 3% of farmworkers’ self-reported having a lifetime HCP-diagnosis of asthma. As noted above, this specific question possesses several limitations making it difficult to establish causation between handling pesticides and other independent variables. Thus, an additional dependent variable was included in subsequent analyses as a validity check. This additional dependent variable represents whether the “respondent has experienced any pain or discomfort in the past 12 months” and was included in the analyses in order to 1) closer examine a farmworker’s overall well-being, and 2) examine whether the factors associated with an asthma diagnosis are also associated with self-reported pain/discomfort within the past years. This dichotomous



variable (0 = “no”; 1 = “yes”) was separately analyzed with the exact same independent variables that were included in the asthma-related models. From the additional analytic sample (N= 19,498), 18% of farmworkers’ self-reported having experienced pain/discomfort within the past 12 months.

### ***Independent Variables***

Additionally, Table 1 provides the descriptions and descriptive statistics of the independent variables, which consist of a focal independent variable represented by “whether a participant has handled pesticides in the past 12 months”, and other factors associated with the social-determinant of health among farmworkers. As presented in Table 1, the original question “In the last 12 months, have you loaded, mixed or applied pesticides?” was relabeled for the purpose of this research as “have you handled pesticides in the past 12 months”, as a method to categorize loaded, mixed or the application of pesticides. It is important to note, this specific variable does not effectively capture the day-to-day interaction with pesticides, pesticide residue, or pesticide drift that routinely occurs in other farm work tasks (Flocks et al. 2012). For the study, the focal independent variable was presented as a dichotomous variable (0 = “no”; 1 = “yes”). 20% of farmworkers handled pesticides within the past 2 years.

Other socio-demographic variables included in the model are a participant's gender (0 = “male”; 1 = “female”), 19% of farmworkers are Female. A dichotomous variable presented whether a participant is a migrant farmworker (0 = “not migrant”; 1 = “migrant”), 22% are migrant farmworkers. Participants’ educational attainment and primarily language was also presented in the model. A participant’s highest level of

educational attainment (education) is captured in a categorical variable divided into three groups; (76%) “Less than High School,” (17%) “High School (or equivalent GED),” and (7%) “More than High School.” Dominant language is categorized as (20%) “English,” (78%) “Spanish,” (0%) “Creole,” (1%) “Indigenous,” which includes Mixtec, Kanjobal, and Zapotec from the original categories, and a category representing (1%) “Other” languages. Identity characteristics such as a respondent’s race, whether a participant was Puerto Rican, and Indigenous are also used in the analyses. Race is captured in a categorical variable divided into; (37%) “White”, (3%) “Black/African American”, (0%) “Asian/Pacific Islander”, (6%) “Native American”, or (54%) “Other”. For the purpose of the study, the Puerto Rican variable is presented as a dummy variable for comparison between all other respondents (0 = “non-Puerto Rican”; 1 = “Puerto Rican”), 1% of farmworkers are Puerto Rican. Indigenous in which the NAWS defines any affiliation that include race, language, and child language, is presented as a dichotomous variable (0 = “not Indigenous”; 1 = “Indigenous”), (9%). In order to capture a respondent’s legal status during the time of interview, a categorical variable is divided into four groups: (27%) “Citizen”, (22%) “Legal Permanent Resident”, (1%) “Other Work Authorization”, and (50%) “Unauthorized”.

The conceptual model also included variables pertaining to a respondent’s economic status, the number of years working in agriculture, and employment composition. Family income is divided into groups of (18%) “Less than \$10K”, (33%) “\$10,000 - \$19,999”, (24%) “\$20,000 - \$29,999”, (14%) “\$30,000 - \$39,999”, (11%) “\$40,000 and over”. The number of years a respondent has worked in agriculture is captured by a categorical variable “Farmwork Experience” and divided into groups; (46%) “0-10 years”, (42%) “11-

30 years”, and (12%) “31 years plus”. For employment composition, the model included the variable work type which was categorized as “Fieldwork”, “Nursery”, “Packing house”, and “Other” in order to examine the specific site location of employment. The variable Task was included in the model as form to distinguish placement and time of employment and is presented in the categories of “Supervisor”, “Pre-harvest”, “Harvest”, “Post-harvest”, “Semi-skilled”, and “Other”. (proportions presented in Table 1).

The study examines the association between occupational pesticide exposure and negative health outcome, specifically, having received a lifetime HCP-diagnosis of asthma among farmworkers. The model could not fail to include access to healthcare and availability of health services. The independent variable whether a respondent has health insurance is categorized as (67%) “no”, (32%) “yes”, and (0%) “don’t know”. An important independent variable and crucial to the analyses models that will further be elaborated in the results section, is whether a farmworker has seen a healthcare provider in the last 2 years either in the U.S., or in a foreign Country, and was presented as (0 = “no”; 1 = “yes”). 64% of farmworkers have seen a healthcare provider within the past 2 years.

**Table 1. Descriptions and Descriptive Statistics for Dependent and Independent Variables in the Analytic Sample Examining an Asthma Diagnosis (Models 1-5)**

<b>Variable</b>	<b>Question</b>	<b>Mean</b>	<b>Std Dev</b>
<b><u>Dependent Variable</u></b>			
Asthma	Have you ever in your whole life been told by a doctor or nurse that you have the following conditions: ASTHMA?	.03	.170
<b><u>Independent variables</u></b>			
Handled Pesticides (last 12 months)	In the last 12 months, have you loaded, mixed or applied pesticides?	.20	.400
Healthcare Provider (last 2 years)	In the last two years have you used any type of health care services from doctors nurses dentists clinics or hospitals in the U.S. or in any foreign Country?	.64	.479
Female	Respondent self-identified as female	.19	.395
Race	Which of the following do you consider yourself ?		
White	Respondent self-identified as White	.37	.483
Black/African American	Respondent self-identified as Black/African American	.03	.180
Asian/Pacific Islander	Respondent self-identified as Asian/Pacific Islander	.00	.035
Native American	Respondent self-identified as Native American	.06	.229
Other	Respondent self-identified with another racial group	.54	.498
Puerto Rican	Respondent self-identified as Puerto Rican	.01	.103
Indigenous	Indigenous definition that include race, language, and child language	.09	.286
Migrant	Respondent is a Migrant farmworker	.22	.411
Education	What is the highest grade in school YOU/THEY completed? (If completed "GED" enter 12)		
Less than HS	Respondent self-reported having completed less than a High School education	.76	.426
High School (or equivalent)	Respondent self-reported having completed High School or "GED"	.17	.373
More than HS	Respondent self-reported having completed more than a High School education	.07	.258
Dominant Language	In which language do you believe you are most dominant (comfortable) conversing?		
English	Respondent self-reported English as dominant language	.20	.399
Spanish	Respondent self-reported Spanish as dominant language	.78	.417
Creole	Respondent self-reported Creole as dominant language	.00	.037
Indigenous	Respondent self-reported Indigenous as dominant language: Mixtec, Kanjobal, Zapo	.01	.109
Other	Respondent self-reported Other as dominant language	.01	.108
Family Income	What was your FAMILY'S TOTAL INCOME last year in U.S.A. dollars (U.S.A. earners only)?		
Less than \$10K	Respondent self-reported family income less than \$10,000	.18	.384
\$10,000 - \$19,999	Respondent self-reported family income between \$10,000 - \$19,999	.33	.471
\$20,000 - \$29,999	Respondent self-reported family income between \$20,000 - \$29,999	.24	.426
\$30,000 - \$39,999	Respondent self-reported family income between \$30,000 - \$39,999	.14	.345
\$40,000+	Respondent self-reported family income \$40,000 and over	.11	.314
Health Insurance	Does the farm worker have health insurance?		
No	Respondent self-reported not having health insurance	.67	.469
Yes	Respondent self-reported having health insurance	.32	.467
Don't Know	Respondent self-reported don't know to having health insurance	.00	.075
Documentation Status	Current Status?		
Citizen	Respondent self-reported having Citizenship	.27	.443
Legal Permanent Resident	Respondent self-reported having a Green Card	.22	.418
Other Work Authorization	Respondent self-reported having Other Work Authorization	.01	.100
Unauthorized	Respondent self-reported being Unauthorized	.50	.500
Work Type	Type of work?		
Fieldwork	Respondent fieldworks	.71	.452
Nursery	Respondent works in Nursery	.24	.424
Packing House	Respondent works in a Packing House	.04	.204
Other	Respondent self-reported Other as type of employment	.00	.080
Farmwork Experience	Number of years doing farmwork?		
0-10 years	Respondent self-reported less than 10 years of doing farmwork	.46	.498
11-30 years	Respondent self-reported between 11-30 years of doing farmwork	.42	.494
31+ years	Respondent self-reported 31 years and over of doing farmwork	.12	.330
Task	Task?		
Supervisor	Respondent is a Supervisor	.00	.029
Pre-harvest	Respondent works during the pre-harvest	.24	.427
Harvest	Respondent works during harvest	.22	.414
Post-Harvest	Respondent works during the post-harvest	.12	.330
Semi-Skilled	Respondent works in semi-skilled tasks	.29	.452
Other	Respondent self-reported Other as their work task	.13	.334

N = 30,533

### ***Analytic Approach***

As both dependent variables used in the analyses are dichotomous, being that they can only take two possible values, the best analytic approach to utilize is a multivariate logistic regression model (Gordon, 2010). Raw coefficients (B) are presented in Table 2 and Table 4, as a method to show the rate and direction according to specific independent variables. Further, as a form of interpretation, the current study utilizes and interprets significant associations by presenting the odds ratios for each specific logistic regression model. This was accomplished through exponentiating raw coefficients from positive and negative statistical associations. Accordingly, missing values were automatically dropped through the process of listwise deletion.

For the purpose of the study, I present statistically significant associations from each distinctive logistic regression models. By presenting each individual model and controlling for different variables in specific models allows to distinguish statistical significance, specifically when controlling whether the respondent has handled pesticides within the past 12 months or if the respondent has seen a health care provider within the past 2 years. Followed by further interpreting statistically significant coefficients as odds ratios. The odds ratios were calculated in excel by exponentiating coefficients for every statistically significant predictor variable. Equations are presented as followed; positive association (odds ratios =  $\exp(Bk)$ ) and negative association (odds ratios =  $(1-(\text{EXP}(Bk)))$ ) (Martinez et al. 2018) Note, the current study presented and interpreted statistically significant association at the  $p < .10$  level, thus these interpretations should be interpreted with caution.

## **LOGISTIC REGRESSION RESULTS: SELF-REPORTED LIFETIME ASTHMA DIAGNOSIS BY A HEALTH CARE PROFESSIONAL**

### ***Model 1: Baseline Model***

Model 1, displayed in Table 2, provides the coefficients and standard errors for the baseline model examining the association between the socio-demographic variables and the likelihood of a farmworker having received a lifetime HCP-diagnosis of asthma. This model does not control for whether the respondent has handled pesticides within the past 12 months or if the respondent has seen a health care provider within the past 2 years. As noted in Model 1, Female, Puerto Ricans, and farmworkers who work in packing houses are positively associated with having received an asthma diagnosis, while Migrant farmworkers, farmworkers whose dominant language is Spanish, Indigenous, or Other, farmworkers who are Legal Permanent Residents or Unauthorized, and every other farmworker besides Supervisors are negatively associated with this outcome.

The results suggest that there is a positive association between gender and having received a lifetime HCP-diagnosis of asthma. Specifically, the odds that females have a self-reported lifetime HCP-diagnosis of asthma are 1.58 times higher when compared to males (odds ratios =  $\exp(B_k)$ ; statistically significant at  $p < .001$ ). There also appears to be something unique about Puerto Rican farmworkers. For example, the odds that Puerto Ricans have a self-reported lifetime HCP-diagnosis of asthma are 3.03 times higher when compared to all other farmworkers ( $p < .001$ ). On the other hand, migrant respondents have 18% lower odds of a self-reported lifetime HCP-diagnosis of asthma when compared to non-migrants ( $1 - (\exp(B_k))$ ;  $p < .10$ ).

Additionally, a farmworkers dominant language also appears to be negatively associated with an asthma diagnosis. After controlling for all other variables, farmworkers whose dominant language is Spanish, have 44% lower odds of a self-reported lifetime HCP-diagnosis of asthma compared to farmworkers whose dominant language is English ( $p < .001$ ). Farmworkers whose dominant language is Indigenous have 66% lower odds of a self-reported lifetime HCP-diagnosis of asthma compared to farmworkers whose dominant language is English ( $p < .10$ ). Farmworkers that selected “Other” as their dominant language have 69% lower odds of a self-reported lifetime HCP-diagnosis of asthma compared to farmworkers whose dominant language is English ( $p < .05$ ). When it pertains to documentation status, after controlling for all other factors, farmworkers who are Legal Permanent Residents have 33% lower odds of a self-reported lifetime HCP-diagnosis of asthma when compared to farmworkers who are US Citizens ( $p < .01$ ). Unauthorized farmworkers have 59% lower odds of a self-reported lifetime HCP-diagnosis of asthma relative to farmworkers who are U.S Citizens ( $p < .001$ ).

Family income, type of employment, and farm work experience are also associated with a lifetime HCP-diagnosis of asthma . Farmworkers that have a family income over \$40,000 have 22% lower odds of a self-reported lifetime HCP-diagnosis of asthma compared to those farmworkers whose family income is less than \$10,000 ( $p < .10$ ). Farmworkers who work in a Nursery have 18% lower odds of a self-reported lifetime HCP-diagnosis of asthma compared to field working farmworkers ( $p < .05$ ). The odds of farmworkers who work in a Packing House and have a self-reported lifetime HCP-diagnosis of asthma are 1.38 times higher when compared to field working farmworkers ( $p < .10$ ).

Those farmworkers who have 11-30 years of farm work experience have 16% lower odds of a self-reported lifetime HCP-diagnosis of asthma compared to farmworkers that have less than 10 years of farm work experience. Finally, farmworkers who work during the Pre-harvest, Harvest, Post-Harvest, Semi-Skilled, or Other, respectively, have 70%, 72%, 76%, 72% and 67% lower odds of a self-reported lifetime HCP-diagnosis of asthma when compared to Supervisors (significance level presented in Table 2, Model 1).

### ***Model 2: Handling Pesticides***

Logistic regression Model 2 examines the association between handling pesticides and the likelihood of a farmworker having received a lifetime HCP-diagnosis of asthma. After controlling for variation in all other socio-demographic characteristics, the analysis shows a positive association between handling pesticides and having received a lifetime HCP- diagnosis of asthma. Specifically, the odds of farmworkers who handled pesticides within the past 12 months are 1.19 times higher to have a self-reported lifetime HCP- diagnosis of asthma relative to those farmworkers who did not handle pesticides ( $p < .05$ ). Once the analysis controls, whether a farmworker has handled pesticides within the past 12 months, the analysis finds similar associations to the baseline model (Model 1) which only includes the socio-demographic variables.

### ***Model 3: Health Care Provider***

Model 3 incorporates a second independent variable “whether a participant has seen a healthcare provider within the past two years, either in the U.S, or in a foreign country”. Given the wording of the dependent variable specifically stating that a lifetime



asthma diagnosis is predicated upon seeing a HCP, this variable was included in the regression model as a form to control for whether a respondent has seen a HCP in the past 2 years. In this model, the independent variable “handled pesticides within the last 12 months” was not included in the analysis. After controlling for all other variables, the results suggest that there is a positive association with farmworkers having seen a HCP within the past 2 years and having received a lifetime HCP-diagnosis of asthma. Specifically, the odds that farmworkers have seen a healthcare provider in the last two years and have a self-reported lifetime HCP-diagnosis of asthma are 2.97 times higher when compared to those farmworkers who have not seen a provider.

After controlling for this independent variable, the analysis continues to present similar statistical associations among the socio-demographic variables. There are two clear differences after including “whether a participant has seen a healthcare provider within the past two years, either in the U.S, or in a foreign country”, the level of association and the odds of Migrant farmworkers and Indigenous language speakers changed. Migrant farmworkers now had 21% (Model 2, 17%) lower odds of a self-reported lifetime HCP-diagnosis of asthma when compared to non-migrants ( $p < .05$ ). Additionally, there is no longer a statistical association between farmworkers whose dominant language is Indigenous and the likelihood of having received a lifetime HCP-diagnosis of asthma.

***Model 4: Handling Pesticides and Health Care Provider (Full Model).***

Model 4, presents the full logistic regression model, including handled pesticides within the past 12 months and whether a respondent has seen a healthcare provider within the past two years. In this model after controlling for both handled pesticides and

healthcare provider, we continue to see similar results from the previous logistic regression analyses. Additionally, after controlling for all other factors and whether a respondent has seen a healthcare provider within the past 2 years, the regression model presented, an increase in p-value on the focal independent variable whether a participant has handled pesticides within the past 12 months and the association of reporting a lifetime HCP-diagnosis of asthma. An increase from being statistically significant in Model 2 at the ( $p < .05$  level), to being statistically significant at the ( $p < .10$ ) level in the current model and should be interpreted with caution. Thus, the odds of farmworkers who handled pesticides within the past 12 months are 1.16 times higher to have a self-reported lifetime HCP-diagnosis of asthma when compared to those farmworkers who did not handle pesticides.

Further, after controlling for all other variables and whether a respondent has handled pesticides within the past 12 months, the odds of farmworkers who have seen a healthcare provider within the past two years are 2.96 times higher to have a self-reported lifetime HCP-diagnosis of asthma relative to those farmworkers who have not seen a provider ( $p < .001$ ). Thus, showing a strong association of having a self-reported lifetime HCP-diagnosis of asthma. All other socio-demographic variable continued to present similar results from the other logistic regression models.

#### ***Model 5: Handling Pesticides Among Respondents that had Seen a Health Care Provider***

As noted in the final full model (Model 4), having seen a health care provider within the past two years is a strong predictor of a lifetime HCP asthma diagnosis. Nevertheless, this finding is unsurprising, considering the question wording associated with the asthma

variable (“Have you ever in your whole life been told by a doctor or nurse that you have the following conditions: Asthma?”). As wording implies, having a lifetime asthma diagnosis is predicated upon having seen a HCP as well as access to healthcare. In an effort to address this limitation, Model 5 includes the same explanatory variables as Model 4, but limits the sample (N=19,638) to only farmworkers who had seen a HCP within the past two years and excludes respondents who have not recently accesses healthcare. The analysis provides a better understanding of the association that seeing a health care provider has on the likelihood of having received a lifetime HCP-diagnosis of asthma among farmworkers. In this model, the associations are mutually presented by each unique variable and whether they have seen a health care provider within the past 2 years. Please refer to Model 4, in Table 2, for comparison.

After limiting the analytic sample (Model 5) specifically to only farmworkers who have seen a healthcare provider within the past two years, the association between handling pesticides and whether a farmworker self-reported a lifetime HCP-diagnosis of asthma, diminished and was no longer statistically significant. Many of the other socio-demographic predictor variables continued to show similar statistical associations but changed ever so slightly. Female farmworkers still had 1.42 times higher odds of having a self-reported lifetime HCP-diagnosis of asthma relative to males ( $p < .001$ ). The odds of farmworkers who are Puerto Ricans are 3.05 times higher to have a self-reported lifetime HCP-diagnosis of asthma when compared to all other farmworkers ( $p < .001$ ).

Slight differences were presented when compared to the full model (Model 4) in the categorical Race variable. Asian/Pacific Islander now had 3.32 times higher odds of having

a self-reported lifetime HCP-diagnosis of asthma when compared to farmworkers who identified as White ( $p < .10$ ). Migrant respondents continued to have 17% lower odds of a self-reported lifetime HCP-diagnosis of asthma compared to non-migrants, but now was statistically significant at  $p < .10$ .

A farmworker's dominant language continued to reveal that those farmworkers whose dominant language is Spanish have a 44% lower odds of a self-reported lifetime HCP-diagnosis of asthma compared to farmworkers' that English is their dominant language ( $p < .001$ ). Farmworkers that selected "Other" as their dominant language have a 74% lower odds of a self-reported lifetime HCP-diagnosis of asthma compared to farmworkers that English is their dominant language ( $p < .05$ ). When it comes to documentation status, farmworkers who are Legal Permanent Residents have 25% lower odds of a self-reported lifetime HCP-diagnosis of asthma when compared to farmworkers who are US Citizens ( $p < .01$ ). Unauthorized farmworkers have 51% lower odds of a self-reported lifetime HCP-diagnosis of asthma compared to farmworkers who are Citizens ( $p < .001$ ). Farmworkers who worked in nurseries, continued to have lower odds in having a self-reported lifetime HCP-diagnosis of asthma compared to farmworkers who did fieldwork, and the statistical association of farmworkers who worked in the packing houses diminished when compared to fieldworkers. Every category in the task variable continued to have lower odds of a self-reported lifetime HCP-diagnosis of asthma relative to those farmworkers who are Supervisors.

Moreover, the first five models provide an analysis and show that farmworkers who have access to healthcare are more likely to have a self-reported lifetime HCP-diagnosis of

asthma. This strongly being determined by farmworkers who have more likely seen a healthcare provider within the past two years. Socio-demographic factors such as females, Puerto Ricans, Supervisors, and farmworkers who worked packing houses had higher odds of reporting lifetime HCP-diagnosis of asthma, even after controlling for handling pesticides and farmworkers who had seen a healthcare provider within the past two years. Other independent variables such as Spanish speakers, Legal Permanent Residents, and unauthorized workers showed negative associations, and consistently presented similar significance levels throughout all of the 5 logistic regression models.

Table 2. Logistic Regression Results for Self-Reported Lifetime Asthma Diagnosis By Health Care Provider

	Model 1		Model 2		Model 3		Model 4		Model 5	
	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE
Handled Pesticides (last 12 months)			.173*	.086			.146+	.086	.109	.092
Healthcare Provider (last 2 years)					1.090***	.104	1.086***	.104		
Female	.461***	.083	.495***	.085	.324***	.084	.353***	.086	.347***	.090
Race (Ref = White)										
Black/African American	.108	.145	.103	.145	.149	.146	.146	.146	.146	.159
Asian/Pacific Islander	.956	.645	.980	.646	.987	.652	1.004	.653	1.200+	.678
Native American	.137	.299	.147	.299	.140	.304	.149	.305	.071	.339
Other	-.123	.085	-.124	.085	-.067	.085	-.069	.085	-.070	.091
Puerto Rican	1.110***	.215	1.123***	.215	1.106***	.215	1.117***	.216	1.116***	.234
Indigenous	-.303	.279	-.304	.279	-.305	.283	-.305	.284	-.281	.316
Migrant	-.200+	.108	-.187+	.108	-.235*	.108	-.224*	.108	-.195+	.116
Education (Ref = Less than HS)										
High School (or equivalent)	-.072	.098	-.074	.098	-.078	.097	-.080	.097	-.082	.104
More than HS	.135	.122	.120	.122	.109	.121	.095	.122	.044	.130
Dominant Language (Ref = English)										
Spanish	-.583***	.134	-.572***	.134	-.575***	.133	-.565***	.134	-.581***	.142
Creole	-.574	1.026	-.556	1.025	-.422	1.026	-.413	1.026	-.150	1.038
Indigenous	-1.092+	.630	-1.073+	.630	-1.003	.632	-.987	.633	-.737	.647
Other	-1.186*	.546	-1.184*	.547	-1.152*	.550	-1.150*	.551	-1.353*	.644
Family Income (Ref = Less than \$10K)										
\$10,000 - \$19,999	-.064	.111	-.073	.111	-.046	.111	-.055	.111	-.096	.121
\$20,000 - \$29,999	.023	.118	-.001	.119	-.001	.119	-.021	.119	-.070	.128
\$30,000 - \$39,999	.054	.131	.029	.131	.004	.131	-.018	.132	-.064	.140
\$40,000+	-.245+	.140	-.280*	.141	-.296*	.140	-.326*	.142	-.342*	.148
Health Insurance (Ref = No)										
Yes	.088	.077	.087	.077	-.029	.078	-.030	.078	.024	.083
Don't Know	.515	.396	.516	.396	.587	.399	.588	.398	.277	.523
Documentation Status (Ref = Citizen)										
Legal Permanent Resident	-.396**	.137	-.387**	.137	-.393**	.136	-.385**	.136	-.282*	.144
Other Work Authorization	-.018	.329	-.020	.329	-.013	.329	-.017	.329	.209	.334
Unauthorized	-.887***	.140	-.881***	.140	-.799***	.140	-.795***	.140	-.708***	.150
Work Type (Ref = Fieldwork)										
Nursery	-.220*	.092	-.205*	.092	-.215*	.092	-.202*	.092	-.243*	.099
Packing House	.322+	.175	.342+	.175	.320+	.175	.337+	.175	.249	.187
Other	.136	.422	.151	.422	.160	.423	.176	.423	.304	.428
Farmwork Experience (Ref = 0-10 years)										
11-30 years	-.169*	.083	-.181*	.083	-.182*	.083	-.193*	.083	-.225*	.090
31+ years	-.105	.111	-.114	.111	-.162	.112	-.170	.112	-.164	.118
Task (Ref = Supervisor)										
Pre-harvest	-1.198+	.629	-1.191+	.629	-1.216+	.631	-1.205+	.631	-1.433*	.642
Harvest	-1.284*	.631	-1.267*	.631	-1.279*	.633	-1.260*	.633	-1.417*	.644
Post-Harvest	-1.439*	.634	-1.423*	.634	-1.475*	.636	-1.457*	.636	-1.569*	.647
Semi-Skilled	-1.260*	.629	-1.267*	.628	-1.289*	.631	-1.290*	.631	-1.437*	.641
Other	-1.118+	.632	-1.124+	.631	-1.153+	.634	-1.153+	.633	-1.275*	.644
N	30,553		30,553		30,553		30,553		19,638	
Pseudo R2	0.0627		0.0632		0.0791		0.0795		0.0473	

+p&lt;.10, \*p&lt;.05, \*\*p&lt;.01, \*\*\*p&lt;.001

## **LOGISTIC REGRESSION RESULTS: ASTHMA DIAGNOSIS COMPARED TO SELF-REPORTED PAIN/DISCOMFORT**

Given the temporal order of events and having an asthma diagnosis be explicit to having seen a health care provider, I am unable to establish causal relationship between pesticide exposure and an asthma diagnosis among farmworkers. Thus, a validity check is incorporated by introducing two additional logistic regression models (Models 6 and 7, presented in Table 4), and introduces a second dependent variable “whether a respondent has experienced pain or discomfort within the past 12 months”. The purpose for the introduction of this variable is to further conceptualize the experience and the overall well-being of farmworkers. Also, to examine whether the same socio-demographic factors that affected an asthma diagnosis, present the same or different association as to how farmworkers have felt within the past 12 months. All of the independent variable used in the asthma-related models are utilized in regression Models 6 and 7. Description and proportions for all variables could be found in Table 3 (see APPENDIX A). Note, this analytic sample will be representative of the subset of respondents who were asked this specific question during the time of interview. The NAWS introduced this specific question during the fiscal year of 1999 and continued until 2004, not asking it during 2005-2007, re-including it in 2008-2010 and then again in 2014 and 2015. Thus, resulting in a smaller analytic sample (N= 19,498).

**Table 4. Logistic Regression Results for Self-Reported Lifetime Asthma Diagnosis By Health Care Provider and Self-Reported Pain or Discomfort**

	Model 6		Model 7	
	Coef	SE	Coef	SE
Handled Pesticides (last 12 months)	.253*	.107	.152**	.052
Healthcare Provider (last 2 years)	1.038***	.127	.608***	.045
Female	.242*	.111	.447***	.050
Race (Ref = White)				
Black/African American	.266	.174	.232*	.104
Asian/Pacific Islander	1.099	.801	-.101	.569
Native American	.087	.395	.557***	.131
Other	.033	.111	-.124**	.047
Puerto Rican	.784**	.272	.045	.183
Indigenous	-.178	.375	.195	.121
Migrant	-.282*	.136	-.006	.051
Education (Ref = Less than HS)				
High School (or equivalent)	-.164	.124	-.271***	.063
More than HS	-.074	.162	-.142	.088
Dominant Language (Ref = English)				
Spanish	-.477**	.167	.000	.088
Creole	-.124	1.039	-.412	.553
Indigenous	-.444	.667	.035	.200
Other	-.747	.566	.172	.181
Family Income (Ref = Less than \$10K)				
\$10,000 - \$19,999	-.147	.136	-.111+	.058
\$20,000 - \$29,999	-.150	.149	-.267***	.067
\$30,000 - \$39,999	-.114	.164	-.240**	.077
\$40,000+	-.457*	.181	-.254**	.085
Health Insurance (Ref = No)				
Yes	-.021	.099	-.056	.047
Don't Know	-.426	.725	-.671*	.321
Documentation Status (Ref = Citizen)				
Legal Permanent Resident	-.441**	.166	.001	.079
Other Work Authorization	-.007	.389	-.054	.204
Unauthorized	-.995***	.173	-.178*	.081
Work Type (Ref = Fieldwork)				
Nursery	-.128	.117	-.184***	.053
Packing House	.271	.227	-.133	.110
Other	.455	.600	.640**	.249
Farmwork Experience (Ref = 0-10 years)				
11-30 years	-.207+	.106	.083+	.047
31+ years	-.230	.143	.247***	.070
Task (Ref = Supervisor)				
Pre-harvest	-.405	1.046	-.745	.518
Harvest	-.506	1.048	-.683	.518
Post-Harvest	-.659	1.052	-.713	.520
Semi-Skilled	-.614	1.046	-.778	.517
Other	-.427	1.048	-.359	.518
N	19,498		19,498	
Pseudo R2	0.0749		0.0347	

+p<.10, \*p<.05, \*\*p<.01, \*\*\*p<.001



***Model 6: Asthma Diagnosis (Reduced Analytic Sample)***

The purpose for Model 6, is to compare and contrast findings from Model 4. For comparison refer to Model 4 in Table 2, which is the full model that includes both independent variables handled pesticides and whether a respondent has seen a healthcare provider within the past two years. After limiting the analytic sample, logistic regression Model 6 presents the association between all conceptual variables and the likelihood of a farmworker to report having received a lifetime HCP-diagnosis of asthma.

After controlling for all other variables and the second analytics sample (N=19,498), the association between handling pesticide within the past 12 months and the likelihood of a farmworker having received a lifetime HCP-diagnosis of asthma is statistically significant, when compared to Model 4. In Model 4, there was an increase of p-value and the association should be interpreted with caution. In the current regression model, the odds of farmworkers who handled pesticides are 1.29 times higher to report having received a lifetime HCP-diagnosis of asthma relative to those who did not ( $p < .05$ ). Across both models females, Puerto Ricans, and farmworkers who had seen a healthcare provider within the past 2 years continued to show positive statistical significance, and had higher odds of having received a lifetime HCP-diagnosis of asthma. Migrant farmworkers continued to show negative statistical significance and had lower odds of having received a lifetime HCP-diagnosis of asthma when compared to non-migrant farmworkers. Farmworkers whose have a family income greater than \$40,000 had 37% lower odds of having received a lifetime HCP-diagnosis of asthma when compared to farmworkers who have a family income less than \$10,000.

Additionally, farmworkers whose dominant language is Spanish continued to show a statistically negative association in both models. Farmworkers whose dominant language is Spanish experienced lower odds of having received a lifetime HCP-diagnosis of asthma relative to farmworkers whose dominant language was English. On the other hand, in the current model, farmworkers who identified “other” as their dominant language was no longer statistically significant, when compared to Model 6. After controlling for all other variables, Legal Permanent Residents and Unauthorized farmworkers have lower odds of having received a lifetime HCP-diagnosis of asthma compared to farmworkers who are U.S. Citizens. This negative association was presented in both Model 4 and 6.

#### ***Model 7: Self-Reported Pain/Discomfort***

The final logistic regression model examines the association between all of the conceptual variables and whether a respondent has experienced pain/discomfort within the past 12 months. Regression Model 7 presents many differences when compared to Model 6, where the dependent variable was the likelihood of having a HCP-diagnosis of asthma. After controlling for all other variables, the odds of farmworkers who handled pesticides are 1.16 times higher to report having experienced pain/discomfort when compared to those farmworkers who did not handle pesticide within the past 12 months ( $p < .01$ ). The odds of farmworkers who have seen a healthcare provider within the past two years are 1.84 times higher to report having experienced pain/discomfort compared to those farmworkers who have not seen a healthcare provider. The odds of female farmworkers are 1.56 times higher to report having experienced pain/discomfort compared to males. In Model 6, Puerto Rican farmworkers were more likely to have a

report having received a HCP-diagnosis of asthma, now in Model 7, Puerto Rican farmworkers are no more less likely to report pain/discomfort when compared to all other farmworkers. Migrants were also no more less likely to report pain/discomfort when compared to non-migrants.

In the current model when compared to Model 6, a respondent's Race did not show any significant association on whether a participant has ever had an asthma diagnosis. The Race characteristic variable in the current model after controlling for all other variables, showed a positive association for farmworkers who identified as Black/African American and Native American relative to farmworkers who identified as White. The odds are 1.26 times higher for Black/African American farmworkers and 1.75 times higher for Native Americans when compared to farmworkers who identified as White. Farmworkers who identified as "other" have 11% lower odds of reporting feeling pain/discomfort within the past 12 months when compared to farmworkers who identified as White.

Further, after controlling for all other variables, a farmworkers' education level showed statistical significance. More specifically, farmworkers who have completed High School or equivalent have 24% lower odds when compared to farmworkers who have lower than a High School educational level. Whereas, in Model 6 there were no clear indicators that a farmworkers' level of education had any association between the likelihood of having received a lifetime HCP-diagnosis of asthma. In Model 6, family income also presented no statistical association and the likelihood of a farmworker having received a lifetime HCP-diagnosis of asthma. On the other hand, Model 7 shows that farmworkers

who have a family income greater than \$10,000 have lower odds of reporting feeling pain/discomfort within the past 12 months.

Additionally, after controlling for all other variables, unauthorized farmworkers have 16% lower odds of reporting pain/discomfort compared to U.S. Citizens. Compared to Model 6, the association of farm working experience shifted to a positive association. Farmworkers who have more farm working experience have higher odds of reporting feeling pain/discomfort within the past 12 months. The odds of feeling pain/discomfort are 1.08 times higher for farmworkers who have 11-30 years of farm work experience and 1.28 times higher for farmworkers who have more than 31 years of farm work experience relative to farmworkers who have less than 10 years of farm work experience. After controlling for all other variables, work type in Model 6 presented no statistical association and likelihood of a farmworker having an asthma diagnosis. By contrast, in the current model, farmworkers who work in Nurseries have 17% lower odds of reporting feeling pain/discomfort within the past 12 months compared to Fieldworkers. Farmworkers who specified "Other" as their employment type have 1.90 times higher odds of reporting feeling pain/discomfort within the past 12 months compared to Fieldworkers

## **DISCUSSION**

This thesis was designed to expand prior literature that examines the effect of occupational pesticide exposure and negative health outcomes among farmworkers. Specifically, the likelihood of having received a lifetime HCP-diagnosis of asthma among farmworkers. Additionally, the current study presents a different approach to previous studies that have utilized the NAWS. For example, a prior study examined socio-

demographic and occupational factors to help explain who is more likely to handle pesticides (Kandel and Donato, 2009). Now, the current study examines the relationship between handling pesticides and the negative health outcomes of having received a lifetime HCP-diagnosis of asthma, as well as self-reporting feeling pain/discomfort among farmworkers. Findings are presented from the full logistic regression model (Model 4). The findings suggest that handling pesticides within the past 12 months is associated with farmworkers' having received a lifetime HCP-diagnosis of asthma. In sum, this allows the study to confirm the central aim of this thesis and hypothesis 1, *farmworkers who handled pesticides within the past 12 months are more likely to report having received a lifetime HCP-diagnosis of asthma than those who have not*. Note this interpretation is significant at the  $p < .10$  level and should be interpreted with caution.

In the analysis, a farmworkers' health insurance status presented no statistical association as to having received a lifetime HCP-diagnosis of asthma. Although, health insurance status did not reveal a statistical association, farmworkers who have seen a health care provider in the last two years is highly significant and are more likely to having received a lifetime HCP-diagnosis of asthma relative to farmworkers who have not seen a HCP within the past two years. In sum, this does not allow the study to confirm Hypothesis 2, *farmworkers with health access to health care are more likely report having received a lifetime HCP-diagnosis of asthma than those who do not have access to health care*. Further, this association could be affected as most of the farmworkers in the analytic sample are Unauthorized (50%) or legal permanent resident (22%), and prior literature has shown that undocumented farmworkers are systematically restricted from receiving healthcare,

such as Medicaid or employer-sponsored health insurance (Chung and Leigh, 2015; Kandilov and Kandilov, 2010). Therefore, my findings show that unauthorized farmworkers and legal permanent residents were less likely to report having received a lifetime HCP-diagnosis of asthma compared to US citizens. In sum this allows the study to confirm Hypothesis 3, *unauthorized farmworkers are less likely to report having received a lifetime HCP-diagnosis of asthma than authorized farmworkers.*

Furthermore, female farmworkers are significantly more likely to report having received a lifetime HCP-diagnosis of asthma compared to male farmworkers ( $p < .001$ ). As presented in the literature, female farmworkers independent of a present child are more likely to have Medicaid or other health insurance coverage (Chung and Leigh, 2015). In sum, this allows the study to confirm Hypothesis 4, *female farmworkers are more likely to report having received a lifetime HCP-diagnosis of asthma than male farmworkers.*

Additionally, farmworkers whose dominant language is Spanish or Other are less likely to report having received a lifetime HCP-diagnosis of asthma relative to farmworkers whose dominant language is English. In his analysis about the importance of literacy barrier Arcury et al. (2010) found that immigrants are unfamiliar with the US medical system and may not know how to gain access (Arcury, 2010). In sum, this allows the study to confirm Hypothesis 5, *farmworkers whose Dominant language is not English are less likely report having received a lifetime HCP-diagnosis of asthma than those who are Dominant language English.*

Moreover, in the analysis, Puerto Rican farmworkers more likely reported having received a lifetime HCP-diagnosis of asthma relative to all other farmworkers. This

potentially being a function that Puerto Ricans are U.S. citizens and have the ability to access different types of healthcare. Given that after controlling for documentation status Puerto Rican farmworkers were still more likely to report having received a lifetime HCP-diagnosis of asthma relative to all other farmworkers, further research is needed to address ethnic variation in health among the farm working community.

Additionally, migrant farmworkers are less likely to report having received a lifetime HCP-diagnosis of asthma compared to non-migrants. Although, Supervisors constitute close to 1% of the analytic sample, farmworkers whose work task is that of a supervisor, are more likely to report having received a lifetime HCP-diagnosis of asthma compared to employment tasks.

The study's results should be interpreted with caution considering the limitations presented in the analysis and the data. Due to specific wording and questions being asked within various timeframes could result in underreporting. Also, the question used to construct the dependent variable in the present study “having received a lifetime HCP-diagnosis of asthma”, limits the ability to present causal interpretation. Specifically, the ability to disentangle causality between handling pesticides and the likelihood of having received a lifetime HCP-diagnosis of asthma among farmworkers. Hence there is a possibility that a farmworker has had an asthma diagnosis prior to working in agriculture. This also further entails, that a farmworker has seen a health care provider and has some sort of access to healthcare. Additionally, being that it is a self-reported dataset participant response bias can occur and may not be representative of true health outcomes. Further, due to the imposed fear and violence that undocumented farmworkers experience,

undocumented farmworkers could be more reluctant to participate in public surveys and disclose their legal status. Thus, potentially not being fully representative of the farm working community.

However, The National Agricultural Workers Survey is the first comprehensive national survey to collect data from hired crop workers, a vulnerable population that because of migration and seasonal patterns can be difficult to reach. The NAWS has been collecting data consecutively since 1989 and have had a worker participation rate of over 90% for each fiscal year since the beginning of the study (Tonozzi and Layne, 2016). Thus, providing the current study with a large sample size.

As noted throughout the study, the limitations presented on the dependent variable “lifetime HCP-diagnosis of asthma”, limited the ability to show causal interpretation between occupational pesticide expose and the negative health outcome of asthma among farmworkers. Thus, an additional logistic regression analysis was conducted, as a validity check by examining the association between socio-demographic characteristics, occupational factor, handling pesticides and whether a farmworker has experienced pain/discomfort within the preceding 12 months.

Findings are interpreted for each unique independent variable after controlling for all other the variables and are presented in Table 4, logistic regression Model 7. The findings suggest that handling pesticides, farmworkers who have seen an HCP with in the past 2 years, and female farmworkers are positively associated with farmworkers reporting pain/discomfort when compared to their respective counterparts. Farmworkers who handled pesticides within the past 12 months are more likely to report feeling



pain/discomfort. Farmworkers who have seen a healthcare provider within the past two years are also more likely to report feeling pain/discomfort. Female farmworkers are also more likely to report feeling pain/discomfort within the past 12 months.

The Race characteristic variable showed that farmworkers who self-identified as Black/African American, Native American, or Other are more likely to report feeling pain/discomfort within the past 12 months compared to farmworkers who self-identifies as white. Higher levels of education attainment and family income are negatively associated with farmworkers reporting feeling pain/discomfort within the past 12 months. Farmworkers who had completed High School or equivalent were less likely to report feeling pain/discomfort within the past 12 months relative to farmworkers who have less than a High School education. Farmworkers who have a family income greater than \$10,000 were less likely to report feeling pain/discomfort within the past 12 months. Additionally, when it pertains to documentation status, unauthorized farmworkers are less likely to report feeling pain/discomfort within the past 12 months when compared to farmworkers who are US citizens. The number of years that a participant has been a farmworker presented a positive association to reporting feeling pain/discomfort with the past 12 months. Farmworkers who had more than 10 years of farm working experience are more likely to report feeling pain/discomfort within the past 12 months. Further, farmworkers who worked in nurseries or specified Other as their employment type are more likely to report feeling pain/discomfort within the past 12 months when compared to fieldworkers.

## CONCLUSION

More broadly, the study demonstrates that handling pesticides in the 12 months preceding the survey is associated with having received a lifetime HCP-diagnosis of asthma, as well as self-reporting feeling pain/discomfort. As presented throughout the study, an asthma diagnosis is explicit upon having seen a health care provider and access to healthcare. As a result, female, Puerto Ricans, US Citizens, English dominant speakers, and Supervisor farmworkers are more likely to report having received a lifetime HCP-diagnosis of asthma compared with their respective counterpart. Overall, the findings demonstrate that farmworkers who have the societal ability to seek a health care provider and have access to healthcare are more likely to report having received a lifetime HCP-diagnosis of asthma.

Additionally, given the limitations to report casual interpretation that handling pesticides is a sole predictor to having received an asthma diagnosis among farmworkers, the additional logistic regression analysis provides a closer examination and further conceptualizes the experience and the overall well-being of farmworkers. Findings demonstrate Female and Racial minority farmworkers are more likely to self-report feeling pain/discomfort within the preceding 12 months. Farmworkers with high levels of educational attainment and family income are less likely to self-report feeling pain/discomfort.

A unique statistical association presented in the analysis suggests that unauthorized farmworkers are less likely to self-report feeling pain/discomfort within the preceding 12months relative to US citizens. This potentially being a basis as to why agricultural

workers view pain as a normal part of life (Vyas, 2012). Further, Sociologists have explored the topic of the normalization of suffering within the literature. For instance, David Spener (2009) elaborates on the negative and dangerous outcomes that Mexican immigrants experience during border crossings at the hands of coyotes, and how these experiences have been structurally normalized by immigrants. The appalling day-to-day living conditions of the Mexican working class has forced migrants to expect and bear bad conditions as a matter of course in their lives and could be seen in the effort to improve their living conditions. Thus, this normalization of suffering can help explain why unauthorized farmworkers in the current study are less likely to self-report having experienced pain/discomfort. Overall, the results demonstrate that farmworkers who are the most marginalized in society are more likely to self-report pain/discomfort within the past year.

There is a limited amount of research that examines occupational health issues connected to farmworkers' over all well-being, such as feeling pain or discomfort (Habib, 2014). For future research, I plan to examine occupational and social-demographic factors that are associated with feeling pain or discomfort among farmworkers, by further including interaction effects into the logistic regression analysis. This will allow to further examine the relationship between predictor variables, as interaction effects consider the simultaneous and combined influence of two or more independent variables (Gordon, 2010). For example, I could distinguish the relationship between unauthorized female farmworkers relative to female farmworkers who are US citizens and self-reported having experienced pain/discomfort. This could be further supported by integrating theoretical

frameworks such as intersectionality (Crenshaw,1989) as a method that further conceptualizes the structural negative experiences of farmworker in the US. The intersectional position of this theoretical framework will assist in analyzing and presenting the findings among the complex identities that consolidates the identity of farmworkers. Moreover, the importance of analyzing the results through a conceptual and theoretical lens can provide society new knowledge that can further explore and create new policies in the agriculture sector. Policies that could help diminish the negative health outcomes and health disparities that affect the farm working community, due to the lack of preventive measures that neglects the humanity and well-being of farmworkers. Further perpetuating structural violence and resulting in the suffering and death of the marginalized.

APPENDIX A:

Table 3. Descriptions and Descriptive Statistics for Dependent and Independent Variables Used in the Analytic Sample Examining an Asthma Diagnosis and Pain/Discomfort Models 6 & 7)

**Table 3. Descriptions and Descriptive Statistics for Dependent and Independent Variables Used in the Analytic Sample Examining an Asthma Diagnosis and Pain/Discomfort Models 6 & 7)**

Variable	Question	Mean	Std Dev
<b><u>Dependent Variables</u></b>			
Asthma	Have you ever in your whole life been told by a doctor or nurse that you have the following conditions: ASTHMA?	.03	.168
Pain/Discomfort	During the last 12 months, have you had any pain or discomfort?	.18	.382
<b><u>Independent variables</u></b>			
Handled Pesticides (last 12 months)	In the last 12 months, have you loaded, mixed or applied pesticides?	.19	.393
Healthcare Provider (last 2 years)	In the last two years have you used any type of health care services from doctors nurses dentists clinics or hospitals in the U.S. or in any foreign Country?	.63	.482
Female	Respondent self-identified as female	.19	.190
Race	Which of the following do you consider yourself ?		
White	Respondent self-identified as White	.36	.479
Black/African American	Respondent self-identified as Black/African American	.04	.188
Asian/Pacific Islander	Respondent self-identified as Asian/Pacific Islander	.00	.034
Native American	Respondent self-identified as Native American	.06	.232
Other	Respondent self-identified with another racial group	.55	.498
Puerto Rican	Respondent self-identified as Puerto Rican	.01	.106
Indigenous	Indigenous definition that include race, language, and child language	.09	.282
Migrant	Respondent is a Migrant farmworker	.23	.423
Education	What is the highest grade in school YOU/THEY completed? (If completed "GED"enter 12)		
Less than HS	Respondent self-reported having completed less than a High School educati	.77	.421
High School (or equivalent)	Respondent self-reported having completed High School or "GED"	.16	.370
More than HS	Respondent self-reported having completed more than a High School educati	.07	.250
Dominant Language	In which language do you believe you are most dominant (comfortable) conversing?		
English	Respondent self-reported English as dominant language	.19	.395
Spanish	Respondent self-reported Spanish as dominant language	.78	.414
Creole	Respondent self-reported Creole as dominant language	.00	.038
Indigenous	Respondent self-reported Indigenous as dominant language: Mixtec, Kanjoba	.01	.109
Other	Respondent self-reported Other as their dominant language	.01	.114
Family Income	What was your FAMILY'S TOTAL INCOME last year in U.S.A. dollars (U.S.A. earners only)?		
Less than \$10K	Respondent self-reported family income less than \$10,000	.20	.399
\$10,000 - \$19,999	Respondent self-reported family income between \$10,000 - \$19,999	.34	.475
\$20,000 - \$29,999	Respondent self-reported family income between \$20,000 - \$29,999	.23	.418
\$30,000 - \$39,999	Respondent self-reported family income between \$30,000 - \$39,999	.13	.338
\$40,000+	Respondent self-reported family income \$40,000 and over	.10	.301
Health Insurance	Does the farm worker have health insurance?		
No	Respondent self-reported not having health insurance	.68	.466
Yes	Respondent self-reported having health insurance	.31	.464
Don't Know	Respondent self-reported don't know to having health insurance	.01	.078
Documentation Status	Current Status?		
Citizen	Respondent self-reported having Citizenship	.27	.442
Legal Permanent Resident	Respondent self-reported having a Green Card	.23	.419
Other Work Authorization	Respondent self-reported having Other Work Authorization	.01	.100
Unauthorized	Respondent self-reported being Unauthorized	.50	.500
Work Type	Type of work?		
Fieldwork	Respondent fieldworks	.72	.450
Nursery	Respondent works in Nursery	.24	.425
Packing House	Respondent works in a Packing House	.04	.201
Other	Respondent self-reported Other as type of employment	.00	.066
Farmwork Experience	Number of years doing farmwork?		
0-10 years	Respondent self-reported less than 10 years of doing farmwork	.47	.499
11-30 years	Respondent self-reported between 11-30 years of doing farmwork	.42	.493
31+ years	Respondent self-reported 31 years and over of doing farmwork	.12	.323
Task	Task?		
Supervisor	Respondent is a Supervisor	.00	.030
Pre-harvest	Respondent works during the pre-harvest	.23	.423
Harvest	Respondent works during harvest	.23	.423
Post-Harvest	Respondent works during the post-harvest	.11	.319
Semi-Skilled	Respondent works in semi-skilled tasks	.28	.450
Other	Respondent self-reported Other as their work task	.14	.343

N = 19,498

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