Managing heat stress among Bangladesh ready-made clothing workers

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1. Executive summary

The ready-made garment sector is key to growing Bangladesh's economy- providing export opportunities and employment and financial security for a large, predominantly female workforce. To ensure sustained productivity and a thriving workforce, workplace hazards, like heat, must be acknowledged, assessed and managed. The existing heat hazard experienced in the sector is set to worsen as temperatures increase due to global warming.

Drawing on qualitative data collection methods this report highlights heat-health-productivity issues and explores heat management through the eyes of workers, managers and other sector stakeholders. This exploratory study identified that workers and health professionals attribute symptoms like headaches, dizziness, fatigue and nausea to heat, particularly during summer months, and that heat was considered an important influence on productivity by workers themselves and others working in or with the sector.

The report identifies diverse experiences relating to hydration and work-rest practices, tensions that exist between wellbeing and productivity driven by daily quotas and a preference for ventilation and space cooling solutions. It provides some recommendations for better targeting heat mitigation to times of the year and places in the factory where workers are most at risk and improved surveillance of heat related illness to ensure that supporting health services are adequate to meet demand.

2. Purpose

The largest global threat of the 21st century is climate change, leading to increased temperatures worldwide (Masuda et al., 2019). This increased heat has negative impacts on overall human health and wellbeing, and it also is projected to have direct financial impacts (or costs) of $100 trillion USD per year on the global economy (Wallace-Wells, 2019). Associated with these high ambient land temperatures is the prevalence of increasing daily environmental heat exposure (Borg et al., 2017), creating occupational health risks. In many industrial workplaces, the impact of heat exposure has a direct and potentially significant impact on workers' health negatively impacting workers' productivity (Fahed et al., 2018). This heat problem diminishes the worker's ability to perform at their full potential, impacting their career and income prospects (Fahed et al., 2018). Environmental heat stress in the occupational sector refers to the physiological effect that reduces a person's health status and consequently hampers their productivity (Lundgren et al., 2013). The impact of heat on the workforce is significant. The recent Lancet Countdown identified that in 2021, heat exposure led to 470 billion lost labour hours, a 37% increase from the 1990-1999 period (Romanello et al., 2022). Moreover, Flouris et al., (2018) argue that by 2030, the global workforce will lose nearly 70 million work life-years in productivity due to reduced labour, as a direct result of occupational heat stress.

The ready-made garment (RMG) sector is a leading Bangladesh industry. It provides employment to 4 million workers, many of whom are unskilled or semi-skilled, and who come from rural areas to improve their economic circumstances (Islam et al., 2020). Factory work is physically demanding, workers are pressured to meet production deadlines, sit in production line formats and are paid piecemeal rates, which can create direct or indirect health problems (Akhter et al., 2019). Akhter et al., (2019) interviewed factory workers to examine their perceptions of their work and health-related problems in the RMG industry in Bangladesh, and reported diverse health problems. Although both male and female factory workers were interviewed, the hierarchical system of the factory means male workers are often in positions of authority rather than being on the factory floor and hence do not engage in as much physical labour. The issues reported by the female RMG workers were back and joint pain, difficulty in breathing, continuous headache, eye pain, fatigue, mental health and wellbeing issues from bullying, along with the pressures of their gendered roles (Akhter et al., 2019a). Akhter et al. (2019a) interviewed the onsite factory team of health professionals, including doctors and nurses, who reported that female workers' health is affected by 3 major factors: the nature of their job, lower socioeconomic status and the workplace physical environment (Akhter et al., 2019a).

One important health issue identified from the RMG Bangladesh literature is heat stress (Chowdhury et al., 2017). The association between occupational heat exposure and health and productivity has been well established (Flouris et al., 2018). Occupational heat stress is a proven, direct threat to workers' health and also has a negative impact on workers' productivity. The general symptoms of heat stress include headache, fatigue, dizziness, diarrhea and stomach pain (Aghamohammadi et al., 2021). These symptoms are generally reversible, however if not managed may become more acute, impacting major organs (e.g., acute kidney injury) which can ultimately lead to more serious health risks such as chronic kidney disease.

This study is concerned specifically with heat stress among workers in RMG factories, Dhaka, Bangladesh focusing on the immediate (self-reported) effects. This investigation further aims to explore the heat stress impact on workers' productivity, and interventions that can be developed to mitigate such impacts. By using the best available evidence about what heat mitigation strategies are most effective in factory settings, combined with understanding multiple stakeholder perspectives on heat, productivity and cooling strategies, progress can be made in developing policies and practices to protect workers health and productivity for this important sector.

The objectives of this study are to:

- Characterise the self-reported heat and health impacts on RMG workers
- Identify the impacts of heat on the productivity of RMG factory workers
- Analyse the potential feasibility and benefits of occupational heat stress intervention measures
- Identify the barriers to workers in the RMG sector in Bangladesh accessing cooling options and medical care for extreme heat.

3. Literature review

3.1. Global heat health

Heat is the single largest threat to overall human health and wellbeing and economic output, costing the global economy over $100 trillion dollars a year in direct costs (Wallace-Wells, 2019). Many excess deaths are common in summer seasons globally due to extreme heat events. As the earth has warmed, the annual numbers of deaths attributable to heat across the globe are illustrated in *Figure 1* (Watts et al., 2021). Human cells, tissues, or organs of the brain, heart, kidneys, liver, and the lungs can be affected by exposure of high internal temperatures (39–40°C) (Ebi et al., 2021).

Findings from the Fifth Assessment Report of the IPCC show that both the living and working environments of humans are affected by rising anthropogenic greenhouse gas concentrations because of unusual global warming in recent decades (Rao et al., 2020). Global warming creates frequent high intensity heat extremes and affects human health, economic activities and comfort (Rao et al., 2020). There are existing differences in vulnerability between populations, depending on culture, demography, infrastructure, climate, and other additional factors (Kovats & Hajat, 2008). Heat-related research usually focusses on vulnerable population groups, particularly people with chronic diseases, elderly persons, and children (Xiang et al., 2014). Those exposed to lower socio-economic conditions and economically vulnerable population groups are also at risk (Dutta et al., 2015). Further those exposed to more heat like certain types of workers are also frequently considered vulnerable to the increasing heat associated with climate change (Moda et al., 2019).

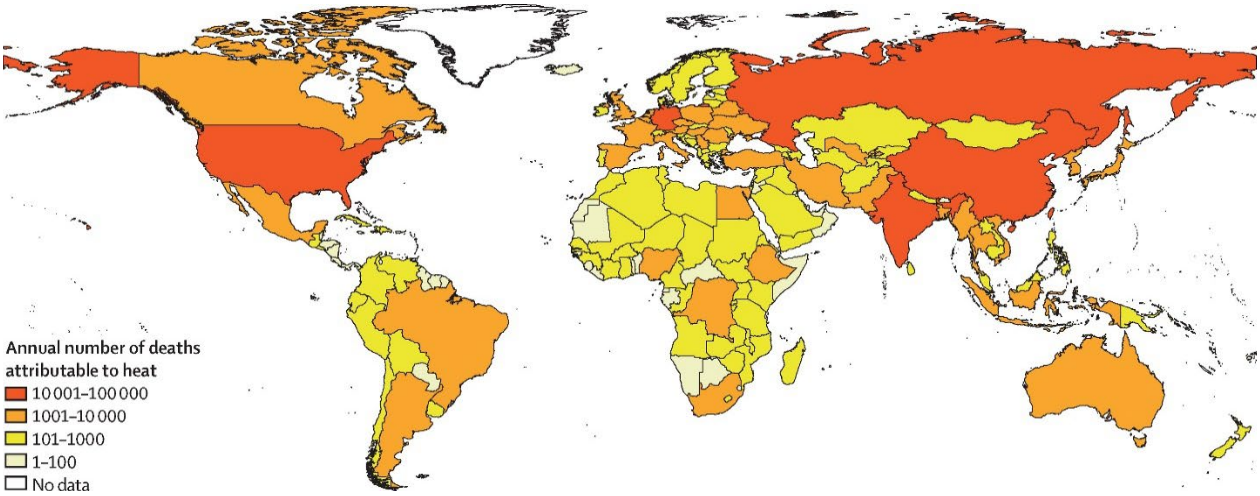

Figure 1. Annual heat-related mortality in the population older than 65 years averaged from 2014 to 2018 (Watts et al., 2021)

In many parts of the world, daily outdoor temperature and relative humidity already have the potential to contribute to heat stress in the population. One city already at risk for heat stress is that of Dhaka, Bangladesh (the location for this research). For a high greenhouse gas emissions scenario, the estimated average annual temperatures are projected to increase by around 3.9°C by the end of this century (The World Bank Group, 2021). This situation will certainly lead to more frequent and more severe heatwaves (Choi et al., 2021) which has the potential to substantially increase heat stress.

3.2. Heat and worker health

Heat exposure in the workplace is a rising challenge for occupational health due to the expected increase in the intensity of extreme hot weather (Moyce et al., 2020). The International Labour Office (ILO) projects that 80 million full-time jobs will be lost by 2030 due to extreme heat conditions (ILO, 2019). Xiang et al.'s (2014) review paper aimed to identify the heat exposure characteristics of selected workplaces for high-risk occupations – construction workers, miners, fire-fighters, farmers and manufacturing workers. They found that workers in low-middle income countries in tropical regions doing extensive physical work in hot environments face concerning heat stress (Xiang et al., 2014). Underreporting of heat illness in the workplace is very common resulting in the impact of heat exposure being underestimated (Abokhashabah et al., 2020). Heat stress is a combination of external heat from the environment and at the same time internal body heat produced from metabolic processes (Moyce et al., 2020). External heat exposure sources in the workplace are defined in two ways: one is directly weather-related and the other is man-made heat exposure (Xiang et al., 2014). In one study that quantified the heat-strain indicators and also evaluated the health impacts of heat stress of 1500 workers in eight industrial sectors, the workers who were heat-exposed had higher odds of reporting adverse health illness compared to heat-unexposed workers (Venugopal et al., 2021).

The identified long-term health effects of workplace heat exposure are cardiovascular diseases, mental health problems, digestive diseases, dislipidemia and kidney disease (Xiang et al., 2014, Crandall et al., 2010). Occupational injuries and accidents can also arise from workplace heat exposure (Kampe et al., 2016). Heat related illness is prominent in manufacturing workers in non air-conditioned indoor workplaces (Xiang et al., 2014). Different epidemiological studies have shown the impacts of heat among factory workers particularly in foundries, automobile, steel plants, and glass manufacturing sites (Ayyappan et al., 2009, Nerbass et al., 2017).

In their study based in Australia, Zander et al., (2018) identified that common symptoms like fatigue, headache, seizure, fainting, nausea and skin rashes can affect people when exposed to extreme heat, even if they are not clinically heat-stressed. The symptoms differed significantly across the level of heat stress experienced, with fainting, nausea, skin rashes and irritability more likely to be mentioned by people who often or very often felt heat stressed than by people who rarely or only sometimes felt heat stressed (Zander et al., 2018). This suggests that it is important to explore the factors behind perceived heat stress (Dutta et al., 2015).

Studies carried out in India aimed to identify the health implications for workers of exposure to hot working environments combined with inadequate sanitation facilities at their workplaces (Venugopal et al., 2016). Hot working environments and inadequate sanitation facilities are common in many Indian workplaces (Dutta et al., 2015). A lack of drinking water (through access and choice), combined with withholding bathroom breaks due to work pressures and poor access to appropriate bathrooms, result in dehydration and poor kidney function. Preliminary evidence suggests that due to occupational heat exposure and inadequate sanitation facilities at many

Indian workplaces, the health of workers is at risk (Dutta et al., 2015). Reflections generated from these studies suggest that intervention through strong labour policies is required to solve this issue, together with general measures to empower workers to speak up (Venugopal et al., 2016 and Dutta et al., 2015). Heat stroke is defined as an acute rise in body temperature which is life-threatening and can create central nervous system dysfunction (Hifumi et al., 2018). Heat stress leads to a wide range of heat illnesses, notably exhaustion and consequently hyperthermic organ failure which can result in death. Heat exhaustion is distinct from heatstroke and is associated with cardiovascular unfitness which leads to excessive sweating, a weak heart rate, dizziness, nausea, and cramping (Binkley et al., 2002). The American Conference of Governmental Industrial Hygienists (ACGIH) recommended that the core body temperature worker should be limited to 38°C where the workers work in hot environments (Lazaro et al., 2021). It is important to identify relative risks for diagnosing heat illness. For heat illness it is not appropriate to focus on a single cut-off of deep body temperature. If heat production remains extreme and symptoms of heat stress are left unchecked then there is the potential for heat stroke.

When environmental heat loads exceed, or extreme workload surpasses the ability to reduce core body temperature this leads to heat stroke because of the body's prioritisation of vital organs over thermoregulation (Seebacher et al., 2009). Heat stress leads to loss of motor function and dehydration, and as a result organs shut down (Periard et al., 2021). Researchers and practitioners can better identify and treat heat stressed/injured individuals during extreme heat events or a period of extreme exercise through an understanding of the biophysical factors influencing core temperature. In addition, proper guidelines may be developed and executed to optimise work performance, health, and safety during heat stress (Cramer & Jay, 2016). It is difficult to accurately predict heat illness in occupational settings as the early symptoms of heat stress are mild. This may be one reason for the underreported rates of heat illness in working populations (Xiang et al., 2014). Human body expresses heat stress in the form of several symptoms like fatigue, sweating and if the heat exposure increases the symptoms progress to illness. Heat illness may lead to heat stroke if exposures continue or the body is not assisted to thermoregulate. It is needed to regulate worker risk to heat health. Some administrative actions to mitigate this risk include environmental monitoring and use of heat indices, non-invasive measuring techniques, protocols for acclimation, treatments, and/or rest breaks, education programs (hydration, signs of heat illness), etc.

3.3. Heat and worker productivity

Asia exports garment products valued at US$668 billion per year, contributing 63.7% of the world's total clothing exports (ILO. 2019). This sector is a key driver of economic development of many garment exporting countries including Bangladesh, Vietnam and Cambodia (Alam et al., 2017). The RMG sector in Bangladesh is responsible for 84% of national export earnings (Swazan et al., 2022). The long-term sustainability of the garment industry depends on the productivity and viability of the individual factories that participate in the sector (ILO, 2019). Occupational heat stress within the garment sector presents a direct threat to worker productivity through declining worker health and wellbeing as well as increasing the likelihood of workplace injury (Kjellstrom et al., 2019). Heat stress creates reduced work intensity, demanding longer breaks for workers which results in significant losses of worker's productivity (Szewczyk et al., 2021). The estimated global reduction of GDP due to climate change and increased heat stress could be 2.6-4% by 2100 (Takakura et al., 2017).

Labour productivity is the most familiarly used partial productivity measure in the garment sector. It is important to measure how capably labour is used to manufacture output by considering output per hours enforced or output per worker (Schreyer, 2001; Kumar et al., 2014). Higher work intensity or higher work efficiency are both considered as the keys to achieving higher labour productivity. Both worker efficiency and intensity are inversely related to unsound working conditions, working environment (e.g., heat, air quality) insecure work and low wages (Karmaker & Saha, 2016). Healthy working environments can directly raise workers' productivity by improving workers' health and reducing absenteeism, and so lead to increased wages. However, workers' productivity cannot be optimised if the working environment is not favorable (Saha & Mazumder, 2015). The authors identified different parameters of the working environment that lead to lower productivity in RMG industries, and crucial environmental factors are highlighted based on empirical analysis which could improve the productivity of those industries. Already, heat stress has a detrimental impact upon health, welfare and productivity of factory workers (Venugopal et al., 2021).

Rising temperatures and global warming make workers more vulnerable to occupational heat stress (Nunfam et al., 2020). To strengthen workers' health, social lives and safety it is important to develop and implement social protection strategies for mitigation (Nunfam et al., 2020). There is a lack of research to identify feasible interventions to apply context specific solutions for work-related heat stress (Nunfam et al., 2020). The recognised heat prevention strategies, like air-conditioners, are established for high income settings due to their costs and requirements for consistent power supply. However, the low- and middle-income tropical countries which are densely populated and have excessive heat exposure have informal heat stress in working environments (Lucas et al., 2014) and combined with projected ambient temperature rises, identifying feasible heat interventions for these settings is increasingly important.

3.4. Heat risk management

The hierarchy of control is an important occupational safety and health framework to mitigate occupational hazards, recognised by NIOSH and CDC. It has been used to examine feasible and effective heat control interventions (Figure 2). The top graphic of this framework shows the most effective way to implement a control is by physically removing ~~of~~ the occupational hazard entirely. Elimination and substitution of the hazard are both ~~are~~ easy and effective if the organisation can implement these at the design stage. The third most effective strategy, engineering controls such as inclusion of cooling devices, are beneficial for the workers but ~~it~~ are highly–dependent on administrative protocols. Administrative controls and Personal Protective Equipment (PPE) are shown as least effective to control occupational hazard (Figure 2).

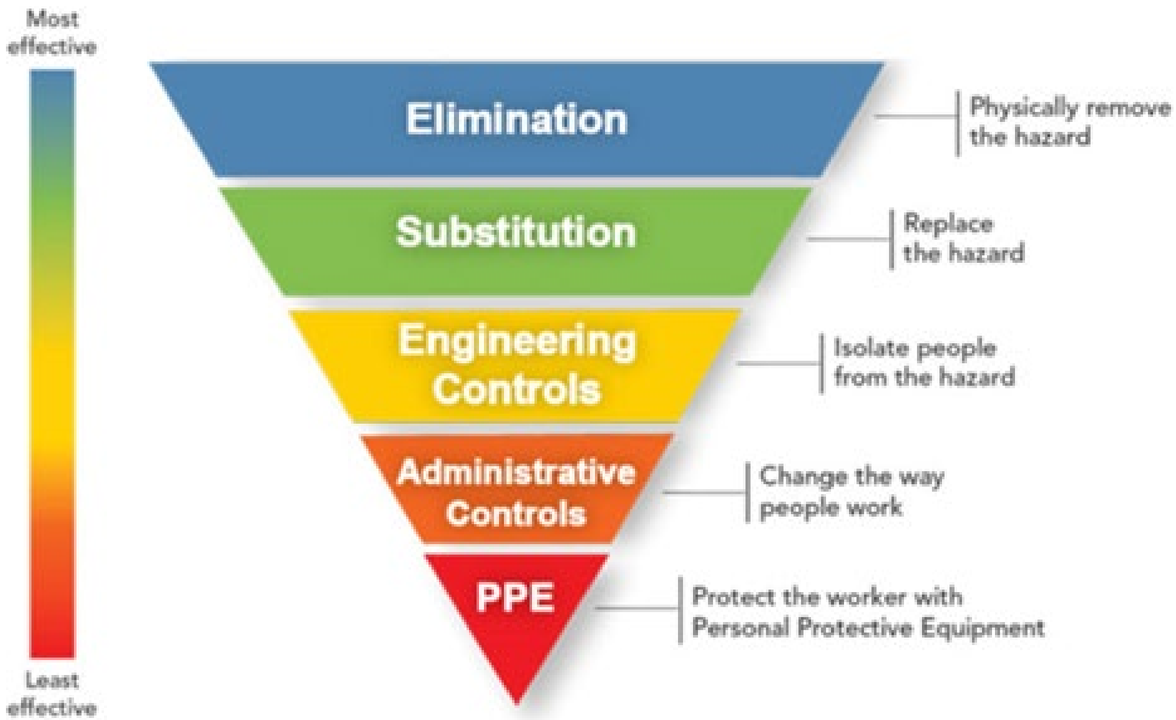

Figure 2. Hierarchy of Control Framework; source: https://www.cdc.gov/niosh/topics/hierarchy/default.html

Rising temperatures and global warming make workers more vulnerable to occupational heat stress (Nunfam et al., 2020). To strengthen workers' health, social lives and safety it is important to develop and implement social protection strategies for mitigation (Nunfam et al., 2020). There is a lack of research to identify feasible interventions to apply context specific solutions for work-related heat stress (Nunfam et al., 2020). The recognised heat prevention strategies, like air-conditioners, are established for high income settings due to their costs and requirements for consistent power supply. The goals of heat mitigation interventions in the work sector are to reduce ambient temperature, reduce heat generation via work output, keep body cool by hydration etc. Environmental interventions include the context of building level structural interventions, air-conditioning, ventilation (ceiling fans, factory ventilation fans, evaporative cooling fans), shading, albedo etc. Administrative interventions include engineering controls such as inclusion of cooling devices, which are beneficial for the workers but are highly dependent on administrative protocols. Administrative interventions are basically controlled by management (e.g., work rest ratios, acclimation for new workers/seasons, hydration standards, WBGT (Wet Bulb Globe Temperature) threshold for work stoppages etc.). Individual/personal interventions include cooling the person with a fan, clothing adjustments, spray bottles (e.g., cooling vest, personal fans) which facilitate evaporative heat loss from the body, not changing the ambient temperature. Preventive interventions include hydration, education of drinking enough water during the working day and, developing and implementing appropriate individual work rest schedules (Lundgren et al., 2014). Morris et al. (2020) in their review paper showed some intervention strategies may be feasible for one setting but not feasible for other settings. For example, for those workers who wear minimal clothing, skin wetting is an effective intervention but not for those workers who wear encapsulating protective clothing (Morris et al., 2020).

Though it is difficult to provide cooling intervention during work, there are many low-cost methods to apply (Morris et al., 2020). For lowering skin temperature and lowering workers' sweat rates, skin wetting, wetting clothing and wrapping the head with a wet rag all are useful. These are more effective in dry environments rather than humid environments (Morris et al., 2020). A ventilation shirt is a novel type of heat intervention that includes a miniature fan embedded within the clothing to provide consistent air flow (Morris et al., 2020). To improve work performance by limiting physiological strain, cooling vests can be used during break time or during work (Morris et al., 2020). Loose fitting clothing with wider knitting pattern is relevant specially for indoor workers (Heat-Shield 2020). Use of ice towels is another method for emergency situations to make the skin temperature lower during periods of high heat stress (Morris et al., 2020). To increase airflow using stationary ventilation is a beneficial method when the air temperature is at or below 34 °C (Morris et al., 2020).

Typical heat reduction/heat stress reduction interventions for indoor workers include, but are not limited to: work-rest ratios, scheduling adjustments, hydration (including water and/ or sports drinks); skin wetting, appropriate clothing, cooling vests and ice towels, depending upon the cost and feasibility (Morris et al., 2020). Xu et al. (2020) recommended regular hydration and enough rest periods and found that keeping hydrated reduced the risk of AKI. Morris et al. (2020) in their review paper identified an urgent need to identify effective, feasible, affordable, and sustainable solutions to reduce heat stress for worker’s health and productivity. The most effective solutions they identified to reduce heat stress in occupational settings were specialised cooling garments to improve aerobic fitness of the workers, heat acclimation (physiological adaptations), improved ventilation and cold-water immersion (Morris et al., 2020). Although in terms of effectiveness the best solutions are air-conditioning and cooling garments, these have some limitations for occupational settings including high economic cost and environmental impact (Morris et al., 2020). There are also some solutions like sufficient breaks, optimised clothing, and acclimatisation (physiological), which may be more easily implemented, however these solutions need to be evaluated with respect to their economic and ecological sustainability aspects (Morris et al., 2020).

A core temperature of 38°C for an average worker and dehydration limits are seen as critical parameters providing an indication of productivity loss (Lundgren et al., 2014). A 3-4% decrease of total body water is tolerable without any adverse health effects but more than that (i.e., a 5-8% decrease) can cause fatigue and dizziness and eventually physical and mental deterioration. Poor ventilation, which can impact both respiratory illness and exacerbate heat stress, inappropriate lighting, and excessive noise can all affect worker productivity and health (Saha & Mazumder, 2015). Karmaker & Saha (2016) suggest that by proper identification of the challenges and taking appropriate corrective measures by the management of RMG factories, Bangladesh has the opportunity to be the market leader of RMG productivity.

A variety of intervention strategies to help workers avoid heat stress are possible, however understanding cost effectiveness is important in deciding which strategy is chosen by management. While intervention strategies come at a price, they may actually result in productivity gains, which then outweigh these costs (Morris et al., 2020). To provide a feasible, transferrable and environmentally sustainable heat management strategy it is important to know the wide range of interventions available. Reducing physical activity is a preventive solution which reduces work capacity (Lundgren et al., 2014). Air-conditioning is a control solution for heat management which is expensive and not environmentally friendly (Lundgren et al., 2014). Both preventive and control solutions together have been shown to have multiple benefits (Lundgren et al., 2014) as they can often offset the disadvantages of the other, with the increased productivity reducing the overall profit shortfall from installing air-conditioning. Capacity building interventions including education and awareness-building among all levels of society is recommended as a low-cost starting point (Lundgren et al., 2014).

One study that conducted an assessment of potential interventions to reduce kidney damage looked at the implementation of a water, rest, shade intervention and efficiency program among sugarcane workers (Bodin et al., 2016). The water, rest, shade approach was shown to be promising in reducing heat stress and subsequently preventing dehydration and acute kidney injury (Bodin et al., 2016). It was associated with fewer adverse impacts on kidney function both across a day and across an entire harvest. Forward planning and policy intervention are required to implement such effective adaptation options as shifting working hours and establishing cool roofs (Day et al., 2019). Both organisational and individual mitigation strategies need to be taken to reduce heat stress of workers.

3.5. The Bangladesh RMG industry

The RMG industry of Bangladesh has been the driving force in its transition to becoming an export-oriented economy (Ahmed, 2013). The reinforcing factors behind the industry's flourishment in Bangladesh are cheap labour costs, dynamic private entrepreneurship and government policy support (Ahmed, 2013). In 2019, the industry generated USD$34.1 billion (contributing 84% of export earnings) to Bangladesh's GDP (Swazan et al., 2022). Though female participation in the workforce in Bangladesh in general is low, the RMG industry is a major employer of women (IMF, 2018). Bangladesh has approximately 5,000 RMG factories and of the 4.2 million employees, women make up over 80 % of the workforce (ILO, 2017). Although both male and female workers face daily strenuous manual work in poor working environments, the women are not often in leadership or managerial roles (Akhter et al., 2019b) making it more difficult for the females to be heard or understood when they speak out about working conditions such as need for hydration or restroom breaks. The workplace hierarchy establishes a class dynamic between the workers and the supervisors of these garment factories according to their economic differences (Gibbs et al., 2019).

Work by Zaman et al., (2018) identified that the RMG working environments of these industries in Bangladesh are below standard, with low-quality indoor environments providing a risk to worker's health resulting in a high prevalence of illness among workers They found that the most commonly reported heat related illnesses are headaches (98%), breathing problems (36%), vomiting (28%), fatigue (28%) and fainting (18%) (Zaman et al., 2018), identifying that the humid indoor environment and insufficient ventilation contributed to these adverse situations (Zaman et al., 2018). Poor working conditions in Bangladesh are not unusual and working conditions in most RMG factories in Bangladesh are physically stressful and low-paid (ILO 2020). The existing window configurations of factory buildings do not support proper ventilation which causes extreme heat in the indoor environment (Hossain et al., 2017). Insufficient lighting, poor ventilation, extreme heat, job insecurity, and inadequate compliance are common in the RMG industry, which creates physical and psychological workplace hazards (Zaman et al., 2018). If physical and social workplace environments can be improved the health and competence of the workers can be improved (ILO, 2020).

Heat is one of the physical stressors for RMG factory workers in Bangladesh (Chowdhury et al., 2017). Using WBGT and predicted heat strain, Chowdhury et al., (2017) showed that present-day conditions exceed comfortable levels and create very high-risk levels (up to 38°C air temperature). During the present century, Bangladesh has been identified as at high risk for the physiological impacts of increasing heat stress due to climate change (Im et al., 2017; Willett et al., 2012). This situation raises questions about increasing impacts of heat stress among RMG factory workers due to ambient temperature and humidity changes. By 2100 temperatures are projected to increase by 3.0-3.5°C (UK Met Office, 2011).

Air conditioning is the most popular worldwide strategy to deal with excessively hot conditions in RMG factories (Zaman et al., 2018). The energy needs of Bangladesh are met mainly by natural gas (56%), however the supply is less than demand, and rolling blackouts are frequent (USAID, 2016).

4. Methodology

4.1. Research setting

The general area of study was Dhaka, the capital of Bangladesh. We conducted the study with the workers of two RMG factories in Dhaka, with another two. Interviews KII of an owner and manager at another two garment factories. One doctor and one nurse from another garment factory were also interviewed. Factories were first selected because they were accessible to contact, and the final factories were visited on the basis that the management were willing to support me to conduct my research with their staff.

To provide context to study findings, some information on the settings were collected and presented in the findings based on researcher observation while on site and based on previous visits to RMG factories and talking about the sector with other researchers undertaking research in similar settings.

4.2. Data collection

Qualitative data collection methods were used to answer the research questions. Data was collected via three methods: Focus Group Discussions (FGD), In-Depth-Interviews (IDI) and Key Informant Interviews (KII) (see *Table 1*).

An experienced research assistant helped with data collection specially during FGD he recorded and kept notes as well as helped with gate keeping. He also helped with transcription the recording.

Table 1. Summary of themes discussed across interview types

Questioning themes	**FGD**	**IDI**	**KII**
Demographic Information			
Your experiences of heat exposure			
Overall concerns about heat in the RMG sector			
Effect of heat on your health			
Effect of heat on worker's health			
Effect of heat on your performance and productivity			
Effect of heat on worker's performance and productivity			
Your drinking water habits			
Relationship between heat and injuries			
Opinion about available cooling options			
Opinions about heat mitigation interventions			
Your usage of break time			
Usage of cooling options and its barriers			
Sustainability of heat mitigation interventions			
Health care facilities			

FGD = focus group discussions (with workers [n = 32]); IDI = in-depth interviews (with workers [n = 8]); KII = key informant interviews (with various [n = 15], factory nurse [n = 2], doctor [n = 2], supervisors [n = 2], management [n = 3], owners [n = 1], industry body [n = 1], non-government organisations [n = 2], government officials [n = 2]).

We obtained written informed consent from the study participants as well as verbal permission to conduct the study activities from the management of the garment factories. The study protocol was reviewed and approved by the ethical review committee of Griffith University (HREC 2022/419) and icddr,b.

A FGD was considered an appropriate method (Creswell et al., 2016) to gather data on the workers' perceptions of heat stress and its impact on health and productivity, and to explore related issues such as direct and indirect impact of heat stress on productivity). FGD and IDI were used to explore the daily behaviours of the factory workers and the impact their working environment has on their health status and productivity. A total of four FGD were conducted - two (1 male, 1 female) each from the two different factories. FGD were small, between 10-12 people in each, so moderators could listen to all comments and the group did not splinter and engage in any side conversations. FGD were separated by gender so that the female workers could describe any heat-health related illnesses without hesitation. This is partly because culturally women are less likely to share their opinions freely and openly in front of males and because males typically work in supervisory roles. FGD also asked about any barriers within their workplace that might influence their heat exposure, such as access to cooling or medical support should they feel unwell.

The managers helped to select the pool of potential FGD participants primarily on the basis of them engaging in common jobs like cutting, sewing, and ironing. The semi-structured FGD question set explored perceived heat-related productivity impacts and how heat impacts health and (consequently) productivity. In line with qualitative protocols (Wong et al., 2008), in the FGD the questionnaire did not always follow the same order, as additional questions were asked, guided by the participants' answers (Wong et al., 2008).

IDI are also one of the most powerful methods for understanding the problems and exploring topics in depth (Carter et al., 2014). Through this study we conducted a total of 8 IDI with both male and female workers generating contextual descriptions of the self-reported impact of heat stress to assist with triangulation of multiple data sources (Creswell, 2018). Through the IDI, we explored perceived heat related productivity impacts and explored further barriers to workers in the RMG sector in Bangladesh accessing cooling options and medical care for extreme heat. Again, the managers helped to select appropriate participants from the factory floors. The participants of IDI and FGD were different.

The FGD and IDI guidelines were pre-tested with several 'mock' focus groups and interviews (Wong et al., 2013). The semi-structured FGD (and IDI) probed within the group around 4 key areas:

- *Demographics*: age, gender, monthly income, education, work profile, years of work.
- *Heat and how heat affects health*: a detailed section on self-reported heat illnesses and the symptoms of each illness were explained to the study participant by the interviewer (Nerbass et al., 2019). The purpose of collecting the qualitative data was to understand the perceptions of the workers regarding their heat exposure and how it might impact health (Dutta et al., 2015). Some example questions included:
    - What kind of job do you do here and how long have you been doing the same work?
    - What do you think about heat? When do you feel hot during your usual working day? Is there a particular time in the day, a particular time in the year, in a particular job?
    - How often do you drink usually? How much do you drink usually? Do you think it is enough? If not why not? Are there barriers to drinking and, if so, what are these?

  - Do you ever experience symptoms like faintness, headache, dizziness, heavy sweating, increased thirst, headaches, vomiting, If yes, when? Is it a time of day, time of year, while doing a particular job?
  - If you experience health issues like this, does it affect your ability to do your job? How?
  - How does this health issue affect productivity?
- *Heat and productivity*: The qualitative data also helped to explain workers' perceptions of heat stress and its impact on productivity (both directly and indirectly via health impacts). The evidence showed that workplace heat exposure resulted in health impacts on workers (Binazzi et al., 2019), which in turn had an indirect impact on workers' productivity. A meta-analysis found epidemiological evidence that heat exposure had an effect on the risk of occupational injuries (Binazzi et al., 2019), which again was likely to have an indirect impact on productivity. To explore these relationships, questions were included on loss of production, not achieving work targets, loss of workdays/work hours due to fatigue/exhaustion, sickness/hospitalisation, and/or wages lost due to heat or heat-related illnesses. Some example questions were:
  - Do you think heat-related illnesses or disorders have any impact on your productivity? How?
  - Do you face any problems to achieve your expected performance due to heat stress? How?

- *Heat mitigation strategies:* Are the cooling systems in your factory accessible? What are those? Is it always available for the workers?

KII were conducted with factory officials (owners, supervisors and managers, workplace health professionals), high-level government (Ministry of Labour and Employment) officials, members of the industry peak body Bangladesh Garment Manufacturers and Exporters Association (BGMEA), and NGOs (ILO and BRAC) to know more about how they perceive heat stress as an issue for their workers/the sector. I selected the key informants purposively to ensure that these people know the industry and issues sufficiently to be able to provide useful insights. Questions related to the hot season and heat affecting different aspects and different heat mitigation strategies of the work sector were also asked. These questions were informed by the five action levels of the Heirarchy of Control framework that is a core element of workplace health and safety control (eg. NIOSH) and the Morrison et al (2020) review of heat interventions. Some example questions included:

- Do you observe any existing intervention strategies going on to mitigate excessive heat? Specifically, what does the RMG industry currently do to reduce heat exposure and cool their factories?
- Do you think the clothing has an impact on heat stress? What is your instruction for appropriate clothing to work in this area (probe: for male and female)? What are the barriers? Is it feasible to instruct some appropriate clothing?

All the FGD, IDI and KII were conducted in Bengali and recorded using an audio recorder.

4.3. Data Analysis

Audio recorded data of FGD and KII were transcribed verbatim in English in Microsoft Word. Transcripts contained proper translations so that we retained the original tone of the interviews. We translated the interviews which contained local terms and expressions. Code lists for each of the question tools i.e., KII, FGD were prepared separately. The coded data were summarised according to the study objectives and relevant themes. I also took additional open-ended field notes to include informal discussions and observations, noting the tone and attitudes of the respondents during data collection. All data were analysed considering the content and context analysis, followed by comparison and triangulation.

Findings related to heat risk management were framed in the context of the principles of the Heirarchy of Control framework for workplace hazards.

5. Findings

5.1. General description of the factories and the participants

Data from RMG workers was collected from two ready-made garments factories, situated in Dhaka city (Mirpur and Tejgoan areas) with additional data collected from managers, factory owners and health staff from three other factories and representatives from peak bodies, NGOs, and government. *Table 2* summarises the characteristics of the two factories. *Figure 3* illustrates some images of the recruitment and data collection process with workers.

Table 2. Characteristics for participating RMG factories.

Factory 1 Mirpur area
This factory is a seven storey building and the 3rd, 4^{th} and 5th floors have cutting, sewing, finishing/quality checking and ironing sections. The first and second floor is for packaging. The ground floor is for embroidery and it has air-conditioning. There is a canteen on the top floor of the building. We selected our participants from the cutting, sewing and ironing section from the 4^{th} and 5^{th} floor of the building. We did not select any participants from the air-conditioned ground floor. There is a health clinic in the factory on the 4^{th} floor. In this factory, there are three break times: morning, lunch and afternoon. Lunch time is the only mandatory break for the workers and the morning and afternoon break times are optional and workers take these breaks if they can manage time during their working day. They take the lunch break line by line. Lunch time starts from 12 noon and closes at 2 pm. Each worker gets 1 hour as a lunch break however the allocated lunch time depends on which line he/she is working on. Drinking water stations are available for the workers on every floor. The factory has available cooling options such as exhaust fans, ceiling fans and evaporative cooling fans which run all the time while the workers are in the factory. There was one doctor and one nurse for the factory. The doctor was available up to 12 pm and the nurse was available during the working hours of the factory.
Factory 2 Tejgoan
This factory is a multi-storey building. There are sewing sections, cutting sections, quality checking sections, ironing sections and packaging sections. The factory authorities would not allow us to enter the factory. We conducted the FGD and the IDI with the workers at an icddr,b meeting room nearby. We conducted a KII with the manager of this garment factory in the icddr,b meeting room. There is a health clinic in this factory however we could not gain access. In this factory, the only break time for the workers is the lunch break. There is water available for workers on each floor. Ceiling fans are the only cooling options in the factory for the workers. The office for the management on the top floor of the factory is air-conditioned.

Figure 3. Focus group discussions with workers (top) and recruitment of participants (bottom).

Data was collected via three different methods: Focus Group Discussion (FGD) and In-depth Interviews (IDI) with workers, and Key Informant Interviews (KII) with key stakeholders from government, the BGMEA peak-body, non-government organisations, garments management and authority (supervisors, managers and owners) and on-site health professionals of garment factories. Characteristics of the FGD and IDI participants are provided in *Tables 3, 4 and 5* respectively.

Table 3. Summary of focus group discussions (FGD) sample characteristics

	Factory 1	**Factory 2**
Sample size	16	16
Males	7	7
Age (y) [range]	23-27	23-30
RMG experience (y) [range]	2-4	1-4
Education level (grade) [range]	3-8	5-9
Monthly salary ($US) [range]	110-140	110-150
Females	9	9
Age (y) [range]	22-35	20-29
RMG experience (y) [range]	2-7	1-3
Education level (grade) [range]	5-10	5-10
Monthly salary ($US) [range]	110-115	110-115

Table 4. Summary of in-depth interviews (IDI) sample characteristics

	Factory 1	**Factory 2**
Sample size	4	4
Males	2	2
Age (y) [range]	28	24-28
RMG experience (y) [range]	3-5	2
Education level (grade) [range]	3-8	5-9
Monthly salary ($US) [range]	120-150	110
Females	2	2
Age (y) [range]	28-35	26-27
RMG experience (y) [range]	2	3
Education level (grade) [range]	8	6-7
Monthly salary ($US) [range]	130	120

Table 5. Summary of key informant interview (KII) sample characteristics

Position	**Organisation**	**Gender**	**RMG Experience (y)**
Government official	Ministry of Employment (administration and planning)	Male	2
Government official	Department of Ministry of Employment (inspection)	Male	2
Industry representative	BGMEA	Male	30
Non-government organisation	ILO	Male	31
Non-government organisation	BRAC	Male	4
Doctor	Factory 1	Female	2
Doctor	Factory (other)	Male	7
Nurse	Factory 1	Female	3
Nurse	Factory (other)	Female	6
Line supervisor	Factory 1	Male	4
Line supervisor	Factory 1	Male	7
Factory Manager	Factory 1	Male	23
Factory Manager	Factory 2	Male	13
Factory Manager	Factory (other)	Male	9
Factory Owner	Factory (other)	Male	12

5.2. Heat, health and productivity in workers

5.2.1. Heat characteristics

Most of the workers mentioned the heat was worst in the afternoon, especially between 12pm and 3pm during the summer season from April to June. This aligns with higher ambient temperatures (and relative humidities) in Dhaka during these months suggesting that the internal factory temperatures track the outdoor ambient temperatures. Those working more actively (such as ironing) indicated this contributed to feeling hot. Places in the factory where heat appeared to be problem from a worker perspective were those where heat was generated by machinery (e.g., those on sewing machines or in the ironing section) or in locations where mechanical cooling, like fans, were absent. Some clothing such as the wearing of hijab or burka, mainly by women, also appeared to influence perception of increased heat and this can be attributed to the number of layers, close fitting nature or textile type.

Another important issue raised was the frequent (daily) electricity load shedding during summer. While it appears that contingency for securing electricity via generators is in place for such times and that this keeps the available fans running, this security of energy supply adds a complexity to risk management strategies.

5.2.2. Heat and health

Sweating was commonly reported as a response and many workers experienced headaches, fatigue and dizziness on hot days. Some indicated they felt nauseous or had stomach upsets or diarrhoea while others indicated frequent thirst and dry throat or loss of appetite. Some of them said that they felt burning sensation during urination potentially indicative of a urinary tract infection (this health issue was mentioned also by a factory doctor). Symptoms appear to be worse in summer, suggesting heat is a contributing factor:

"We suffer from headache. Especially we suffer from headaches in the summer season. Then they provide balm."

Female Worker, Factory 2, FGD Participant

A few workers indicated that following blood pressure checks at the factory clinic they identified high or low blood pressure attributed to the heat by a factory health professional.

In addition to direct heat related health issues identified, other health issues were probed with KII. One doctor reported that workers experienced minor injuries, especially needle injuries. They were more prone to these injuries and others (such as falling) related to dizziness associated with heat.

Factory workers have access to onsite health services including first-aid facilities and primary health care services. One factory employed a designated doctor (MBBS) and nurse (both are female) with the doctor available the first half of the day and the nurse available during work hours (including overtime). This clinic had two beds (a male and female) with curtaining for privacy though there was no additional cooling in this space.

Workers generally were satisfied with the health care facilities and indicated they accessed the health professionals to help them with illness, and most workers indicated they received treatment via medicine for headache, fever, cough, fatigue and in the summer in particular, they were provided oral saline solution if they were fatigued. Doctors provided monthly health promotion meetings to engage workers about managing their health and wellbeing.

Clinics seem to be focussed on acute injury and illness and those that could not be treated onsite were referred to hospital with some reduced fees negotiated between factories and nearby health facilities. Laboratory and diagnostic services are included in this health service and workers received services from these health services free of charge. However, if there is a health emergency at the factory, accessing this offsite facility is problematic due to lack of a reliable ambulance service. Despite this, a government KI expressed concern that though factories referred workers to these hospitals, workers faced obstacles in receiving these healthcare services in terms of lack of medicine, being rejected from emergency services, and lack of healthcare facilities available. One KI stated that as the educational qualification of the workers are not high, the standard of paperwork they need to access these services sometimes seemed difficult to the workers.

Government informants indicated room for improvement in factory provided worker healthcare. One government official suggested a need to increase the number of beds, medicine, and oxygen cylinders in the medical centres of many factories:

"In many factories there is, only one bed in the medical center, but if the number of sick people is two or three, then those factories do not have a place to put a bed for worker. Whenever, a worker comes and he/she needs to take rest for some time, the factory do not have the facilities to provide that."

Government Official, KII Participant

The factories provided health care training to newly recruited workers, and the older ones were given messages through monthly meetings. A factory doctor stated:

"We usually have training once a month. Besides, we create a group with some workers who provide primary treatment to others when we are unavailable."

Doctor, Factory 1, KII Participant

5.2.3. Heat and productivity

Heat exposure in the factories had an influence on productivity. Factory key informants (managers, owner, supervisors) explained how they measured productivity and the differing factors that influence it in their factory settings. They identified that workers' productivity could be affected by factors such as materials, monitoring, and the physical or mental conditions of the workers. They also said that the heat exposure affected the workers' physical and mental conditions, which impacted their productivity.

Some workers reported feeling discomfort because of heat. They indicated that because of heat, their working speed decreased, impacting their performance and productivity. In some cases, they wanted to drink water, but they could not do so as they had demanding workloads or quotas to maintain. The interviewed workers reported that,

"I face problems to complete my work. The production wants one hundred and twenty percent of production. But they do not understand that it is a problem to achieve that. Whenever I work to achieve that, I become sick."

Male Worker, Factory 2, IDI Participant

One of the interviewed workers stated that,

"Because of heat, the work will be affected. Now it is hot, and we have the pressure of work every day. If the work pressure is more at workplace, then the risk of becoming sick is high."

Male Worker, Factory 2, FGD Participant

The other way that heat appeared to impact an individual's productivity was time away from work, whether this be for a few hours or days. Some workers of *Factory 2* stated that when they were hot and went to the washroom to freshen up, this caused a break in their work which sometimes made their supervisor angry. One of the interviewed workers stated that,

"If I feel bad, I go to the washroom and it will cause loss of work. If it is too hot, it is difficult to work, the brain becomes dizzy, and the eyes become dark. It doesn't feel good. Then I go to the washroom to freshen up and come again after a while. Then our supervisor and our line chief (supervisor) yell."

Male Worker, Factory 2, IDI Participant

In contrast, one factory worker suggested that heat exposure did not affect the factory's productivity overall, because whenever the workers fell sick because of heat or any other illness and went on leave, the workers were replaced by other workers. One of the interviewed workers stated that,

"No, it [the heat] doesn't affect the productivity much, and if it affects anyone, then it can be filled up by another. If anyone gets sick, any of the workers can be replaced by him."

Female Worker, Factory 1, IDI Participant

However, the situation is more complicated than this, as expressed by one of the interviewed BGMEA officials:

"Many people are working on a floor. When more people work on a floor, breathing becomes a problem. If there is not enough ventilation, then it becomes a problem. Like there are 50 machines in a line, the production line is hampered if two people become sick. It is required to replace those two people and getting two people with the same experience isn't easy. Then they have to reduce the line number like if there is a line with 20, then we reallocate them to 18."

BGMEA Official, KII Participant

All key informants expressed their thoughts regarding the impact of heat on the performance and productivity of the workers. BGMEA and government informants indicated that the guideline temperature of 24°C is not frequently met with temperatures on the factory floor frequently exceeding this. Most of the key informants thought that productivity would increase when workers could work at an ideal temperature.

Consistent with views of the workers themselves and other key informants, ready-made garment management officials were aware that heat affects the worker's health particularly mentioning fatigue. They indicated that because of this, workers took more time than expected, resulting in less production. In addition, during summer days, the worker became sick more, and the absentee rate of the workers was high, which impacted reaching of production targets. One of the interviewed supervisors of a garments factory reported that,

"The workers faced an obstacle in completing the target. Heat-related illness of the workers creates the absence of the workers. When the body sweats in the heat, the body becomes weak. Then they cannot work for a long period."

Consistent with the views of garment management KII, the factory doctors believed that heat-related illness and productivity were linked. When the workers remained healthy, there was no issue with performance and productivity. The factory and the workers missed meeting the targets when the workers took leave for a few days due to sickness and this occurred most often in summer months:

"We found a good number of patients with such heat related illnesses at the end of June to the first week of July. In previous months, from January to May, when the weather was not so hot, these illnesses occurred less among workers, and the production rate was also good. The number of patients increased during June and July."

Doctor, Factory 1, KII Participant

And:

"If the workers don't get comfort [while working], they will have problems, and there will be no mental satisfaction. Then they are giving 80 or 90 [pieces] instead of 100 [pieces]."

Doctor, Factory 2, KII Participant

The BGMEA officials confirmed the links between heat and productivity with speculation that efficiency of the workers is generally reduced to 50% due to heat making it difficult to achieve targets.

5.3. Heat mitigation strategies

5.3.1. Hydration

Hydration is a key mitigation measure for heat stress and it appears there is a high awareness in workers, supervisors and the industry about its importance.

Most of the workers indicated that during the summer season, they commonly felt thirsty and the need to drink water at regular intervals. Most of the workers reported that they felt thirst because of the excessive heat on the factory floor during the summer season, especially in June to August. Workers indicated they were concerned about the effect of drinking less water while working. Most of them were aware about the impact of drinking less water on their health but indicated their drinking water habits depended on the heat and their workload and expressed that it was difficult to drink sufficient water due to workload pressures.

Workers have their own water bottles (1-1.5litres) beside them at their work stations and some of them indicated that they refill two to three times daily. Water provision for refills seems to be adequate with infrastructure provided on each floor in both factories of study.

Factory 1 had no such restriction from the authority side to intake water. The workers worked in the factory from 11 hours to 12 hours daily, and the doctor of the factory suggested that workers should drink at least five to six liters daily while working in the factory. He stated that:

"If they drank enough [water], they would not be weak. We encourage them [to drink water], but they cannot do it due to work pressure and their unwillingness. They engage in work heavily and do not drink water."

Doctor, Factory 1, KII Participant

There appeared to also be a high awareness of the need for access to quality drinking water with a BGMEA official indicating it was the duty of the factory authorities to ensure safe drinking water for the workers:

"Water is part of compliance. If the water of any garments is not hygienic then it will not be a part of compliance. So there is always drinkable water in every garment. I do not think there is a problem with drinking water in any garments."

BGMEA Official, KII Participant

And at the factory level:

"Water purification system is installed on every floor for the workers. Firstly, the water is pumped from underground sources and it is not from WASA line. This water is then purified by the purification system installed. This water is tested by icddr,b every year."

Garments Factory Owner, KII Participant

Despite the provision of water stations on each floor, many workers of *Factory 2* said that due to work pressures of the quota system, sometimes the workers did not take the opportunities to drink water frequently as this would require stopping to refill. They indicated a reluctance by authorities to encourage them to take a hydration break to ensure adequate production. A few of them said that they faced scolding from supervisors if they took a break to refill water bottles or use the toilet:

"The supervisors speak angrily which is mentally stressful. Such as, what is the reason for doing less work? Work must be submitted within the time [deadline]. Does the company not pay us? Why will the company's work be reduced? The supervisors say such things…I drink less water for fear of hearing these, but work must be done properly."

Female Worker, Factory 2, FGD Participant

One NGO official further added:

"She [the female worker] needs permission from her supervisor to leave her seat. The work [that] she is doing then she needs to leave it and go for other thing [works], and supervisor observes how many times she leaves her place. Though many of them carry water with them, but they have to refill it. If she drinks more water then she needs to go to the toilet frequently, and supervisor will ask, "Why are you going [to the toilets] again and again? based on the assumption that she is hampering the work."

NGO Official, KII Participant

An important health consequence of inadequate hydration, particularly for female workers, was identified by one factory doctor who also identified a worker preference for saline water:

"The habit of drinking water [of the workers] indicates to consuming less water. Especially women consume less water and that's why we create awareness [among the workers]. Many women get urinary tract infections due to less water intake and face many problems. We suggest them to drink 12 glasses of water or drink three liters of water daily. Because of awareness many workers drink [that amount of water], and many do not. But they prefer saline more, thinking that drinking saline will make them feel better."

5.3.2. Break/rest times

Formal and informal breaks/rest times are important for workers to reduce the risks of both heat stress and exertional fatigue. They can provide opportunities for physiological and cognitive recovery, as well as refueling and rehydration. RMG workers of *Factory 1* indicated that they had formal break times up to three times a day: for morning snacks, lunch and evening snacks. There was no specific time for morning tea and evening snacks, however they were allowed to visit the canteen for morning tea and snacks and evening snacks for 10 to 15 minutes. Despite the availability of a canteen and the 'allowance' to have breaks, many workers indicated they were unwilling to go for morning and evening snacks as they preferred to continue to work at that time in order to meet their daily targets:

"Morning tea time is in between 10:00 and 11 for ten minutes to fifteen minutes. Every worker can go to the canteen, but they do not. There is no barrier to go for it. As the canteen was opened from the company. But due to workload we cannot go."

Male Worker, Factory 1, IDI Participant

These breaks were not compulsory and the extent to which they were encouraged by management was not explored. However, the factory doctors were very supportive of breaks, understanding the challenges of working for long periods without rest and the value of breaks to worker wellbeing and productivity:

"I suggest every worker to walk for 15 minutes after working for 30 minutes, or one hour, or one and a half hours. So, your blood circulation can improve, which removes your monotony and enables you to work again."

Doctor, Factory 1, KII Participant

RMG workers from factory 2 indicated that they had a one-hour lunch break, staggered by group, sometime between 12.30 and 2pm. However, officially lunchtime was the only break time the workers usually had. The FGD with workers in this factory revealed that some workers felt it very difficult to continue work from the early morning to 1pm without any break. Further they sometimes faced barriers to take hydration and toilet breaks as the supervisors did not like them to take any breaks during their working hours. Workers expressed that they did not think that their supervisors saw the benefit of breaks for food or water as they only thought about the time taken out from being productive.

The workers of *Factory 2* had suggested to the management and asked for a morning snack break for 10 minutes to 15 minutes around 10am. This was seen as particularly important for the many workers who start work without having had any breakfast:

"I think it would have been better if I had given some time in the morning, around 11am. Then I could have had water and breakfast. Even if this opportunity is given, it would be better. The advantage is that if many people do not eat in the morning, they can eat something and drink water during the break. A little energy in the body means a lot and it feels good."

Female Worker, Factory 2, FGD Participant

The worker stated that,

"If I go to [the canteen] have snacks, maybe the pressure [of hourly production] will remain on me for the whole day. Because of this, I will not be able to complete my target until the holiday. Then the pressure increases even more."

Female Worker, Factory 1, FGD Participant

Despite the concern expressed by some workers of not being allowed to break between factory start to lunch (around 5 hours), the manager indicated that their break of one hour following a five-hour work period was compliant with policy and regulation. An NGO official suggested that the drive to ensure daily quotas meant that allowing more breaks would impact factory productivity:

"They [factory authorities] want them [workers] to work more…12 hours instead of 8 hours. If their [workers] work time decreases by 30 minutes, their [workers] productivity will be decreased. The factory authorities will not agree to it [providing break time]."

NGO official, KII Participant

5.4. Heat mitigation preferences and barriers to use

From the literature (see a sample in *Section 3.4*) the most effective heat mitigation interventions appropriate for an indoor work setting were identified and discussed with KII. These included ventilation and space cooling (e.g., windows, ceiling fans, personal fans, air-conditioning, exhaust fans, evaporative cooling fan (air coolers), worker hydration, worker clothing, administrative changes like shift rescheduling and job rotation and worker behavioral change.

The key informants prioritised the ventilation system and space cooling as the most important heat mitigation intervention. They indicated that there were very few air-conditioned factories but that existing ventilation systems included table fans, ceiling fans, factory ventilation fan (a ventilation equipment attached with wall), air conditioning and maintenance of air flow among the floors so that the temperature remained cool for the workers. Though there was consistent recognition expressed by most of the KII that ventilation systems were essential for cooling workers and helping to maintain productivity they all indicated that it is not feasible to adopt air conditioning as a solution. They indicated the high installation and maintenance cost of air-conditioning. Though many workers though installing more ceiling fans was a good solution, all KII identified that installing more cooling devices like ceiling fans would be difficult due to lack of space. Most of the KII also mentioned that it is difficult to provide personal fans in RMG as they do not have sufficient space to promote this.

Passive ventilation was also mentioned with one KI identifying the value of cross-ventilation via use of openable windows in the absence of air-conditioning:

"I will keep ventilation in the first place because it will ensure a good environment. Main thing is that windows should be opposite of one another so that wind can pass easily. Factories do not have AC. So the first priority should be ensuring normal air flow."

Government official, KII Participant

One factory had ceiling fans, evaporative cooling fan, factory ventilation fans and windows as cooling options. It was observed from visits that cooling devices operated regularly and while workers were on the floor. The workers of the factories also reported that they did not find any difficulties in using the cooling options and that there was an electrician assigned to operate the cooling options in the factories. The workers thought that there were lack of spaces to set up new cooling options.

While there was universal agreement on the value of ventilation and space cooling, the issue of maintenance was raised by one factory health professional. This doctor also identified the value of temperature monitoring as a trigger to improve cooling when needed:

"Whether the adjustable fans are running properly or not and the large indoor fans are rotating properly or not - there are the constraints of monitored these. If one person can be kept to check that if these are running properly or not, he will only monitor these. Or whether the ventilation is working properly, or we can use a temperature meter to actually measure the temperature of the floor. If we see that the temperature is high, we can take more measures, maybe we should take care of the issues."

Doctor Factory (other), KII Participant

In one factory, workers indicated autonomy about how and when the cooling options were operated as per their need:

"We can turn it on ourselves whenever we need. There are switches to turn them on. There are people to control [means maintain] it. But when they are busy on other works or can't come to turn it on, we can easily turn it on."

Male Worker, Factory 1, FGD Participant

When asked to rank the interventions, most of the KII placed worker hydration after ventilation. They indicated that in particular during the summer season, dehydration was more of an issue and that it was important to provide cold water for drinking via drinking water taps in the three months of summer. Their comments demonstrated knowledge of drinking water relieving the heat and providing the energy required for workers to stay productive. One KII official demonstrated knowledge of the value of hydration for his factory workers:

"By drinking water, their health will be getting better, their fatigue will be getting relieved, and their energy will be increasing. Their bodies will be refreshing…"

Garments Officials, Factory 1, KII Participant

The KII ranked clothing interventions third after ventilation and hydration. They indicated that while the workers usually wore cotton clothes during summer, no specific dress code was enforced, and workers mostly wear clothes in which they felt most comfortable. The garment workers mostly wore light, loose and cotton clothes though cultural and religious norms, particularly for women mean that multiple layers of clothing are common and clothes cover much of the skin (e.g., arms, neck and shoulders). For example, male workers mainly wore short-sleeved shirts or t-shirts and long trousers (e.g., jeans or other) and female workers generally wore hijab and salowar kamiz (traditional fully covered dress) with full sleeve and some wore a burqa. There appeared to be knowledge of the cooling benefits of certain fabrics like cotton but there are certain expectations of clothing coverage and style based on culture:

“There are no rules for the dress code. Anyone can work here wearing jeans, shirts, and t-shirts. But you can't work here in a lungi (a traditional clothing for male). I prefer jeans, t-shirts, and shirts. But wearing cotton reduces extreme heat.”

Male Worker, Factory 1, IDI Participant

And this,

It is very effective of wearing thin and loose clothing. It let the workers feel less hot. If you wear heavy clothes, then you will feel the heat less. So if you wear thin and loose clothes during summer, the heat will be less.

Line Supervisor, Factory 1, KII Participant

The interviewed key informants placed fourth in the list of heat mitigation interventions presented to them was the notion of job rotation or changing hours of operation. Job rotation could reduce heat by reducing the hours working in particularly hot areas or doing particularly hot tasks. The nature of the industry is such that workers largely stay in one place on the floor, doing the same task all day and every day. For example, the sewers work in the same place and they are unable to change the seats. The ironing workers had a specific place for ironing the clothes and they had to work in the same place. One of the interviewed workers said that,

“I work in one place, there is no change. [The changing of place] depends on the job. But since I work in sewing, I mostly work in one place.”

Female Worker, Factory 1, IDI Participant

The idea of changing working hours (e.g., work could be done at night or in the evening or in the afternoon) was not seen as a viable option - the factory authorities and workers were not used to doing it in this way in Bangladesh. In this regard, there was uncertainty about this rescheduling of work strategy. The FGD and the IDI participants thought rescheduling of work would not help to reduce heat.

The behaviour of workers was ranked in the last position. There was some consideration that awareness was an important part of encouraging cooling behaviour with suggestions for individual cooling strategies like washing hands and face and drinking water could helpful to reduce the effect of heat exposure. Garment factory KII stated that in every summer season, there was a meeting regarding how individuals could do things themselves (workers) during hot days. The factory authority remind the workers to go to the washroom and to be freshened up whenever they felt the heat and to wear cooler, thinner clothes in summer. They also provide sessions to raise awareness about heat related illnesses.

6. Conclusions

This small qualitative study has revealed that heat is a workplace hazard in the RMG factories studied, that is most significant in summer and during the middle of the working day. Heat stress was most linked to jobs that include machinery such as sewing and ironing (heat generation) and/or activity (intensity) (e.g., ironing and cutting) and was influenced by clothing (e.g., close fitting hijabs in female workers which reduce the cooling potential of sweat evaporation). The proximity to a cooling device, such as a fan was also an important influence on heat perception.

Heat impacted workers in diverse ways with signs and symptoms of headache, fatigue, dizziness, nausea, loss of appetite mentioned. Some symptoms like headache, were particularly more frequent in summer. Factory health professionals also observed blood pressure issues and other informants identified higher absenteeism in summer. Factories provide some medical services and dedicated infrastructure, though it appears that in the summertime demand is higher and often the onsite infrastructure via health clinic is insufficient. Further, in the two factories of focus, there appeared no additional cooling of the health clinics. Health professionals served an important role in promoting rest, adequate nutrition, hydration and appropriate clothing. They also identified that demands for beds and absenteeism were higher in the summer months.

Access to health services in RMG factories included doctors and nurses and some infrastructure (dedicated spaces and beds for rest). This appears to be further supplemented in some areas by sector provided health clinics in areas of high factory density and agreements with nearby hospitals for emergency worker referrals, though the extent to which workers can access and afford these services and sick leave provision was not explored in depth. Factory employed health professionals played both a treatment and prevention role though most focus was on acute issues. They were aware of the impacts heat played on worker health and could articulate seasonal patterns of heat related illness signs. It appears that they play an important role in educating the workforce about appropriate clothing, nutrition, hydration and rest to cope with the work demands, particularly heat. Health professionals indicated increased demand in summer raising questions about adequacy of infrastructure to cope with this increase (e.g., sufficient beds for rest, sufficient ancillary support). Further, while protocols and supports are in place for severe and acute health risks like injury, consideration of treatment of HRI or screening for chronic related conditions such as kidney disease appears absent.

Productivity impacts are complex and exacerbated by the nature of an industry driven by volume and meeting quotas. Workers felt a high degree of pressure to meet daily quotas and the impacts of heat on worker performance and subsequent productivity (e.g., via fatigue) were identified by workers, managers and factory health professionals, particularly during summer periods. This production quota pressure also impacted on workers taking rests or hydrating sufficiently – both of which are important heat mitigation strategies. Interestingly, while one factory provided hydration stations and encouraged hydration breaks and the health professionals actively encouraged hydration, workers appeared unwilling to sufficiently hydrate due to the time impact of doing so (both drinking and then need for toileting) expressing concerns about meeting performance targets.

Thirst was commonly reported by workers and the *value of hydration* as a health protection action appeared to be widely promoted and supported by factory managers and health staff and acknowledged by workers in one factory. However, water drinking habits were highly influenced by workload pressures – both concern about not meeting production targets and concern about being scolded by supervisors for ‘not working hard enough’ i.e., when they request permission to get water or use the restrooms. Similarly, sufficient breaks from work (resting from the heat) were influenced in two ways. Firstly, in one factory, an insufficient number of breaks were included in the working day factory (a long break of 1-1.5 hours in the hottest part of the day). Secondly, while the other factory included three rest breaks across the working day and provided a canteen on site, workers reported that they did not often take their break so as to meet their production quotas. This is concerning, and its importance was consistently identified by NGOs, health professionals and the BGMEA, particularly as health professionals reported that some workers did not eat breakfast before starting and that officials interviewed indicated that legislation required that workers must not work for longer than five hours in between breaks.

When asked about which *cooling options* were most important, ventilation and space cooling are considered key to providing a comfortable environment for workers to reduce heat stress and improve productivity. This aligns with higher orders of heat risk control as per the Heirarchy of Control which are more effective for sustained risk mitigation. The types of space cooling varied across the factories but included different types of fans, evaporative cooling devices and passive ventilation through use of window opening. The expense of cooling like air conditioning was considered prohibitive and increasing ceiling fan or personal fan use was identified as being difficult due to space constraints. For effective cooling the need for regular maintenance and appropriate guidance on operations was commonly identified. Along with maintaining hydration, consideration of cooler clothing choice was a focus of health advice, though clothing recommendations were not enforceable and heavy fabrics, high level of skin coverage and layering of clothes is common, particularly for women. Administrative changes such as job rotation and changing hours of production were not considered viable.

7. Limitations

- Due to project scope and access constraints, workers from only 2 factories and management, health professionals or owners from 5 factories only were included. Hence generalisability of these findings to the entire sector is not possible, but instead this study facilitates the identification of further inquiry questions that could be used to identify research needs or generate training and support guidance for the sector.
- This research did not examine any of the guiding government policy or industry guidelines related to buildings and design, workplace health and safety or energy efficiency workplace, hence any differences in policy and practice identified are based on individual perspectives of informants.
- While the researcher used the best available evidence on heat mitigation for RMG workers to structure questions about heat mitigation solutions, available evidence on feasibility and effectiveness is largely derived from outdoor workers and/or from HIC settings.

8. Recommendations for practice, policy and research

This small study has revealed that heat is an important issue for workers and factory supervisors, health professionals and managers, manifesting in heat related illness signs and symptoms that are greater in summer months and have flow on productivity impacts.

Short term solutions to reduce heat stress must continue to be a focus, though to be effective, workers must be supported to utilise these solutions without personal implications (e.g., being scolded or working back long hours to meet daily targets) when they impact productivity.

- There appeared to be a high level of awareness of the role of hydration in protecting worker health in factory staff (inc. supervisors and health professionals) and some workers, but production quotas appeared to deter individuals from stopping work to adequately hydrate, even though some workers identified that staying hydrated helped maintain their productivity. Similarly, breaks in work when offered, are not always taken. This suggests that when appropriate (e.g., During the hottest times) regular hydration and rest breaks should be enforced by management, through appropriate and enforced work-rest-hydration protocols built into daily schedules.
- Clothing can impact on heat risk and hence research that considers cultural and religious practices along with fabric, fit and style considerations to minimise heat risk provide another potential cooling solution

Medium to longer term research and policy activity could include:

- The development of an *industry wide summer heat system* to optimise heat mitigation efficiency and reduce costs, to be developed that includes a trigger (based on some temperature and relative humidity monitoring within factories), identification of factory hot spots and most at-risk workers and identification of a set of strategies that are actioned when indoor temperatures reach particular levels. This could focus on those locations and for those workers where heat risk is greatest and include enhanced hydration provision and enforcement, enhanced work-rest cycles and increased use of mechanical ventilation in high heat risk areas. Such a system could also be linked to any broader heat alert systems that may be developed city-wide or nationally. Some preparedness strategies around maintenance of ventilation systems and power supply security (for powered ventilation systems) and awareness raising programs with management and workers could be developed and be integrated into an annual cycle of heat preparation and mitigation.
- Potential for administrative changes - *job rotation* is a common administrative strategy used by workplaces to reduce exposure to workplace hazards, but the nature of work in the RMG sector and the design of workflows means that individuals are trained in one task and do this task all day, every day. Administrative changes to working protocols was not considered a viable heat mitigation strategy by most informants. This has impacts on those working in the highest heat risk jobs (e.g., those who exert the most energy or work with machinery that generates heat) who should be considered for job rotation to reduce their time spent in high heat work, and/or be a focus of targeted cooling efforts, such as increased mechanical cooling, increased hydration, and increased rest periods. Consideration of *hours of operation* so that production occurs during the coolest period of the day could be considered as a sector-wide strategy to be explored by the government and the sector. This would require a detailed examination of the cost-benefit (including workforce impacts) of changing factory production times during elevated temperature periods.
- Self-reported health signs and symptoms of heat related illness, confirmed by factory health professionals were most apparent in summer suggesting an impact of heat on worker health. *Better surveillance of heat-related illness* and other potential associated health conditions, such as injury, would improve the evidence base about who is most vulnerable (demographics and where in the factory) and when (time of day and time of year) and hence assist with better targeting cooling strategies to those people and the higher heat-risk jobs. Better *measures of health service demand* would also assist in ensuring health infrastructure is sufficient (sufficient cooling in clinics and sufficient water and resting infrastructure) to meet need, particularly during summer months. Addressing these issues would require development of an enhanced workplace health surveillance process to better inform actions taken in the future as the heat risk increases.

9. Appendix A. – Dissemination presentation in Dhaka (November 2022)

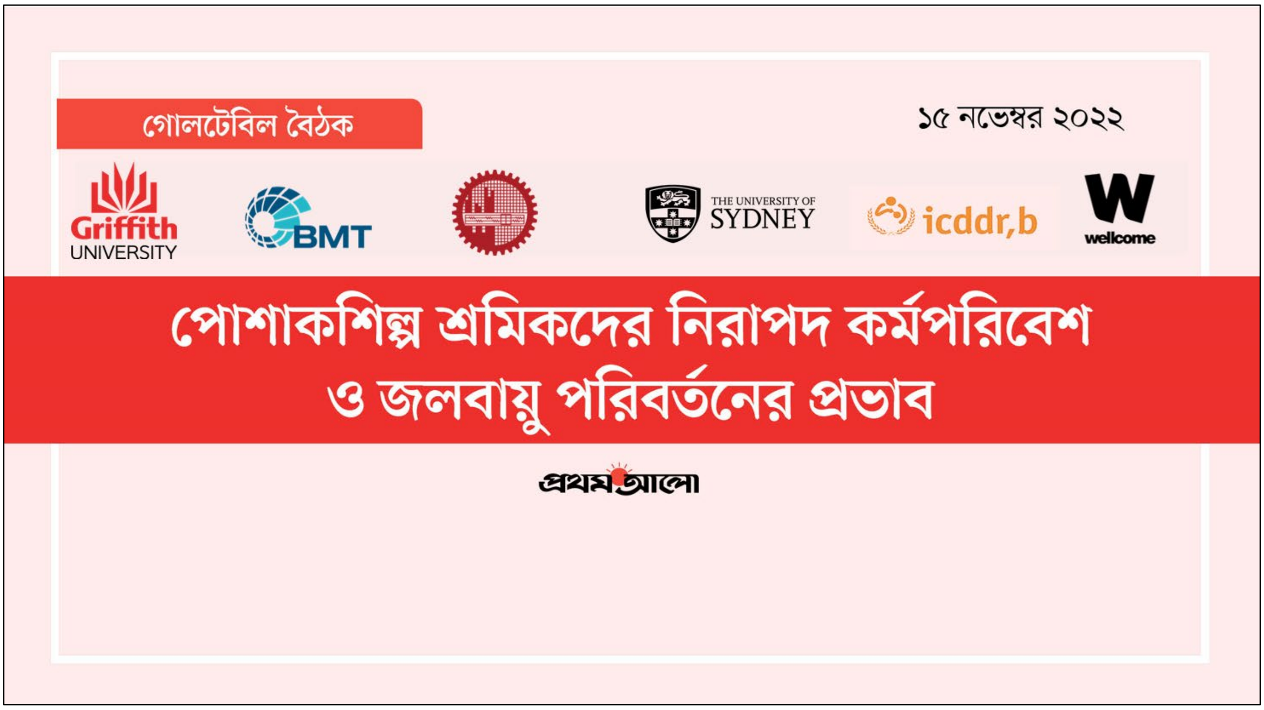

Figure A. Flyer for dissemination round-table discussion.

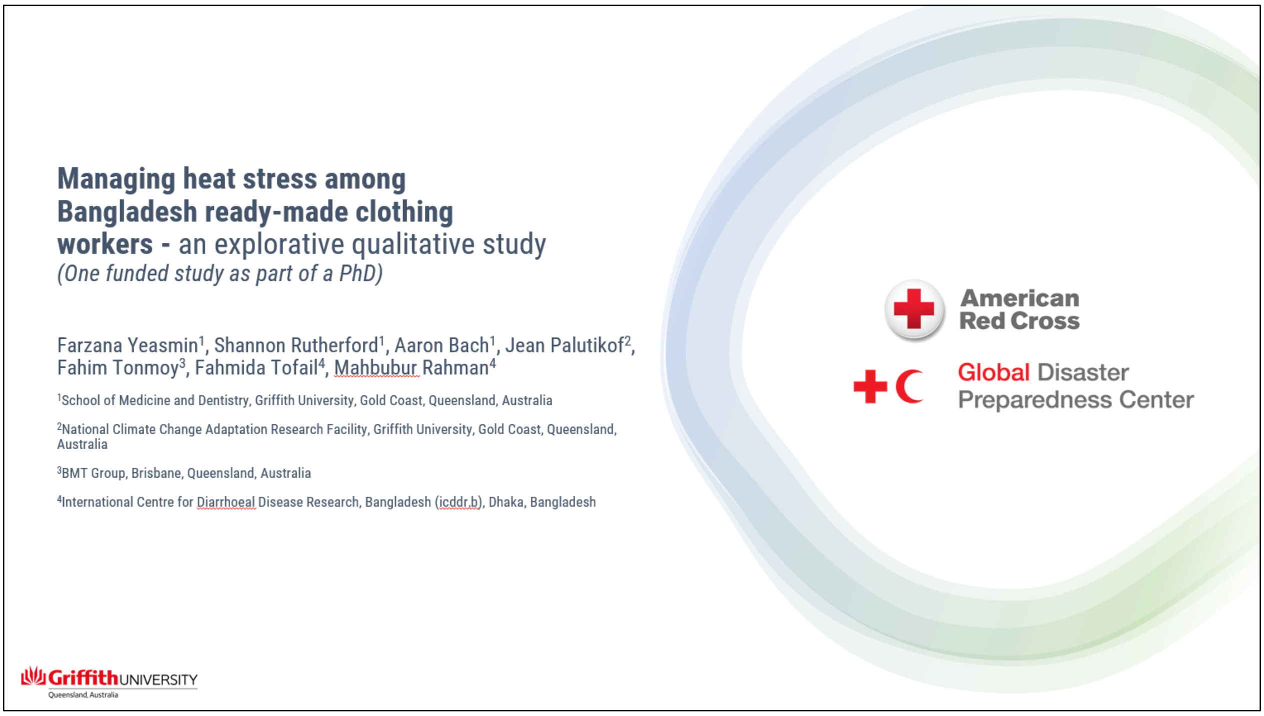

Figure B. Presentation of Farzana Yeasmin for the round table event.

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