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Occupational Health Hazards on Tobacco Farm Workers: A Systematic Review

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Abstract

Background: Tobacco farm workers are exposed to numerous occupational health hazards, involving chemical, biological, and physical concerns. These hazards can cause acute and chronic health problems, affecting workers' well-being and productivity. Objective: This systematic review aims to integrate available information on occupational health hazards among tobacco farm workers, identify important risks, and provide feasible mitigation techniques.
Methods: A systematic search was conducted in Scopus, ScienceDirect, and PubMed for studies published between 2015-2023. Inclusion criteria comprised reviewed articles focusing on occupational health hazards among tobacco farm workers. Studies were screened, and data were extracted according to PRISMA guidelines. The Joanna Briggs Institute (JBI) and Mixed Methods Appraisal Tool (MMAT) were used to assess quality for the Critical Appraisal Tool.
Results: This review found five studies that highlighted major health hazards, such as green tobacco sickness (GTS) caused by nicotine exposure, pesticide poisoning, respiratory problems, musculoskeletal disease, and cancer. Risk factors include extended exposure, a lack of protective equipment, and poor working conditions were frequently noted. Preventive strategies, such as the use of personal protective equipment (PPE), education programs, and government policies, must be prepared. There are research gaps in long-term health impacts and gender-specific concerns among tobacco farm workers.
Conclusion: Tobacco workers face several occupational health hazards, including green tobacco sickness (GTS), pesticide exposure, respiratory illnesses, and ergonomic issues that require several interventions for prevention.

Keywords: green tobacco sickness, occupational health, occupational safety, pesticide exposure, tobacco farm workers

1. INTRODUCTION

Tobacco production has a significant impact on the economy of many developing countries, bringing with it both opportunities and difficulties. In these countries, the agricultural industry makes a significant contribution to national income, jobs, and livelihoods. Tobacco is cultivated as a cash crop by smallholder farmers in these regions because of its comparatively high market demand and profitability (1). Tobacco farming sustains rural livelihoods and local economies by employing a significant number of people (2).

Tilling, disinfecting the nursery, planting, transplanting, trimming, topping, chemical spraying, harvesting, stacking, curing, and

wrapping for transit are all part of the process of growing tobacco. Farmers may come into contact with wet tobacco leaves during the ongoing process of cultivation, which focuses mostly on watering the tobacco plants (3). Many different types of pesticides are used in the process of growing tobacco. Among the substances that are frequently utilized are pyrethroids, synthetic pyrethroids, organophosphates, and neonicotinoids (1)

Tobacco farm workers face several potential health risks directly associated with their work in cultivating and harvesting tobacco crops. There are serious health risks associated with prolonged exposure to several chemicals, such as fertilizers, herbicides, and insecticides. These chemicals are frequently used in tobacco cultivation to reduce pests and increase crop yields, but workers who are exposed to them may have a variety of health problems (1).

One of the primary risks is pesticide exposure. Farmworkers involved in applying pesticides may suffer acute health effects like skin irritation, eye damage, respiratory problems, dizziness, nausea, and headaches. Chronic exposure to these chemicals has been linked to more severe health conditions such as neurological disorders, cancer, reproductive issues, and respiratory illnesses (4). In addition, workers who handle tobacco leaves during planting and harvesting run the risk of absorbing nicotine via their skin, which can result in "green tobacco sickness." The symptoms, which frequently arise from touching moist tobacco leaves and allowing nicotine to enter the bloodstream, include nausea, vomiting, headaches, and dizziness (5).

The health hazards connected to tobacco production were recognized as early as 1713 by the founding father of occupational medicine, Bernardino Ramazzini. He noted several symptoms in Italian tobacco workers, including stomach aches and headaches, and linked them to tobacco dust exposure (6). A common occupational illness among those who work in the tobacco business is Green Tobacco Sickness (GTS). Nicotine toxicity in an acute form brought on by direct skin contact with moist green tobacco leaves is known as "green tobacco sickness" (7). When tobacco plants or farmers' garments are damp from perspiration, dew, or rain, the danger of GTS rises. Typical symptoms of Green Tobacco Sickness (GTS) include headaches, dizziness, nausea, vomiting, and seizures (7). The risk of GTS is further increased by high humidity, rainfall, and wet tobacco leaves (8). Activity experience, the nature of the activity, and the absence of personal protective equipment (PPE) are among the hazards that lead to GTS (9). Unfortunately, the number of studies on health hazards associated with tobacco workers is limited. In addition, the majority of existing studies tend to be geographically limited, thus not representative of global conditions and populations. Some studies also exhibit methodological weaknesses, such as small sample sizes and inconsistent study designs, which may affect the reliability and validity of the results. Given this context, a systematic review is needed to comprehensively identify and address gaps in the literature. This is important to gain a more complete and reliable picture of the health risks faced by workers in the tobacco growing industry, and to support the development of more effective policies and interventions.

2. MATERIALS AND METHODS

In October until November 2023, we conducted a systematic review of occupational health hazards on tobacco farm workers. This review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.

a. Search strategy

Initial searches were carried out utilizing three electronic databases (Scopus, ScienceDirect, and PubMed). A wide search of the literature was carried out to discover keywords in the field. The primary word is used to broaden the scope of the literature review. The key terms for the search were as follows (Table 1).

Table 1. Keywords used in each database

No	Database	Keywords
1	Scopus	'health' AND 'risk' AND 'tobacco' AND 'workers'
2	Science Direct	'health' AND 'risk' AND 'tobacco' AND 'workers'
3	PubMed	'health' AND 'risk' AND 'tobacco' AND 'workers'

We independently selected and reviewed all English-language articles that described occupational health risk among tobacco farmers. We used the established methodologies for systematic reviews, and all titles and abstracts were checked to verify they met the eligibility requirements. Then we read the entire text to assess its relevance. To avoid duplication, all articles were obtained using Mendeley Reference Manager.

b. Eligibility Criteria

These eligibility criteria will ensure that our review focuses on high-quality research directly addressing the occupational health hazards faced by tobacco farm workers. This includes workers engaged in all stages of tobacco cultivation, processing, and curing. We will prioritize studies focusing on adult farm workers (typically defined as 18 years or older). However, if relevant studies addressing adolescent or child farm workers exist, they may be considered on a case-by-case basis. To provide a broader context, we will consider studies from various geographic regions, particularly those with significant tobacco farming activity. However, we may prioritize studies from developing countries, where occupational health concerns in tobacco farming are likely more pronounced. The quality of included studies was assessed using the Joanna Briggs Institute (JBI) tool for cross-sectional and case-control studies, while for mixed-method studies, we used the Mixed Methods Appraisal Tool (MMAT). The results of this critical appraisal showed that the majority of studies were of good quality, as shown by the fulfilment of almost all the criteria. The results of the critical appraisal are available in supplementary materials.

3. RESULTS

a. Study Selection

Our initial literature search generated 454 articles (Scopus 128 articles, ScienceDirect 281 articles, and PubMed 45 articles). Figure 1 shows an overview of the selection process. Following the elimination of duplicate articles (271 articles), titles and abstracts were evaluated to determine whether the articles were related to this systematic review. The majority of these articles did not match the inclusion criteria. Only 8 articles were evaluated for eligibility, and the complete text was reviewed. So, the systematic review comprised 8 articles.

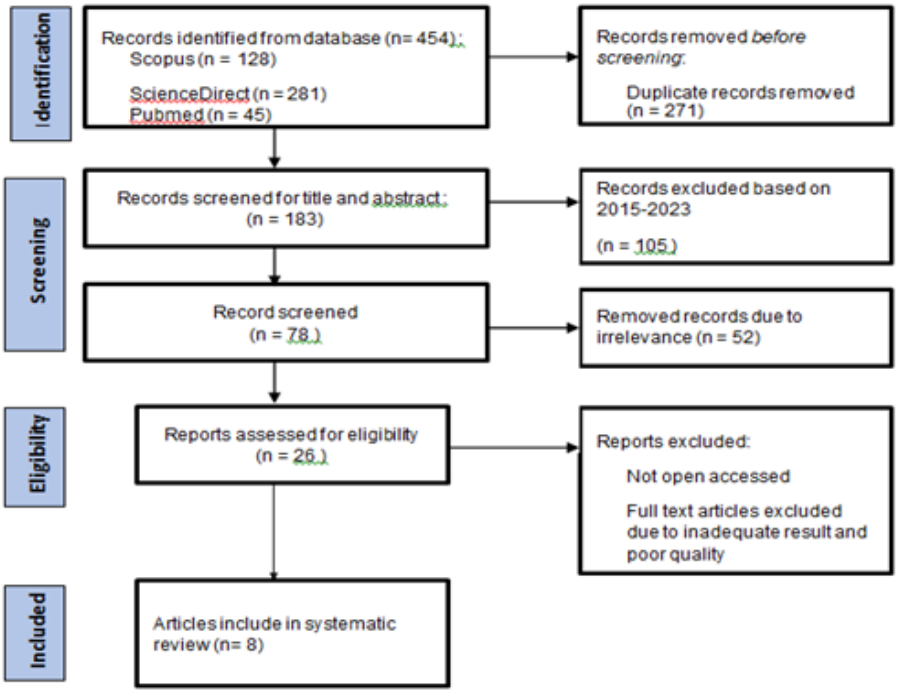

Figure 1. PRISMA diagram of this review

b. Data Extraction and Qualitative Analysis

A standardized data abstraction form created specifically for this systematic review was used to abstract all of the included publications. Information about the study's design, sample size, geographic location, participant characteristics, exposure (such as tobacco kind), definition of outcome measured (such as GTS), and study findings was all included in the form. The methods and results sections served as the only foundation for data abstraction. For every pertinent study and population attribute, heterogeneity was evaluated. If not published, odds ratios, incidences, and prevalence were computed using the data provided in the papers.

c. Study Characteristics

We identified eight studies that assessed several health risks among tobacco farm workers. Study publication dates varied from 2015 to 2023; two studies were carried out in India (4,10), two in Thailand (3,11), one in Indonesia (12), one in Brazil (13), one in Bangladesh (5), and one in South Africa (1). The number of respondents included in the studies ranged from 99 to 603. The most respondents were 603 people in Thailand.

Table 2. Characteristics of the Study

Authors	Type of Study	Sample size and population characteristics	Location
Kumar et al., (2023) (10)	Case control	Cases group: 120 farm workers Control group: unclear	Andhra Pradesh, India
Fassa et al., (2021) (13)	Cross sectional	99 young workers at 79 family farms	São Lourenço do Sul, Southern Brazil
Ali et al., (2022) (5)	Mix Method	Quantitative data sample: 384 tobacco farmers. The qualitative data sample isn't explicitly stated	Eight districts of Rangpur Division; three Districts; and three Thanas from three Districts; and three Thanas, nine Villages in Bangladesh

Sujoso et al. (2020) (12)	Case control	155 participants (case and control groups aren't explicitly stated)	Jember Regency, Indonesia
Muniswamy & Maliakel (2021) (4)	Cross sectional	422 participants: 212 tobacco farmers and 210 non-tobacco farmers	Hassan District, Karnataka, India
Saleeon et al. (2015) (11)	Cross sectional	473 Thai traditional tobacco farmers	Nan Province, a region in Northern Thailand
Moyo et al., (2023) (1)	Cross sectional	279 tobacco farm workers	Zomba, Malawi, South Africa
Kongtawelert et al. (2022) (3)	Cross sectional	603 tobacco farmers	Sukothai Province, Thailand

Eight studies were designed with different designs. One of the studies was designed with mix mixed-method design study (5), three of the studies were designed with a case-control study (10–12), and four of the studies were designed cross-sectional study (1,3,4,13). One of the studies (12.5%) indicated sample sizes of fewer than 100 participants (13), while seven of the studies (87.5%) reported sample sizes of 100 or more participants.

According to statistics examined from eight articles, the majority of respondents who grow tobacco are dominated by male. Four articles mentioned that most tobacco farmers are male (1,4,10,13), three articles mentioned most female (3,11,12), and 1 article did not specifically mention the gender of tobacco farmers (5). As in the research from Kumar et al, mention that the study included 64 male and 56 female tobacco farmworkers in Andhra Pradesh, India (10). According to Fassa et al, male (51.5%) and female (48.5%) tobacco farmers in Brazil were included in the study (13). Participants in the study were both male and female, but there were more males in the groups of tobacco producers than non-growers (4). Similar to Moyo et al, the participants of this study were mostly male (68%).

There are also some studies where the respondents are mostly female. Based on Sujoso et al research, most tobacco growers are female. The reason is that tobacco production involves certain tasks that require patience (12). Similar to Saleeon's research, the number of female tobacco farmer respondents is more than male tobacco farmers, with 40.2% of the population being male, while 59.8% is female (11). Likewise, Kongtawelert et al research states that most of the tobacco farmers are female, with 58.5% of respondents (3).

The tobacco farm worker participants had varying levels of education. Some participants have a high level of education, whereas others are not as well educated (12). The majority of participants had poor educational status, with tobacco growers having comparatively lower education levels than non-growers (4). With 83.1% of participants having completed primary school and only 15.8% having completed secondary education, primary school was the most common educational background for participants (11). The majority of workers (73%) claimed to have completed at least a primary education, although a higher percentage of female tobacco farmers said they had never attended school (1).

Based on the eight articles, the average participant has a long period of time working as a tobacco farmer. The study in Andhra Pradesh, India, found that 60.71% of female farmworkers and 89.06% of male farmworkers had 1 to 10 years of job experience. Furthermore, 3.13% of males and 35.71% of females reported having worked for 10 to 20 years, while 7.81% of men and 3.57% of women reported working for more than 20 years (10).

The study on Thai tobacco farmers found that the majority of participants had been working on a traditional tobacco plantation for more than 20 years (11). However, there is also research in Malawi that states the average tobacco farmer has been working for 5 years (1). According to the study in Brazil, the hours that teenage tobacco farm workers have worked varied; some began working on the farm before the age of 14, and during the off-harvest season, they put in at least five hours a day. 84.6% of teenage laborers worked more than four hours each day during the harvest, while 65.9% worked more than seven hours (13).

d. The Significant Health Risks

This review identified key occupational health hazards and their prevalence among tobacco farm workers. It's written on the table about the case definition and the result.

Table 3. Health Risk Profile among Tobacco Farmers

Authors	Health risk identified	Sample size	Age (y.o)	Gender	Duration of occupational exposure	Working season	Use of PPE
Kumar et al., (2023) (10)	Green Tobacco Sickness (GTS), skin disease, and breathing difficulty	120	38 on average	The majority are male	Majority >4 hours/day during harvest	Harvest season (June-August)	30% use gloves; hat and shoes <50%
Fassa et al., (2021) (13)	GTS and back pain	99	16-17	51.5% are male	4-6 hours/day during harvest	Harvest season (Jan-March)	Not wearing PPE; frequent direct contact
Ali et al., (2022) (5)	GTS, respiratory illness, skin rash, cancer	384	Varied age	Not specifically mentioned	Until 10 hours/day for tobacco farmers	High pesticide season	Almost no training on PPE; very rarely used
Sujoso et al. (2020) (12)	GTS, dermal nicotine exposure	155	Young middle-adult	Not specifically mentioned	5-9 hours/day at harvest time	Harvest season (July-October)	Gloves use <50%, closed clothing ~60%

Muniswamy & Maliakel (2021) (4)	GTS, insomnia	212	18-60	The majority are male	Not explicitly mentioned; 7 days work/week	Harvest season	Most do not wear PPE because they do not know its benefits
Saleeon et al. (2015) (11)	GTS, nicotine poisoning	473	Not specifically mentioned	Male and female	>6 hours /day when watering and harvesting	Curing and watering season	19% wear wet clothes; only a small percentage wear protection
Moyo et al., (2023) (1)	COPD, GTS, respiratory illness	279	38 on average	68% are male	6-8 hours/day	Flue-curing season	The majority did not use PPE; only 24% said they did
Kongtawelert et al. (2022) (3)	Musculoskeletal Disorders (MSDs)	603	49 on average	58.5% are female	>6 hours/day	Harvest season	a small percentage wear masks & gloves

e. Green Tobacco Sickness

According to eight articles that have been reviewed, almost all articles mentioned that occupational health risks in tobacco farmers are Green Tobacco Sickness (GTS). There are six articles (1,4,10–13) which list Green Tobacco Sickness as a frequent health hazard in tobacco farm workers. Tobacco farmers are frequently exposed to agricultural chemicals like pesticides and fertilizers, as well as nicotine found in tobacco. They are at a heightened risk of developing Green Tobacco Sickness (GTS). Through skin absorption, both prolonged and direct exposure can result in acute nicotine toxicity. When nicotine is absorbed through the skin, it circulates throughout the body (14). This will result in dizziness, nausea, vomiting, dyspnea, pallor, and elevated heart rate, which are all GTS indications and symptoms.

The study in Andhra Pradesh, India, identified a significant prevalence of Green Tobacco Sickness among tobacco farm workers. A lack of protective gear, age, gender, and working months were all linked to increased risk of GTS in farmworkers. The risk of GTS was found to be greater in female farmworkers than in male farmworkers (10). Tobacco farmers who experienced GTS symptoms experienced both occasional and frequent symptoms. Headache (14.17%) was the most common symptom, followed by nausea (11.67%), weakness (7.5%), exposed runny eyes (2.5%), dizziness and increased sweating (9.17%), and breathing difficulties (1.67%). Vomiting accounted for 24.17% of the occasional GTS symptoms, which were followed by headache (19.17%), nausea (20%), weakness (12.5%), dizziness (10.83%), excessive sweating (9.17%), red, watery eyes (2.5%), and breathing difficulties (1.67%) (10).

Research from (13) emphasizes that exposure to nicotine in tobacco leaf dust can increase the prevalence of GTS symptoms. The prevalence of GTS symptoms reported in this study was 24.5%. Tobacco farmworkers' health risks are additionally affected by things like alcohol intake and passive smoking. Even though it is illegal for child labor under 18 years old, young people who work in tobacco cultivation are also subjected to these health hazards.

The study in Jember, Indonesia, states that most tobacco farmers experienced GTS (12). It is observed that the prevalence of GTS in female workers is 5,308 times greater than in male workers. Age, gender, years of service, smoking status, and dietary status are strongly linked to GTS. Tobacco farmers with lower education, poor nutrition, and longer working terms are at a higher risk of developing GTS, with those who smoke having a higher risk, and those with a shorter working term being more likely.

Research from (4) emphasizes that tobacco growers in Hassan District, Karnataka, India, experienced higher rates of GTS symptoms. 63% of participants had high to moderate symptoms of GTS. These health risks were caused by several factors, such as inadequate use of personal protective equipment, dust exposure, smoke during the curing process, and ignorance of the health concerns associated with tobacco cultivation. Fatigue and sleeplessness were the most common symptoms, with 8% of the respondents reporting these symptoms more than three times per week.

According to the study in Thailand, 22.6% of Thai traditional tobacco growers had GTS symptoms. It was discovered that the incidence of GTS was about 1.5 times higher in females than in males (11). This result was in contrast to previous research that found almost all tobacco farmers impacted by GTS were male (15). In Thailand's traditional tobacco farming, female farmers work alongside their male counterparts to share the role of intensive producers. Gender, smoking, skin rashes, wearing wet suits, and particular duties involving tobacco cultivation are risk factors for GTS occurrence (11).

Likewise, the research from Moyo et al states that 26% tobacco farmers reported experiencing symptoms of green tobacco sickness (GTS) within the previous year (1). Over 35% of workers reported ever having an episode of GTS symptoms, with an annual GTS prevalence average of three episodes per year. Common GTS symptoms that have been reported were headache, nausea, dizziness, and vomiting, where headache (29%) is the most common symptom. Some of the factors that influenced the occurrence of GTS include low education level, gender, and lack of use of personal protective equipment (PPE). So, it exposes them to pesticides, nicotine, and other hazards with minimal protection. The variation in GTS symptom prevalence may be influenced by several factors, including the study location, climate conditions, tobacco harvesting methods, and levels of worker protection. For example, Sujoso et al. conducted their study in a humid tropical region with limited use of protective equipment, while Saleeon et al.'s study was in a region with different agricultural practices and possibly better protective measures in place.

f. Respiratory and Lung Disease

Farmers are exposed to a number of risks during each of these tobacco growing processes, including pesticides, biomass smoke, organic and inorganic dusts, as well as nicotine, which have the potential to significantly damage respiratory health (16). The tobacco growing process uses many different pesticides. Among the substances that are frequently utilized are pyrethroids, synthetic pyrethroids, organophosphates, and neonicotinoids. However, workers' development of chronic respiratory diseases in agricultural settings has been connected to exposure to nicotine and pesticides (17).

As in the study of Ali et al, explained that tobacco dust exposed farmers so it causes a respiratory problem (5). The prevalence of respiratory problems among tobacco farmers is 58.9%, higher than other health risks. Respiratory problems in tobacco farming are caused by several factors, such as exposure to substances like nicotine, the use of pesticides, the use of

inadequate protective gear, and a lack of awareness of health concerns.

Similar research in Malawi found a high load of obstructive lung disease in tobacco farmers. High exposure to pesticides was linked to respiratory symptoms (1). The prevalence of respiratory problems that often occur is ocular nasal symptoms (20%), chronic bronchitis (17%), and work-related chest symptoms (29%). Overall, the incidence of chest problems related to workers was higher in males. Compared to ocular-nasal symptoms, that was more common in females. The study discovered that while pesticides, soil dust, and dried tobacco are common sources of work-related upper airway symptoms, exposure to dried tobacco, smoke from fires, soil dust, pesticides, and field farming is the primary cause of work-related chest symptoms.

g. Skin Disease

Besides green tobacco sickness and respiratory problems, nicotine exposure can also cause skin diseases or allergies. Tobacco growers' hands, legs, and face may come into contact with tobacco leaves, leading to nicotine absorption via the skin. Nicotine, which is soluble in water, can be taken out of tobacco by rain, dew, or perspiration and absorbed through the skin (18). Similar research from Kumar et al found that Skin problems were also reported among tobacco plantation workers (10). Allergies were the most often reported disease (4.17%), followed by itching (3.33%), rashes (2.5%), superficial wounds, contact dermatitis, and traumatic skin lesions (0.8% per). The usage of protective clothing was associated with an increased risk of skin disease among farmworkers.

Tobacco farming is frequently associated with the emergence of new ailments such as skin disorders. The research from Ali et al. (2022 found that most working conditions, hot and humid climates, past skin injury, contact with chemicals, such as the use of pesticides, and exposure to dangerous plants, are a few variables leading to a high frequency of skin illness (5). The frequency of skin disease cases was found to be 9.3% of all respondents.

h. Musculoskeletal Disorders

Tobacco farmers are at high risk of developing musculoskeletal disorders due to ergonomic hazards such as prolonged bending, repetitive movements, and heavy lifting. The nature of tobacco farming requires frequent stooping and bending while planting and harvesting, which puts excessive strain on the lower back. Additionally, repetitive tasks like transplanting seedlings and handpicking leaves can lead to cumulative trauma in the wrists, shoulders, and knees. Heavy lifting of tobacco bundles further exacerbates muscle fatigue and increases the likelihood of injury (19).

According to the research from Kongtawelert et al., tobacco farmers had significantly higher musculoskeletal disorders (MSDs) in the shoulders, wrists, lower back, hips, and knees during the harvesting season than in the planting season. This is partly caused by the long working hours, heavy lifting, repetitive cutting, and excessive reaching. To decrease MSDs, tobacco farmers should be equipped with proper equipment to lessen muscular tension (3).

Cancer

Tobacco producers suffer a significant risk of cancer, which is mostly caused by continuous exposure to toxic chemicals. Tobacco cultivation requires continuous exposure to insecticides, herbicides, and fertilizers, many of which include carcinogenic chemicals. Chronic exposure to these agrochemicals by inhalation, skin absorption, and accidental ingestion has been associated with an increased risk of cancer, including lung, skin, and hematologic malignancies, including leukemia and lymphoma. Tobacco growers are also exposed to nicotine through skin absorption, a disease known as Green Tobacco Sickness (GTS), which may contribute to long-term health complications such as cancer (20).

The research from Ali et al. reported that tobacco production has led to the emergence of several dangerous and deadly illnesses. For instance, almost 38% of respondents claimed that the introduction of tobacco to the research region had made cancer more widespread. This mainly originated from the use of extensive pesticides during production (5). Similar research from Kumar et al. found that tobacco farm workers also get bladder cancer. This is caused by tobacco

farmers who handle tobacco leaves may be exposed to high levels of nitrosamines (10). Nitrosamines can cause bladder cancer because they are potent carcinogens that damage DNA and lead to genetic mutations in urothelial cells lining the bladder (21).

4. DISCUSSION

Overall, most of the significant occupational health risks faced by tobacco farm workers are Green Tobacco Sickness (GTS) and pesticide exposure. Green tobacco sickness is an acute form of nicotine poisoning that occurs when workers absorb nicotine through their skin while handling wet tobacco leaves. Green tobacco sickness symptoms include nausea, vomiting, dizziness, headaches, and elevated heart rate, which frequently lead to significant pain and work absences (15). Green tobacco sickness is especially prevalent in humid situations where workers sweat heavily, allowing for increased nicotine absorption. The majority of the studies indicated that a lack of protective clothes and continuous exposure to wet tobacco aggravate the illness, making it a persistent occupational concern in tobacco growing (22).

In addition to green tobacco sickness, chemical exposure offers serious health concerns to tobacco producers. Tobacco farming necessitates considerable use of pesticides to manage pests and illnesses, which exposes tobacco farm workers to high levels of chemicals. Many tobacco farmers, especially in low- and middle-income countries, lack basic protective gear and suitable training in pesticide use, increasing their risk of acute and chronic health consequences (23). Acute pesticide exposure can cause respiratory disorders, skin irritation, and neurological abnormalities, whereas long-term exposure has been related to cancer, reproductive issues, and neurological impairments. The use of dangerous chemicals in tobacco production, combined with poor safety measures, raises serious public health concerns (24).

Besides that, ergonomic problems compound the health burden on tobacco farm workers, making them more susceptible to occupational problems. Tobacco cultivation is physically demanding, with repeated motions, extended bending, heavy lifting, and unnatural positions, all of which lead to musculoskeletal disease such as chronic back pain, joint pain, and muscle strain. Improving workplace ergonomics and strictly enforcing safety standards are all necessary to prevent workers from long-term health implications (19). Additionally, tobacco farm workers have considerable respiratory hazards as a result of exposure to organic dust, mold spores, and insecticides. According to studies, inhaling airborne particles from dried tobacco leaves can lead to chronic bronchitis, asthma, and other respiratory problems. Pesticide inhalation exacerbates respiratory discomfort, raising the likelihood of lung inflammation and long-term pulmonary damage. Improving workplace ergonomics, providing access to protective breathing equipment, and strictly enforcing safety standards are all necessary to prevent tobacco farm workers from long-term health repercussions (25).

To minimize the health hazard to tobacco farm workers, an integrated strategy including education, policy enforcement, and technology solutions is required. One of the most effective preventative strategies is to provide education and training in occupational health and safety. Tobacco farm workers should be educated on the risks of green tobacco sickness (GTS), chemical exposure, ergonomic hazards, and respiratory issues. To limit cutaneous nicotine absorption, training programs should emphasize wearing protective clothes such as gloves, long-sleeved shirts, and waterproof aprons (19). Additionally, programs to improve tobacco farm workers' knowledge about pesticide safety can help to reduce exposure hazards. For the prevention of secondary nicotine and pesticide exposure, proper hygiene measures such as washing hands and changing clothes after work should be promoted (26).

Another critical action to protect tobacco farm workers is enforcing policies and regulations. Governments and agricultural organizations should implement and uphold labor rules that limit overtime, require the use of personal protection equipment (PPE), and control pesticide usage. Creating buffer zones between pesticide-treated regions and residential or communal places might

further minimize exposure concerns. Pesticide safety standards can be strengthened by prohibiting the most dangerous compounds and encouraging the use of harmless alternatives, such as biopesticides. Furthermore, regulations that promote tobacco growers' access to healthcare services can help assure early identification and treatment of occupational hazards (24).

Technological developments and agricultural innovations can also help reduce health concerns. Mechanized harvesting and automated pesticide application methods can minimize direct exposure to harmful compounds. Implementing integrated pest management (IPM) measures, such as crop rotation, biological pest control, and resistant crop types, may lower the need for chemical pesticides while preserving production. Ergonomic changes, such as the use of lightweight equipment and adjustable workstations, may help mitigate musculoskeletal strain and improve overall working conditions for tobacco farmers (15).

Eventually, a combination of education, regulatory enforcement, and technology innovations is required to protect tobacco farmers from occupational health risks. Governments, non-governmental organizations (NGOs), and the tobacco business should work together to emphasize worker safety and health through the implementation of sustainable and worker-friendly farming techniques. Adopting these preventative measures will considerably reduce the burden of work-related problems among tobacco farm workers, resulting in a healthier workforce and increased agricultural sustainability (27).

5. CONCLUSIONS

Tobacco farm workers deal with several occupational health hazards, including green tobacco sickness (GTS), pesticide exposure, respiratory disease, and ergonomic concerns. Addressing these difficulties requires comprehensive measures such as education, policy enforcement, and health monitoring. Future studies should concentrate on the long-term effects of occupational exposures and the efficacy of intervention initiatives to protect the well-being of this vulnerable workforce.

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