

# Air pollution and workers' health in Cambodia's garment sector



## SEI policy brief March 2023

Him Chandath<sup>1</sup>  
Ing Chhay Por<sup>1</sup>  
Yim Raksme<sup>2</sup>  
Diane Archer<sup>3</sup>

<sup>1</sup> Department of Air Quality, Noise and Vibration Management, General Directorate of Environmental Protection of Ministry of Environment of Cambodia

<sup>2</sup> National Consultant

<sup>3</sup> Stockholm Environment Institute

This policy briefing draws on a longer report prepared by the Ministry of Environment: Chandath, H., Chhay Por, I., Sokyimeng, S., Dana, S., Raksme, Y. 2023. *Understanding Air Pollution in the Garment Sector and Health Impacts on Workers: A Cambodian Case Study*. Ministry of Environment, Cambodia. <https://epa.moe.gov.kh/pages/categories/view/document-daqnm>

## Key Messages

- Garment factories' particulate matter levels complied with Cambodian national air quality standards and World Health Organization (WHO) guidelines on the day of assessment for the study on which this brief is based; however, some factories had higher indoor and outdoor readings than reference values in the area.
- Only half of the factory owners interviewed conducted air quality monitoring on a regular basis (6 monthly or annually). Not enough was done to ensure workers were aware of their exposure to air pollution.
- Nearly all the factory workers (99%) interviewed reported that the air quality within their workplace was satisfactory, but most thought "air quality" referred to temperature. All the interviewed workers experienced at least one symptom related to air pollution.
- The garment sector employs mostly female workers; therefore, air pollution precautions and policies should ensure provisions that address the specific needs of women workers.

The garment sector is one of the most important manufacturing industries in Cambodia, contributing 19% to gross national product and 72% of the nation's export earnings. As of 2015, Cambodia has 640 officially registered garment and footwear factories (Merk & Nuon, 2016). The garment and footwear factories provide about 77% of all manufacturing work in Cambodia (Merk & Nuon, 2016).

The sector is also the largest for formal employment and has a majority female workforce: textile factories employ 80% women (ILO, 2018), with the sector representing about 8% of women's total employment and over one-third of all paid employment for all women in Cambodia (Asian Development Bank, 2013). The manufacturing sector employs 840 000 female workers, compared with 475 000 male workers (Kingdom of Cambodia, 2019).

The sector has expanded formal employment of women and indirectly supported their thousands of family members, as well as service providers in industrial zones such as food sellers (Lawreniuk & Nuon, 2022). However, the sector also includes unregistered subcontracting factories, which fall outside the mandate of the Better Factories Cambodia program; these are less likely to apply labour rights principles and comply with regulations, opening up opportunities for worker abuse and unsafe work conditions.

While the garment sector serves as Cambodia's economic backbone and creates much-needed jobs, it is also a highly polluting industry, alongside being regularly implicated

IMAGE (ABOVE): Courtesy of Chandath Him

---

for not upholding labour rights. The sector emits pollutants to air from intensive energy use, solid and hazardous waste emissions, noise pollution and wastewater pollution discharge (MOE & GGGI, 2016). Despite this, the sector's environmental impacts in Cambodia, particularly in relation to air pollution, are not well known, and this gap was highlighted in the development of Cambodia's 2021 Clean Air Plan.

Aiming to fill this gap, in cooperation with SEI, the Air Quality and Noise Management Department of the General Directorate of Environmental Protection of Cambodia's Ministry of Environment conducted a research project to improve understanding of air pollutant emissions from the textile industry and the health impacts on workers in Cambodia's garment industry. The study drew on in-depth interviews with 323 garment factory workers across 16 factories, interviews with 16 factory owners, and quantitative data to better understand all interviewees' experiences with occupational air pollution. While the research documented any symptoms related to air pollution, it did not employ medical research to assess the workers' health status, nor did it attempt to investigate the cost or impact of air pollution on factory production.

The findings of this study seek to inform and enable policymakers to introduce interventions for improving occupational air pollution, including addressing air pollution, pollution sources and other related issues. Such interventions will help to uphold the health of workers as a human right, ensure safe workplaces, and also be beneficial for the country's economic growth, as a healthy workforce is more productive.

## Findings

Monitoring showed that sources of workplace pollution included emissions from stacks of boilers or generators, small working buildings or workspaces with high numbers of workers, or sites lacking cooling fans or ventilation systems. Below are results from air quality monitoring and interviews with workers and factory owners.

### Emissions from factories

The study surveyed 16 garment factories in four provinces of Cambodia: Phnom Penh, Kandal, Kampong Speu and Sihanouk. At each location, two sampling sites were selected to assess the air quality of each factory: inside the factory to represent indoor air quality and outside the factory to represent outdoor air quality. Indoor and outdoor air quality data were measured over 8 hours, from 8:00 to 16:00 hours, and compared to the nearest reference pollution monitoring station, in order to understand the differences in exposure level for workers in the factory.

All 16 factories used electricity as the main fuel source; in addition, 11 also used liquefied petroleum gas (LPG), 5 used wood, 3 used diesel, and 1 used biomass. Of the 16 factories, 7 used three fuel sources, 4 used two, and 4 only used electricity, while 1 factory used four fuel sources. Electricity, in comparison to the other fuel sources, would generate indirect emissions at the point of the power plant, whereas the other fuel sources generate emissions directly on-site.

Four categories of toxic compounds were measured for the air quality sampling: particulate matter at 2.5 microns and 10 microns ( $PM_{2.5}$  and  $PM_{10}$ , respectively), nitrogen oxides (NOx) and non-methane volatile organic compounds (NMVOCs). Of the  $PM_{2.5}$  emissions detected at the factories, the majority came from the five factories that used wood as a fuel source, which is indicative of the significantly higher emissions connected with burning solid fuel in comparison to other fuels (diesel and LPG).

---

In terms of emissions of other pollutants, NOx and NMVOCs, the five wood-using factories emitted the most. Compared to indirect emissions relating to electricity consumption, direct fuel consumption at factories was the major source of emissions for all air pollutants taken into account.

The snapshot of particulate matter concentrations provided by the monitoring in 16 factories provides the following insights:

- Indoor and outdoor concentrations in factories on the day of assessment complied with the WHO guideline levels for the protection of human health (15g/m<sup>3</sup> 24-hour average or 5g/m<sup>3</sup> annual average for PM<sub>2.5</sub>, and 45g/m<sup>3</sup> 24-hour average or 15g/m<sup>3</sup> annual average for PM<sub>10</sub>).
- Indoor PM<sub>2.5</sub> and PM<sub>10</sub> concentrations in many cases were similar or lower than outdoor and reference concentrations. However, five factories had indoor PM<sub>2.5</sub> concentrations substantially elevated compared to outdoor concentrations. Such measurements typically indicate that outdoor air has infiltrated indoors, bringing particulate matter with it, rather than coming from an indoor source.
- The higher exceedance of reference particulate matter measures at wood-burning factories suggests that using wood as a feedstock fuel for the garment manufacturing process may contribute to higher particulate matter concentrations.
- The five factories using wood were the most polluting in terms of emissions of other pollutants, such as NOx and NMVOCs, but for these pollutants other fuels, such as diesel, gasoline and LPG, also had substantial emissions associated with them.

For all air pollutants considered, the direct fuel consumption at factories contributed the majority of emissions compared with indirect emissions. For greenhouse gas emissions, such as carbon dioxide (CO<sub>2</sub>), indirect emissions at power stations were the largest source of CO<sub>2</sub> emissions from the garment factory operations; a significant contribution also came from direct consumption of LPG, diesel and gasoline in garment factories themselves.

## **Workers' experiences with and understanding of air pollution**

In order to gather insights into workers' experiences with and understanding of air pollution, the research team interviewed 323 workers from 16 textile factories across Cambodia.

### **Gendered exposures to air pollution within garment factories**

Of the workers interviewed, 83% of respondents were women and only 16% were men. The stark gender disparity highlights the gendered nature of garment factory work. Indeed, the total number of employees working in garment and footwear in Cambodia is estimated at around 1 million workers, and nearly 80% are women (International Labour Organization, 2018). Furthermore, the interview data also indicate that the workforce is relatively young; among the interviewees, 22% were 18 to 25 years old; 49%, 25 to 35; 26%, 35 to 45; and only 3%, 45 to 55. The disproportionate representation of young women in garment factory work aligns with the industry's preference across Asia for employing young women, who typically migrate from rural provinces and find waged labour at garment factories out of economic necessity and will accept lower wages. Considering this gender imbalance in employment, we did not find any significant difference in results between men and women in terms of their perceptions of air quality and its effects (Table 1).

Table 1. Key results from survey disaggregated by gender

Does working in the factory affect your health? %			
	Yes	No	No Idea
Male (n=53)	7.55	90.57	1.89
Female (n=270)	5.55	93.7	0.74

Do you wear PPE? %		
	Yes	No
Male (n=53)	86.79	13.21
Female (n=270)	87.41	12.59

What do you think of air quality in the workplace? %						
	Acceptable	Good	No idea	N/A	Bad	Acceptable (hot)
Male (n=53)	90.57	9.43	0.00	0.00	0.00	0.00
Female (n=270)	86.67	8.65	0.37	0.37	0.37	0.37

### Lack of understanding of air pollution

Most workers were unsure what “air quality” means or entails, with many equating it with temperature. As a result, many workers were uncertain what type of symptoms or diseases are caused by air pollution. Almost all the interviewed factory workers (99%) said that the air quality within their workplace was acceptable but that sometimes they felt hot, especially in the dry season (Table 1).

Despite this misunderstanding, when workers were asked about their experiences with specific symptoms, the results showed all the interviewed workers experienced at least one of the symptoms that can be related to air pollution (see Figure 1). Women reported very slightly higher incidence of symptoms compared to men (Table 2), with 2.4% of women reporting symptoms “often” compared to less than 1% of men. However, in terms of perceptions, women were less likely to think that air quality affected their health (Table 1).

Figure 1. Frequency of symptoms experienced by workers at the factory, gender disaggregated

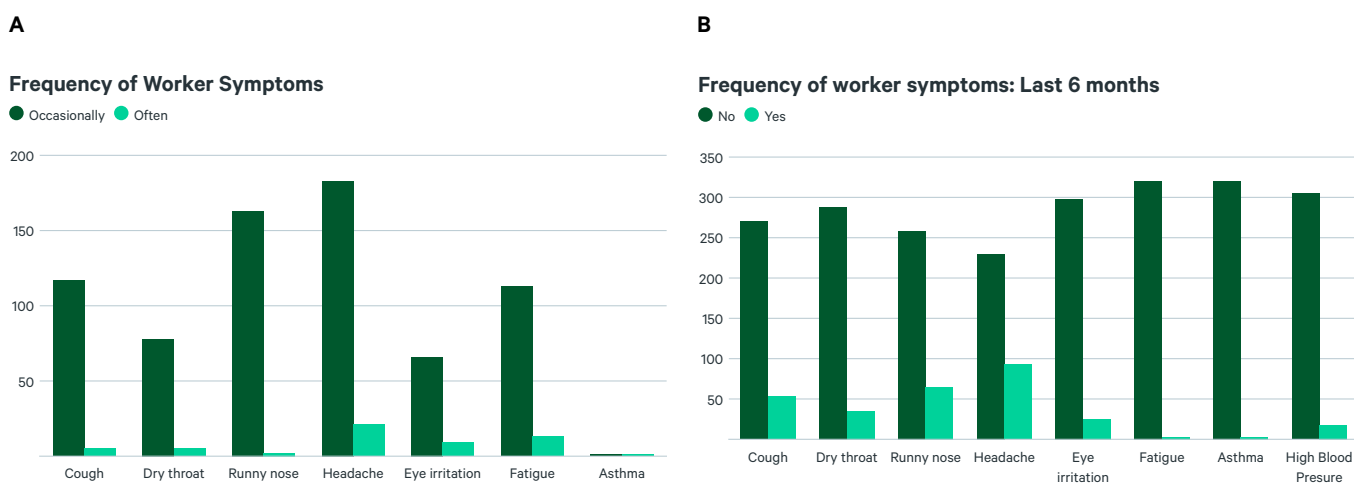


Table 2. Gender differences in reported frequency of symptoms

<b>Male</b>			
	<b>Often</b>	<b>Occasionally</b>	<b>Never</b>
Cough	0	16	37
Dry throat	0	12	41
Runny nose	0	24	29
Headache	1	24	28
Eye irritation	1	12	40
Fatigue	1	18	34
Asthma	0	1	52
Other	0	0	53
<b>Total (424)</b>	<b>3</b>	<b>107</b>	<b>314</b>
Percentage	1%	25%	74%
<b>Female</b>			
	<b>Often</b>	<b>Occasionally</b>	<b>Never</b>
Cough	5	101	164
Dry throat	5	66	199
Runny nose	2	139	129
Headache	20	159	91
Eye irritation	8	54	208
Fatigue	12	95	163
Asthma	1	0	269
Other	0	2	268
<b>Total (2160)</b>	<b>53</b>	<b>616</b>	<b>1491</b>
Percentage	2%	28%	69%

## Factory owners' experiences with and understanding of air pollution

All 16 interviewed factory owners took actions to improve air quality and prevent their workers from air pollution exposure: for example, they reported that they stored chemicals and raw materials properly and separated from production buildings, private companies collected wastes, and they provided protective equipment as well as knowledge on safety practices/health protection to workers. However, only 50% of the factory owners conducted air quality monitoring either annually or once a year, according to their interview responses.

They reported trying to take actions in order to improve the air quality in their factory. Examples included the installation of cooling fans or ventilation systems; the allocation of numbers of workers according to building size; and energy-saving practices (use of energy-efficient machinery and appliances, promoting energy-saving habits); as well as the separation of production buildings from storage or material buildings. They perceived the air quality in different buildings as acceptable, especially if the production building was equipped with fans and exhaust fans or had a water cooler or drinking water for workers to cool themselves.

---

## Policy recommendations

In light of the findings above, we suggest several policy recommendations to address the issues raised in terms of gender disparities, awareness of air quality and the risks that air pollution can cause.

Foremost is that while manufacturing sites comply with the Cambodian national air quality standards, the air quality at these sites can be well above thresholds recommended by the WHO to prevent harm to human health; the Cambodian national air quality standards could be strengthened to align with WHO standards.

Indoor and outdoor air pollution policies and regulations have been developed by Cambodia's Ministry of Environment and partner agencies and should be scaled up to all factories. For example, the programme "Resource Efficient and Cleaner Production" run by Cambodia's Ministry of Industry, Sciences, Technology, and Innovation (MISTI) aims to reduce emissions in the industrial sector, while International Labour Organization (ILO) runs a "Better Factories Cambodia" programme to ensure improved working conditions and productivity in the garment sector, including worker's health and safety. Government agencies such as the Department of Air Quality Management should strengthen the implementation of existing regulations and programmes such as the sub-decree on Control of Air Pollution and Noise Disturbance and maintain conducive working conditions that will benefit the health of workers through frequent inspections.

The gender imbalance within the garment sector suggests that garment sector-related policies should explicitly acknowledge the stark gender disparity that characterizes the sector, in particular the disproportionate representation of young women workers in the garment supply chain. Existing labour policies should be aligned with relevant international frameworks on gender and labour practices. For example, the key ILO Conventions on gender includes the Equal Remuneration Convention, Discrimination (Employment and Occupation) Convention, Workers with Family Responsibilities Convention, Maternity Protection Convention, and the Violence and Harassment Convention. Alongside this, new policies relevant to the garment sector such as the new Occupation Safety and Health Code should be gender inclusive. The policies need to ensure provisions that address the specific needs of women workers, including safety precautions and acknowledge the particular risks that air pollution can pose to women workers, particularly during pregnancy. Risks during pregnancy include pregnancy loss, pre-term birth and low birthweight (Ghosh et al., 2021).

Policies should further work to ensure formalization of garment sector work and guarantee workers' entitlements to health insurance and paid sick leave, and to ensure fair pay for women workers, especially in the less regulated subcontracting sector. The introduction of maternity allowances to garment workers<sup>1</sup> from the National Social Security Fund, as well as Employment Injury Insurance and Social Health Insurance are welcome, but steps remain to be taken to ensure workers are fully aware of these benefits and to identify and hold unethical employers to account. Additionally, unions and civil society organizations should facilitate social dialogue and awareness among garment workers, as supported by relevant labour policies, to encourage workers, especially women, to exercise their rights in the workplace. The World Health Organization (WHO) can provide more engagement in the garment sector in the context of providing training on WHO guidelines to government officers and factory staff in charge of health protection.

The study revealed that workers had little understanding of air quality. If workers are trained and more people know about how air pollution affects their health and a factory's

---

<sup>1</sup> <https://www.khmertimeskh.com/50801246/7-9-million-in-maternal-allowances-paid-by-nssf-to-garment-workers-last-year/>

productivity, this knowledge should incentivize better air quality. Raising awareness of air pollution and its health impacts among workers will help them become more aware of air pollution and health protection measurement practices. Unions, health agencies and NGOs could carry out education campaigns and other communications work.

The public and private sector agencies that work closely with the garment sector, such as the Ministry of Labour and Vocational Training, part of MISTI, should work cooperatively with ILO, buyers from export markets, and civil society in order to ensure that all garment industries comply with the required standards.

## References

- Asian Development Bank. (2013). *Gender Equality in the Labor Market in Cambodia*. ISBN 978-92-9254-401-0 <https://hdl.handle.net/11540/795>
- Chandath, H., Chhay Por, I., Sokyimeng, S., Dana, S., & Raksmei, Y. (2023). *Understanding Air Pollution in the Garment Sector and Health Impacts on Workers: A Cambodian Case Study*. Ministry of Environment, Cambodia. <https://epa.moe.gov.kh/pages/categories/view/document-daqnm>
- Ghosh, R., Causey, K., Burkart, K., Wozniak, S., Cohen, A., & Brauer, M. (2021). Ambient and household PM<sub>2.5</sub> pollution and adverse perinatal outcomes: a meta-regression and analysis of attributable global burden for 204 countries and territories. *PLoS Med.* 18(9). <https://journals.plos.org/plosmedicine/article?id=10.1371/journal.pmed.1003718>
- International Labour Organization. (2018). Living conditions of garment and footwear sector workers in Cambodia. *Cambodia Garment and Footwear Sector Bulletin* (Issue 8). [https://www.ilo.org/wcmsp5/groups/public/---asia/---ro-bangkok/documents/publication/wcms\\_663043.pdf](https://www.ilo.org/wcmsp5/groups/public/---asia/---ro-bangkok/documents/publication/wcms_663043.pdf)
- Kingdom of Cambodia. (2019.) *Report on the Cambodia Labour Force Survey 2019*. <https://nis.gov.kh/index.php/en/28-clfs/98-cambodia-labour-force-survey-2019-clfs>
- Lawreniuk, S., & Nuon, V. (2022.) *Social Protection for the Apparel Industry in Cambodia: Gaps and Opportunities*. Oxfam Cambodia. <https://cambodia.oxfam.org/latest/publications/social-protection-apparel-industry-cambodia-gaps-and-opportunities?q=latest/policy-paper/social-protection-apparel-industry-cambodia-gaps-and-opportunities>
- Merk, J & Nuon, V. (2016.) *Country Study Cambodia – Labour Standards in Garment Supply Chain*. CNV International. [https://www.cnvinternationaal.nl/\\_Resources/Persistent/0/e/0/5/0e05eebdbf4a1a6c31409dc12aee83b8f532a4b5/20161102%20CNV%20CS%20Cambo\\_clickable%20extern%20ENG%20DEF.pdf](https://www.cnvinternationaal.nl/_Resources/Persistent/0/e/0/5/0e05eebdbf4a1a6c31409dc12aee83b8f532a4b5/20161102%20CNV%20CS%20Cambo_clickable%20extern%20ENG%20DEF.pdf)
- MOE & GGGI. (2016). *Phnom Penh Green City Strategic Plan 2017-2026*. Ministry of Environment and Global Green Growth Institute. <https://ncsd.moe.gov.kh/sites/default/files/2019-05/Phnom%20Penh%20Green%20Strategic%20Plan.pdf>



### Published by

Stockholm Environment Institute  
Linnégatan 87D, Box 24218  
104 51 Stockholm, Sweden  
Tel: +46 8 30 80 44

### DOI:

<https://doi.org/10.51414/sei2023.017>

### Author contact

diane.archer@sei.org

### Media contact

rajesh.daniel@sei.org

Visit us: [sei.org](http://sei.org)

Twitter: [@SEIresearch](https://twitter.com/SEIresearch)  
[@SEIclimate](https://twitter.com/SEIclimate)

Stockholm Environment Institute is an international non-profit research and policy organization that tackles environment and development challenges. We connect science and decision-making to develop solutions for a sustainable future for all.

Our approach is highly collaborative: stakeholder involvement is at the heart of our efforts to build capacity, strengthen institutions, and equip partners for the long term.

Our work spans climate, water, air, and land-use issues, and integrates evidence and perspectives on governance, the economy, gender and human health.

Across our eight centres in Europe, Asia, Africa and the Americas, we engage with policy processes, development action and business practice throughout the world.

This publication is an output of the project “The impact of air pollution on the world of work for women and youth in East and South East Asia”, a joint initiative between the International Development Research Centre (IDRC) of Canada, the International Labour Organization (ILO) and the Stockholm Environment Institute (SEI) in the context of the UN Global Initiative on Decent Jobs for Youth. The project is funded by IDRC under grant number 109451 001, led and implemented by SEI, and supported by ILO as a technical partner. The contents of this document are the sole responsibility of the authors and may not be taken to reflect the views of the ILO, or those of the UN Global Initiative on Decent Jobs for Youth or the Climate Action for Jobs Initiative.



Canada

