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Research Paper

Respiratory Symptoms and Protective Equipment Use Among Manual Sugarcane Workers in Guyana: A Cross-Sectional Survey

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ABSTRACT

Pre-harvest burning and manual harvesting of sugarcane persist in many low- and middle-income countries, including Guyana, exposing field workers to smoke, dust, and agrochemicals. Evidence on these workers' respiratory health comes largely from Brazil, and little has been published from the Caribbean. This study aimed to estimate the prevalence of self-reported respiratory symptoms and to describe workplace exposures, smoking, and use of personal protective equipment among manual sugarcane field workers in Guyana. A cross-sectional survey of 99 field workers was conducted on a Guyanese sugar estate in May and June 2025, between harvest seasons. An interviewer-administered questionnaire assessed workplace exposures and respiratory symptoms experienced at work and on days of cane burning or pesticide spraying. The analysis was descriptive, and prevalence is reported with 95% confidence intervals (CIs). Nearly all workers reported exposure to dust (99.0%) and to smoke (96.0%), and most reported several exposures at once. Coughing was reported by 76.8% of workers (95% CI [67.5, 84.0]) and shortness of breath by 59.6%, nighttime cough (40.4%) and wheezing (25.3%) were less common, and 80.8% reported that their symptoms improved away from work. Only 29.3% (95% CI [21.2, 38.9]) used any protective equipment (masks or gloves), and 28.3% were current smokers. Self-reported respiratory symptoms were common, most workers linked them to work, and protective equipment was rarely used. Year-round exposure control, effective respiratory protection, enforcement of occupational safety law, and respiratory surveillance are warranted in Guyana and in other countries where sugarcane is burned and harvested by hand.

Keywords: *Sugarcane, Occupational exposure, Respiratory symptoms, Personal protective equipment, Agricultural workers, Guyana*

Work remains a major determinant of health worldwide. Work-related diseases and injuries caused an estimated 1.9 million deaths in 2016, and chronic obstructive pulmonary disease was the leading single cause (World Health Organization & International Labour Organization, 2021). Agricultural workers face particularly high risks, yet they are among the least protected by occupational safety and social protection systems (International Labour Organization [ILO], n.d.). Manual sugarcane harvesting brings these

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problems together. In many low- and middle-income countries, cane is still burned before it is cut by hand, exposing workers to smoke, dust, and agrochemicals (Leite et al., 2018; Stem et al., 2024). Guyana is one such setting: although now classified as a high-income economy (World Bank, 2026), it continues to harvest cane by hand after pre-harvest burning, and the respiratory health of its cane workers has received little research attention since a community survey more than five decades ago (Miller & Ashcroft, 1971). This gap matters: the sugar industry remains an important source of livelihood in rural Guyana (United Nations Guyana, 2021), and evidence is needed to guide employers, health services, and regulators. It also matters beyond clinical medicine. The 2030 Agenda for Sustainable Development commits countries to protect labor rights and promote safe and secure working environments for all workers (United Nations General Assembly, 2015), and whether that commitment reaches the people who cut cane by hand is a question of social equity as much as of health. Answering that question requires, as a first step, documenting the conditions under which cane workers labor and the health problems they report. In this study, we describe respiratory symptoms, workplace exposures, smoking, and use of personal protective equipment (PPE) among field workers on a Guyanese sugar estate and consider what the findings mean for workers, employers, and occupational health policy in Guyana and other sugarcane-producing countries.

REVIEW OF LITERATURE

Occupational Health in Agriculture

Agriculture employs an estimated 874 million people, more than a quarter of the global workforce, and agricultural workers face more than three times the risk of dying on the job as workers in other sectors (ILO, n.d.). Work-related disease adds substantially to this toll: the ILO (2023) estimates that nearly three million workers die each year from work-related causes, 2.6 million of them from disease rather than injury. Respiratory disease is a major part of this burden: in the first joint estimates of the World Health Organization and the ILO, occupational exposure to particulate matter, gases, and fumes was responsible for about 450,000 deaths in 2016, and chronic obstructive pulmonary disease was the largest single cause of work-related death (World Health Organization & International Labour Organization, 2021). Within agriculture, the most vulnerable groups include daily-paid plantation laborers and seasonal workers, and in many countries only some categories of agricultural workers are covered by national labor legislation, employment injury benefits, or insurance schemes. Where legislation exists, enforcement may be weakened by insufficient labor inspection and limited training on hazards for both employers and workers (ILO, n.d.). The ILO's Safety and Health in Agriculture Convention (No. 184) was adopted in recognition of the sector's particular hazards (ILO, 2001).

The organization of agricultural work compounds these risks. Agricultural workers are often dispersed across remote rural areas where public health services are limited, and agriculture has historically been excluded from the provisions of many national labor laws (ILO, 1997). Hazards can also extend beyond the worker: farm families frequently live on or near the land they work, so family members may be exposed to the same respiratory hazards as the workers themselves (American Thoracic Society, 1998). Occupational health in agriculture is therefore shaped not only by the hazards of the work but by where and how agricultural workers live and by the legal and social protections available to them.

Respiratory disease was among the first occupational hazards to be recognized in agriculture (American Thoracic Society, 1998). Farm workers may inhale a wide range of agents,

including inorganic soil dust, organic dusts containing microorganisms and allergens, gases, and agrochemicals, and preventive strategies have been developed for only some of these exposures (American Thoracic Society, 1998; Linaker & Smedley, 2002). Pesticide exposure has been linked to respiratory symptoms and impaired lung function (Mamane et al., 2015), and dust exposure during farm work has been associated with respiratory symptoms among farmers (Faria et al., 2006). In Ethiopia, a comparative study of 288 farmers found a higher prevalence of cough among farmers than among non-agricultural controls (20.5% vs. 9.0%), with lung function declining as the duration of agricultural work increased (Woldeamanuel et al., 2020). The same study found a higher prevalence of restrictive lung function impairment among farmers than among controls (12.8% vs. 3.1%; Woldeamanuel et al., 2020). This excess respiratory morbidity persists even though farm workers smoke less than the general population, which further implicates occupational exposures (American Thoracic Society, 1998).

The contribution of work to chronic respiratory disease is substantial but often unrecognized. An official statement of the American Thoracic Society and European Respiratory Society estimated that occupational exposures account for about 16% of asthma, 14% of chronic obstructive pulmonary disease, and 13% of chronic bronchitis, and noted that these conditions are frequently not recognized as potentially work related (Blanc et al., 2019). Such disease develops gradually and its link to work is easily overlooked, so cases among agricultural workers are unlikely to appear in official statistics without deliberate effort to find them. An American Thoracic Society review accordingly identified surveillance systems for agricultural respiratory disease and exposures, education of health professionals on diagnosis and prevention, and primary prevention strategies as priorities for the field (American Thoracic Society, 1998).

Where exposures cannot be eliminated, PPE is the last line of defense in the hierarchy of controls (National Institute for Occupational Safety and Health, 2024). Its use among agricultural workers is often inconsistent. A systematic review of 121 studies identified education and literacy, income, and previous experience of illness among the determinants of PPE use and pesticide safety practices (Sapbamrer & Thammachai, 2020), and discomfort, limited availability, and lack of training are recurring barriers (Damalas & Koutroubas, 2016). Several of these barriers lie with employers rather than workers, so effective protection depends substantially on employers' provision of suitable equipment and training.

Even when PPE is worn, the type of equipment matters. Citing a global systematic review, Sapbamrer et al. (2021) reported that only 43.2% of agricultural pesticide handlers wore masks and only 13.9% wore respirators while working, and that the respiratory equipment commonly available to farmers in low- and middle-income countries varies widely in the protection it provides. They argued that choices about respiratory protection in tropical climates must balance the hazard against what workers can realistically wear. A more recent systematic review found that farmers' education, knowledge, and attitudes toward safety are among the most consistent influences on protective behavior (Kangavari et al., 2024), underscoring the importance of training alongside the provision of equipment.

Sugarcane Harvesting: Exposures and Health Effects

Sugarcane is the world's leading sugar crop, with more than two billion metric tons produced in 2023 (Food and Agriculture Organization of the United Nations, 2024). Mechanized harvesting of unburnt cane is spreading in some producing countries, but in many low- and

middle-income countries the crop is still cut by hand, and burning before harvest to remove leaves and speed cutting persists despite policies to restrict it (Chaya, 2024; Leite et al., 2018; Stem et al., 2024). Pre-harvest burning has been characterized as a wicked problem, one sustained by interacting economic, practical, and regulatory pressures and resistant to simple solutions (Chaya, 2024).

Manual cane workers are exposed to smoke, ash, soil dust, and agrochemicals (Leite et al., 2018; Stem et al., 2024). Median particulate matter (PM_{10}) concentrations of about 1,800 μg/m³ have been recorded during pre-harvest burning on South American estates (Le Blond et al., 2017). In a Brazilian study, concentrations of fine particulate matter ($PM_{2.5}$) rose from 8 μg/m³ outside the harvest to 23.5 μg/m³ in a nearby town and 61 μg/m³ on the plantations during the harvest (Prado et al., 2012). Over the same period, wheezing, coughing, and breathlessness increased among both cane workers and town residents, more markedly among workers, who also showed greater declines in lung function and larger increases in markers of oxidative stress (Prado et al., 2012).

The effects of burning extend beyond the fields. In Piracicaba, Brazil, increases of 10.2 μg/m³ in $PM_{2.5}$ and 42.9 μg/m³ in PM_{10} were associated with increases of 21.4% and 31.0% in respiratory hospital admissions among children and older adults, respectively, and particles generated by cane burning were those most strongly associated with admissions (Cançado et al., 2006). In Araraquara, a 10 μg/m³ increase in total suspended particles was associated with an 11.6% increase in hospital admissions for asthma (Arbex et al., 2007). Cane burning has also been associated with acute respiratory illness on Maui (Mnatzaganian et al., 2015), and in South Florida, sugarcane fires were estimated to emit an amount of primary $PM_{2.5}$ similar to that from motor vehicles across the state and to contribute to excess mortality in surrounding communities (Nowell et al., 2022).

Respiratory hazards are not the only concern. In Mesoamerica, an epidemic of chronic kidney disease of non-traditional origin has caused tens of thousands of deaths, mostly among young men, and occupational heat stress has emerged as its main driver, with sugarcane cutters regarded as a sentinel population (Wesseling et al., 2020). Prevention appears feasible: a water–rest–shade intervention introduced midharvest in El Salvador appeared to halt declining kidney function among cane cutters, although a similar program in Nicaragua was insufficient for workers with the heaviest workloads (Wesseling et al., 2020). Taken together, this evidence shows that manual cane work combines several serious hazards. The evidence base is, however, geographically narrow: a recent scoping review found that nine of 12 studies of sugarcane workers' health came from Brazil and called for research elsewhere (Ruths et al., 2023).

Sugarcane Work in Guyana

Sugar has long been central to Guyana's economy and rural life. At the time of the 2016–2017 closures of the Wales, East Demerara, Rose Hall, and Skeldon estates, the state-owned Guyana Sugar Corporation was the country's largest employer, with about 16,000 staff, and an estimated one-fifth of the population depended indirectly on the industry (United Nations Guyana, 2021). A sugar workers' union expected about 800 workers to lose their jobs with the closure of Rose Hall (Chabrol, 2017), and more than 400 received redundancy letters in late 2017 ("Over 400 Rose Hall Workers Laid Off," 2017). A study funded by the ILO later found that the livelihoods of laid-off sugar workers had been severely compromised: many felt too old to be considered by new employers, still had children in school, and were unsure

whether their skills would be valued outside the industry (United Nations Guyana, 2021). Rose Hall Estate was officially reopened in September 2023 (Department of Public Information, Guyana, 2024). Guyana has since been reclassified by the World Bank as a high-income economy (World Bank, 2026), yet its cane is still harvested by hand after pre-harvest burning.

Occupational safety in Guyana is governed by the Occupational Safety and Health Act 1997, which applies to agricultural undertakings as well as industrial establishments (Occupational Safety and Health Act, 1997). In 2018, the National Advisory Council on Occupational Safety and Health, working with the Ministry of Social Protection and the ILO, published a national policy on occupational safety and health (Government of Guyana, 2018). Penalties under the Act have nevertheless been modest; employers could be fined as little as G$7,500 for failing to equip workers with necessary safety gear, and in 2021 the government indicated that it was seeking stronger penalties ("Workplace Accidents," 2021).

Published research has not examined how this legal and policy framework operates on sugar estates, and research on the health of Guyanese cane workers remains sparse, dated, and indirect. A community survey published in 1971 found chronic bronchitis to be more common among field laborers on sugar estates, but it was not designed to study cane workers or their working conditions (Miller & Ashcroft, 1971). A household survey linked cane burning to self-reported disease among residents of communities near two estates, but it did not assess the workers themselves (Gamell et al., 2020). A qualitative study explored cane workers' experiences of occupational health but did not measure exposures, use of protective equipment, or physical health outcomes (Naipaul et al., 2026). As a result, there are no recent quantitative data on the respiratory health of Guyana's cane workers, on the hazards they encounter, or on whether they are protected from them, and, to our knowledge, no such data from elsewhere in the Caribbean.

The Purpose of This Study

Agricultural workers face substantial respiratory hazards, and their protection often depends on equipment, training, and enforcement that are unevenly provided. Manual sugarcane harvesting concentrates these hazards, combining smoke from pre-harvest burning with dust and agrochemicals, yet the evidence on cane workers' respiratory health comes overwhelmingly from Brazil. In Guyana, sugar remains central to rural livelihoods and cane is still burned and cut by hand, but the little research available is decades old or has focused on nearby communities and on workers' experiences. The respiratory health of the workforce, the exposures workers face, and the extent to which they are protected have not been documented in recent research. This gap matters now: without baseline data, employers, health services, and regulators have no basis on which to set priorities, and if harvesting practices change, as they are changing in other producing countries, there will be no reference point against which to judge whether workers' health improves.

The purpose of this study was therefore to provide a current description of respiratory health and related exposures among field workers on a Guyanese sugar estate. Specifically, we aimed to (a) estimate the prevalence of self-reported respiratory symptoms, (b) describe self-reported workplace exposures and smoking, and (c) describe the use of PPE. The study was descriptive, so no formal hypotheses were tested. In addressing these aims, the study extends research on sugarcane workers beyond Brazil to an under-studied Caribbean workforce, and provides baseline data against which future changes in working conditions can be assessed.

METHODS

Study Design and Participants

A cross-sectional survey was conducted and is reported following the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines (von Elm et al., 2007). The study took place at Rose Hall Estate, a large state-owned sugarcane estate in Guyana employing approximately 250 field workers; the estate had previously been closed and was officially reopened in September 2023 (Department of Public Information, Guyana, 2024). Cane in Guyana is harvested by hand in two seasons each year (February to April and July to December), and fields are burned before cutting to remove dry leaves. Field work at the estate includes manual harvesting as well as other field tasks, including pesticide application by spraying gangs, so that individual workers may encounter smoke, dust, and agrochemicals at different times of the year.

Eligible participants were field workers with at least six months of continuous employment at the estate. Participants were recruited by convenience sampling at the estate compound before and after shifts; probability sampling was not feasible, as work schedules were irregular and workers were dispersed across the estate and rarely present at the compound at the same time. The target sample size of 152 was calculated a priori to estimate a prevalence of 50% (the most conservative assumption) with a 5% margin of error at 95% confidence, applying a finite population correction for the approximately 250 field workers employed at the estate. Within the study period, 99 workers were recruited (65% of the target), as recruitment was constrained by workers' availability during field activities and by time limitations; all workers approached agreed to take part. As planned in the study protocol, the analysis of survey data was descriptive, and the precision of each estimate is reported as a 95% confidence interval (CI). With 99 participants, the maximum half-width of a 95% CI for a prevalence estimate is just under 10 percentage points rather than the 5 points originally targeted, which remains sufficient to describe the burden of common symptoms and exposures with useful precision.

Data Collection

Data were collected in May and June 2025, between the two harvest seasons, at the estate compound before and after shifts. A structured questionnaire, developed for this study by the investigators and piloted with 10 workers for clarity given variable literacy, comprised 48 items covering demographics, workplace exposures, respiratory health history and symptoms, and healthcare access. This report presents the items on demographics, smoking, workplace exposures, protective equipment use, and respiratory symptoms; their wording is shown in Table 1.

Table 1. Questionnaire Items Analyzed in This Study

Domain	Question	Response options
Demographics	What is your sex?	Male; female
	How old are you?	Open (grouped for analysis)
Smoking	Are you a smoker?	Yes; no
Protective equipment	Do you use any protective equipment (masks, gloves) during work?	Yes; no
Workplace exposure	In your day of work, are you exposed to any of the following pollutants?	Smoke; dust; pesticide; other
Symptoms on	On the days of burning trash, do you	Coughing; ongoing nighttime

Domain	Question	Response options
burning and spraying days	experience any of the following?	coughs; wheezing; difficulty breathing; prolonged or excess coughs with colds
	After a day in the spraying gang, do you experience any of the following?	Same options as above
Symptoms while working	Do you experience coughing while working?	Yes; no
	Do you experience wheezing while working?	Yes; no
	Do you experience shortness of breath while working?	Yes; no
Symptoms away from work	Do your symptoms improve when you are away from work?	Yes; no

Note. Items are reproduced from the questionnaire developed for this study, with minor corrections to spelling.

Coughing, wheezing, and shortness of breath were asked about as symptoms experienced while working and on days of trash burning or pesticide spraying; nighttime cough was asked about in relation to burning and spraying days; and workers were asked whether their symptoms improved away from work. All symptom items analyzed were answered yes or no and did not specify a fixed recall period. Each participant was guided through the questionnaire by a member of the study team, who explained terms and assisted workers who had difficulty with reading or medical terminology. The remaining items, on respiratory health history and healthcare access, were outside the scope of this report, which focuses on current symptoms, exposures, and protective behaviors, and are not presented; the complete questionnaire is available from the corresponding author on request.

Measures

Sex was recorded as male or female, and age was recorded in years and grouped for analysis as 18–30, 31–45, and 46 years or older. Current smoking was recorded as a yes-or-no response. Workplace exposure was assessed with a single item asking whether workers were exposed to smoke, dust, pesticides, or other pollutants during their working day; each exposure was analyzed as a separate yes-or-no variable. Use of protective equipment was assessed with a single yes-or-no item that gave masks and gloves as examples and did not distinguish between types of equipment.

Four respiratory symptoms were analyzed: coughing, shortness of breath, wheezing, and nighttime cough. For coughing, wheezing, and shortness of breath, a worker was classified as reporting the symptom if he or she reported it while working or on days of burning or spraying; nighttime cough was taken from the items on burning and spraying days. This inclusive definition counted a symptom reported in any of the settings asked about, so the resulting prevalence estimates are likely to be higher than those obtained with standardized definitions. Improvement of symptoms away from work was analyzed as a separate yes-or-no variable.

Data Analysis

Data were analyzed in IBM SPSS Statistics for Windows, Version 27 (IBM Corp., Armonk, NY, USA). The analysis was descriptive: categorical variables are presented as frequencies

and percentages, and 95% CIs for prevalence were calculated using the Wilson score method, which performs better than the conventional normal-approximation interval for proportions estimated from modest samples and for proportions close to 0% or 100% (Brown et al., 2001). Percentages were calculated using all 99 participants as the denominator; one response on dust exposure and two on pesticide exposure were missing, so the corresponding percentages are, if anything, slight underestimates. This report does not examine associations between exposures and symptoms; with subgroups of this size (28 smokers, 29 workers using protective equipment, and three women), such comparisons would have had limited power. Where informative, the minimum number of workers reporting a combination of characteristics (for example, two exposures together, or an exposure without protective equipment) was derived from the marginal counts: the number of workers reporting both of two characteristics is at least the sum of those reporting each, minus the total sample. These bounds are conservative. Percentages are reported to one decimal place, and figures were prepared in Microsoft Excel.

Ethical Considerations

The study was approved by the Institutional Review Board of the Ministry of Health, Guyana (approval number: 022/2025; approved March 20, 2025, before data collection began), and was conducted in accordance with the Declaration of Helsinki. Participation was voluntary. The study purpose was explained verbally to account for varying literacy, and all participants gave written informed consent by signature or mark; data were anonymized.

RESULTS

All 99 workers who were approached agreed to take part, and all completed the questionnaire. Item-level missing data were minimal: one worker did not answer the question on dust exposure and two did not answer the question on pesticide exposure, and there were no missing responses for the other items analyzed. All analyses are therefore based on the full sample of 99 workers, and participant characteristics and exposures are summarized in Table 2.

Table 2. Characteristics and Self-Reported Workplace Exposures of Sugarcane Field Workers (N = 99)

Characteristic	*n*	%	95% CI
Sex			
Male	96	97.0	[91.5, 99.0]
Female	3	3.0	[1.0, 8.5]
Age group, years			
18–30	27	27.3	[19.5, 36.8]
31–45	46	46.5	[37.0, 56.2]
≥46	26	26.3	[18.6, 35.7]
Current smoker	28	28.3	[20.4, 37.8]
Workplace exposure			
Dust[a]	98	99.0	[94.5, 99.8]
Smoke	95	96.0	[90.1, 98.4]
Pesticides[b]	65	65.7	[55.9, 74.3]
Uses protective equipment (masks, gloves)	29	29.3	[21.2, 38.9]

Note. Percentages are of all participants. 95% confidence intervals (CIs) were calculated using the Wilson score method. Data were collected at Rose Hall Estate, Guyana, in May and June 2025. *n* = number of participants. [a]One missing response. [b]Two missing responses.

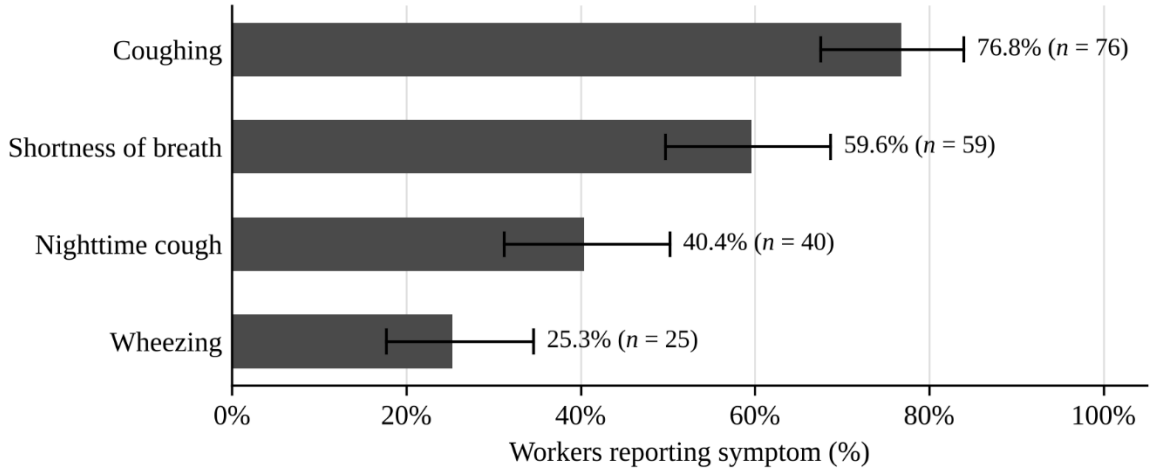
As shown in Table 2, the workforce was almost entirely male, and no single age group made up a majority: nearly half of the workers were aged 31–45 years, with roughly a quarter in each of the younger and older age groups. More than a quarter of participants were current smokers.

Self-reported exposure to dust and to smoke was almost universal, and about two-thirds of workers reported pesticide exposure (Table 2). As workers could report more than one exposure, the marginal counts also indicate how commonly exposures occurred together. At least 94 workers (94.9%) reported exposure to both dust and smoke, and at least 60 (60.6%) reported exposure to all three of dust, smoke, and pesticides. For most of the workforce, therefore, exposure was not to a single hazard but to a combination of respiratory hazards in the course of their work.

Fewer than one in three workers reported using any protective equipment, such as masks or gloves, during work (Table 2); about seven in 10 reported using none. Set against the near-universal exposures described above, this represents a substantial protection gap. At least 69 workers (69.7%) reported exposure to dust without using any protective equipment, and at least 66 (66.7%) reported exposure to smoke without protection. The item also counted gloves, which offer no respiratory protection, and did not distinguish respirators from cloth or surgical masks, so the share of workers with any respiratory protection was at most 29.3%, and the share with effective respiratory protection is likely to have been lower still.

Coughing was the most frequently reported symptom, reported by about three in four workers, followed by shortness of breath, reported by more than half, so that the symptom profile was dominated by cough and breathlessness. Nighttime cough and wheezing were less frequent but were each reported by at least one in four workers (Figure 1). Most workers (n = 80, 80.8%, 95% CI [72.0, 87.4]) reported that their symptoms improved when they were away from work. This percentage uses all 99 workers as its denominator; among workers who reported symptoms, the proportion is likely to be higher. A perceived link between work and respiratory symptoms was therefore widespread across the workforce.

Figure 1. Prevalence of Self-Reported Respiratory Symptoms Among Sugarcane Field Workers (N = 99)



Note. Bars show the percentage of workers reporting each symptom; error bars show 95% confidence intervals (CIs) calculated using the Wilson score method. Prevalence (95% CI): coughing 76.8% [67.5, 84.0]; shortness of breath 59.6% [49.7, 68.7]; nighttime cough 40.4% [31.3, 50.3]; wheezing 25.3% [17.7, 34.6]. n = number of participants.

DISCUSSION

To our knowledge, this is the first study to focus specifically on the respiratory health of sugarcane field workers in Guyana. Its findings describe a workforce in which respiratory symptoms are common, exposure to several respiratory hazards is near universal, and protection is largely absent. Taken in the context of the wider literature, this pattern suggests that the respiratory hazards documented among manual cane workers in Brazil are not confined to one country's industry and may be present wherever cane is burned and cut by hand, including in the Caribbean, where such evidence has been scarce.

The burden of symptoms is consistent with studies of cane cutters in Brazil, where respiratory symptoms increased during the burnt-cane harvest, more markedly among workers than among town residents (Prado et al., 2012), and with reviews that identify respiratory effects as a recurring consequence of manual cane work (Leite et al., 2018; Stem et al., 2024). The prevalence of cough in this study also exceeds the 20.5% reported among Ethiopian farmers (Woldeamanuel et al., 2020), although that study used a standardized questionnaire for chronic symptoms, so the figures are not directly comparable. Even allowing for differences in measurement, the contrast is consistent with the possibility that pre-harvest burning adds to the respiratory hazards of agricultural work in general (Le Blond et al., 2017; Prado et al., 2012).

The finding that most workers' symptoms eased away from work is perhaps the most informative for interpreting the results. In clinical practice, improvement away from work is a key feature raising suspicion of work-related respiratory disease, including occupational asthma (Tarlo & Liss, 2003). Work-related respiratory disease is often reversible in its early stages, but continued exposure can lead to persistent airway disease, and occupational exposures account for a substantial share of asthma and chronic obstructive pulmonary disease in the general population (Blanc et al., 2019). Symptoms that improve away from work may therefore mark a window in which prevention can still change the course of disease. Without spirometry, this study cannot determine how many workers already have fixed airflow limitation, but the pattern suggests that exposure reduction now could prevent chronic disability later.

The timing of the survey also shapes how the findings should be read. The questions referred to symptoms experienced at work and on burning and spraying days, so the results reflect workers' overall experience of their working conditions, including recent harvest periods, rather than symptoms confined to the time of the survey. Much of the literature on cane workers has focused on the burning season (Le Blond et al., 2017; Prado et al., 2012), but exposure to soil dust and agrochemicals continues throughout the year (Leite et al., 2018; Stem et al., 2024). The near-universal reporting of dust exposure in this study supports the argument that prevention and surveillance should not be limited to the harvest.

The co-occurrence of exposures has important implications. Agricultural workers typically encounter mixtures of dusts, gases, and chemicals rather than single agents (American Thoracic Society, 1998; Linaker & Smedley, 2002), and the present findings indicate that this is true of cane work in Guyana, where almost all workers reported more than one respiratory hazard. This has two consequences. First, symptoms cannot be attributed to any single exposure, and the combined effect of several irritants may be greater than that of any one. Second, measures that address only one hazard, such as reducing burning without controlling

dust or chemical exposure, are unlikely to be sufficient on their own. Prevention on cane estates needs to address the full range of respiratory hazards that workers encounter.

Low use of protective equipment is the most actionable finding. Although the measures are not directly comparable, protection in this workforce appears no better than the low levels reported among agricultural pesticide handlers internationally, fewer than half of whom wear masks and only a small minority respirators (Sapbamrer et al., 2021). Even the reported level overstates respiratory protection: the survey item included gloves and did not distinguish respirators from cloth or surgical masks, which offer little protection against fine particles (Shakya et al., 2017). The pattern mirrors findings among agricultural workers elsewhere, where PPE use is shaped by education, income, and previous experience of illness (Sapbamrer & Thammachai, 2020), and where common barriers such as discomfort, limited availability, and lack of training are within employers' control (Damalas & Koutroubas, 2016). The choice of equipment matters as well: the respiratory equipment available to farmers in low- and middle-income countries varies widely in effectiveness, and equipment that is uncomfortable in hot conditions is unlikely to be worn consistently (Sapbamrer et al., 2021). Provision of respirators without fit, training, and attention to comfort is therefore unlikely to deliver real protection.

Smoking adds a further, modifiable risk. Tobacco smoke and occupational exposures may act together to increase the risk of chronic respiratory disease (Blanc et al., 2019), and in agricultural populations the excess respiratory morbidity attributable to work has been observed even where smoking is less common than in the general population (American Thoracic Society, 1998). Smoking cessation support therefore belongs in workplace health programs, but it should complement rather than replace measures to reduce occupational exposure; focusing on workers' smoking alone would risk shifting responsibility for work-related disease onto the workers themselves.

Exposure is also unlikely to end at the estate boundary. Communities near cane fields are exposed to smoke during the burning season, with measurable effects on respiratory health (Arbex et al., 2007; Cançado et al., 2006), and farm workers' families often share their exposure to agricultural hazards (American Thoracic Society, 1998). In Guyana, households near sugar estates have reported disease that they attribute to cane burning (Gamell et al., 2020). If workers in this study live in such communities, the improvement in symptoms they report away from work may understate the contribution of burning to their respiratory health, as smoke may follow them home. Respiratory protection for cane workers and environmental protection for estate communities are therefore closely linked.

The findings should also be read against the social and economic context of sugar work in Guyana. The estate where this study took place was closed and many of its workers made redundant in 2017 before it reopened in 2023 (Department of Public Information, Guyana, 2024; "Over 400 Rose Hall Workers Laid Off," 2017). Workers who have experienced job loss may be reluctant to raise health concerns or to decline hazardous tasks. If so, self-reported symptoms may understate the true burden, and lasting improvement is unlikely to come from individual behavior change alone.

The age structure of the workforce adds to this picture. Nearly three quarters of the workers (72.7%) were aged 31 years or older, and more than a quarter (26.3%) were 46 or older. Length of service was not recorded, but many of these workers are likely to have

accumulated years of exposure to smoke, dust, and agrochemicals. Older sugar workers laid off in the estate closures reported feeling too old to be considered by new employers (United Nations Guyana, 2021). For this group in particular, leaving cane work may not be a realistic option, which makes the quality of protection on the estate all the more important. For younger workers, effective prevention now could avert decades of cumulative exposure.

Governance is a further part of this context. Guyana has a legal framework that covers agricultural undertakings (Occupational Safety and Health Act, 1997) and a national policy on occupational safety and health (Government of Guyana, 2018). Yet penalties for failing to provide safety equipment have been modest ("Workplace Accidents," 2021), and the low use of protective equipment observed here suggests a gap between legal provision and practice, of the kind the ILO (n.d.) has described across agricultural sectors where labor inspection and training are limited. Closing this gap will depend less on new legislation than on inspection, enforcement, and the involvement of workers and their representatives in decisions about workplace safety.

The study has several strengths. To our knowledge, it is the first study to focus specifically on the respiratory health of cane workers in Guyana, and it adds recent Caribbean evidence to a literature dominated by Brazilian studies. Every worker approached agreed to take part and completed the questionnaire, and item-level missing data were minimal. The questionnaire was piloted with workers and administered face to face, which allowed terms to be explained and made participation possible for workers with limited literacy. Prevalence estimates are reported with confidence intervals, the study is reported following the STROBE guidelines, and the wording of all items analyzed is provided so that the findings can be replicated and compared in future research.

Implications

These findings may be relevant to manual cane workforces across the Caribbean, Central America, Africa, and Asia, where burning persists (Chaya, 2024). For estate managers and safety practitioners, the hierarchy of controls, which ranks PPE last (National Institute for Occupational Safety and Health, 2024), and the ILO's agricultural safety convention (ILO, 2001) point to reducing burning and, where exposure remains, providing fitted respirators with training. As producers move toward unburnt, mechanized harvesting (Chaya, 2024), these baseline data will help judge whether workers' respiratory health improves, while the social consequences of mechanization for a workforce that has already experienced large-scale redundancy will also need attention.

At the workplace level, a respiratory protection program should include selection of respirators suited to the particles and conditions of cane work, fit testing, training in correct use, and provision of replacements, rather than simply making masks available. Burning schedules, wind direction, and the distance between burning and cutting crews could be managed to reduce exposure, and workers could be consulted on which measures are practical in the field. Health education should help workers recognize persistent cough, wheezing, and breathlessness as reasons to seek care rather than as an expected part of the job. For rural healthcare providers, a brief occupational history can identify workers needing assessment for occupational asthma or chronic airway disease, and periodic symptom questionnaires combined with spirometry would allow early detection of disease among workers with ongoing exposure.

For the national occupational safety and health system, the findings point to priorities for implementing existing policy. Agricultural estates could be explicitly included in inspection plans under the national policy on occupational safety and health (Government of Guyana, 2018), the notification of occupational diseases already provided for under the Occupational Safety and Health Act 1997 could be applied consistently to respiratory disease, and the health and labor sectors could collaborate on surveillance of workers in high-risk industries. Workers' organizations also have a role: involving unions and worker representatives in the design and monitoring of protective measures is likely to make those measures more acceptable and more durable.

The study also has implications for how occupational health evidence is gathered in settings like this one. A short, guided questionnaire was sufficient to document symptoms, exposures, and protection among workers with varying literacy. Similar brief surveys could be built into routine estate health and safety activities at low cost, giving managers, unions, and regulators a practical means of monitoring whether conditions improve over time rather than relying on occasional research studies.

Limitations and Future Research

This study has several limitations. The sample was smaller than planned and was recruited by convenience at a single estate, so the findings may not represent cane workers elsewhere in Guyana, and the target precision of ±5 percentage points was not achieved, although all 95% CIs remained within about ±10 points. As the analysis was descriptive, the study cannot show whether PPE use, smoking, or specific exposures were related to symptoms, and with only three women in the sample, the findings may not apply to female workers. The cross-sectional design cannot establish causality, and a healthy worker effect, in which the workers most affected by symptoms have already left the workforce, may have led to underestimation of symptom prevalence (Li & Sung, 1999).

Measurement was also limited. Symptoms and exposures were self-reported using a study-specific questionnaire rather than standardized instruments such as the British Medical Research Council and American Thoracic Society respiratory questionnaires (Woldeamanuel et al., 2020), which limits comparison with other studies. No spirometry or exposure measurement was performed, and the item on protective equipment did not distinguish respirators from cloth or surgical masks, or from gloves. The exposure item also asked about smoke without specifying its source, although cane burning is the most likely source in this setting. The symptom items had no fixed recall period, and some referred to burning and spraying days, so the findings cannot separate symptoms during the harvest from those between seasons and may be affected by recall bias. The inclusive symptom definition is also likely to have produced higher prevalence estimates than standardized definitions would. Face-to-face administration by the study team may also have introduced interviewer or social desirability bias.

Future research should address these limitations and extend the evidence base. Surveys using standardized, time-anchored symptom questionnaires and spirometry, timed to compare harvest and non-harvest periods and combined with personal exposure monitoring, would provide more precise and comparable estimates. Larger, multi-site studies are needed to examine PPE use and smoking as determinants of symptoms, and these should deliberately include women working in the sugar industry. Given evidence from Mesoamerica (Wesseling et al., 2020), heat stress and kidney function among Guyanese cane workers also warrant

study. Beyond the workplace, studies of household exposure in estate communities would clarify how much of workers' respiratory burden arises outside working hours, and qualitative research with workers, managers, and inspectors could explain why protective equipment is so rarely used and how occupational safety law is applied in practice. Finally, interventions such as respirator programs and unburnt, mechanized harvesting should be evaluated for their effects on health and livelihoods, as well as for their costs and acceptability to workers and estates.

CONCLUSION

Self-reported respiratory symptoms were common among sugarcane field workers on this Guyanese estate, and most workers reported that their symptoms eased away from work, consistent with a work-related origin. Few workers used protective equipment, despite near-universal exposure to dust and smoke. Dust and agrochemical exposures continue throughout the year, and most workers were exposed to several hazards at once; prevention should therefore address dust, smoke, and agrochemicals together and should not be limited to the burning season. Reducing pre-harvest burning, providing properly fitted respirators with training, supporting smoking cessation, and introducing routine respiratory surveillance are practical steps for estates and health services wherever sugarcane is still burned and harvested by hand. These measures will be most effective if they are backed by consistent enforcement of existing occupational safety law and developed with the participation of workers themselves. The baseline data reported here also provide a reference point for judging whether future changes in harvesting practices, regulation, and working conditions improve workers' respiratory health. This study offers a starting point; sustained attention from employers, health services, regulators, and researchers will be needed to build on it. Protecting these workers is not only a clinical concern but also a question of decent work in an industry on which many rural Guyanese families depend.

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