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Heat stress and adaptive capacity of low-income outdoor workers and their families in the city of Da Nang, Vietnam

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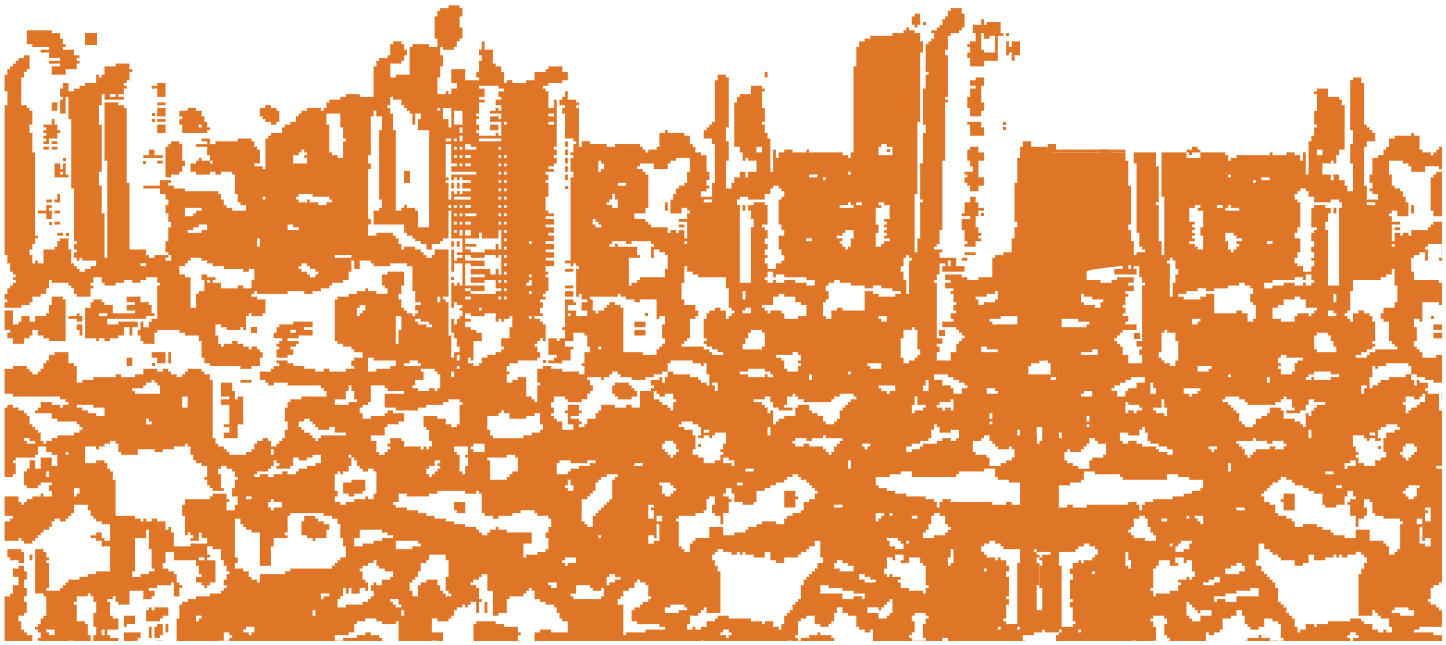

Acronyms

ACCCRN	Asian Cities Climate Change Resilience Network
CCCO	Climate Change Coordination Office of Da Nang
CDC	Centers for Disease Control and Prevention
COHED	Center for Community Health and Development
CtC	Challenge to Change
CSOs	Civil society organisations
DONRE	Department of Natural Resources and Environment
DOLISA	Department of Labour, Invalids and Social Affairs
FGD	Focus group discussion
HCVA	Hazard, capacity and vulnerability assessment
IDI	In-depth interview
IPCC	Intergovernmental Panel on Climate Change
MOH	Ministry of Health
MONRE	Ministry of Natural Resources and Environment
MOLISA	Ministry of Labour, Invalids and Social Affairs
SPRCC	Support Program to Respond to Climate Change
WHO	World Health Organization

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Abstract

As global average temperatures rise, heat-related illnesses are emerging as a major health issue, with extreme temperatures being a leading cause of weather-related fatalities in many cities. Heat stress is a particular concern in outdoor occupational settings in developing nations such as Vietnam, where access to cooling systems is limited.

This study, conducted in Da Nang city in 2012, explores the impact of heat stress on unregistered migrant and outdoor workers, and examines the factors influencing their adaptive capacity. The study employed both qualitative and quantitative research methods, including questionnaires, in-depth interviews and policy reviews.

The study finds that heat exposure in the workplace is prevalent and serious, with the vast majority of workers reporting very hot conditions in the workplace. This is compounded by the fact that the provision of adaptive measures by employers is limited, leaving workers to find their own solutions. This is especially the case for poor female, freelance, migrant outdoor workers, street vendors and workers in medium and small private enterprises, including construction workers, stone workers and other outdoor occupations. These groups tend to be among the poorest, with limited access to public services, local social support programmes or healthcare provision. Their knowledge of adaptive and coping mechanisms to deal with heat stress is also limited. At home, they employ coping rather than adaptive measures. The legislative framework to regulate occupational hygiene and safety in the workplace and to protect workers' health is comprehensive. However, its implementation is challenging because of the complexity of the regulating documents, the lack of resources within the responsible agencies, and the lack of cooperation and compliance with the law by employers. There is no formal guidance protecting workers' health in the context of increased and more frequent heat waves, and no regulations on hygiene and safety for outdoor workers.

Appropriate responses will therefore become progressively urgent to protect vulnerable workers from extreme temperatures. Findings from this research support the application of interventions by a range of actors, including government guidance measures for employers, improvement of health services in the treatment of heat stress, and capacity development among the outdoor working population to build their knowledge and awareness of, and resilience against, heat stress.

1 Introduction

1.1 Climate change and health

During the last 100 years, the mean global average surface temperature has increased about 0.74°c . Over the past 50 years, more widespread changes in extreme temperatures and precipitation have been reported and the rate of change has increased over time (IPCC 2007). It is estimated that it will go up a further 1.8–4.0°c (estimated average 3.0°c) by 2100 (IPCC 2007).

Concomitant with these changes, there is an increasing interest in the implications of climate change for health. In 2011 at COP 17 in Durban[1], health was identified as an adaptation priority, and a series of events highlighted aspects of health and climate. These included the Durban Declaration, which calls upon climate negotiators to rapidly advance climate mitigation policy measures, while also supporting health-oriented adaptation actions (WHO 2011).

In simple terms, the expected health impacts of climate change worldwide are typically distilled to concerns over heat stress, cardiorespiratory disease, diarrhoeal disease, malnutrition and food insecurity, health impacts of extreme weather events, and changes in infectious disease distribution (McMichael *et al*. 2003; Confalonieri *et al*. 2007). The anticipated health effects of climate change are global in scope but their impacts will almost certainly fall most heavily on the poorer populations of the world. As mean temperatures rise with global warming, so there will also be an elevation in the extreme temperature and extreme heat events experienced in future years (Hales *et al.* 2003, Fischer and Schär 2010; Kintisch 2009; Meehl and Tebaldi 2004). The burden of heat stress is therefore likely to become ever more serious, especially in regions of the world already experiencing intense heat extremes (McMichael *et al*. 2008). Efforts to better understand how extreme heat will affect population health, especially among the most vulnerable groups, are necessary (Ebi 2008, WHO 2009b).

A number of epidemiological studies have examined high temperatures in relation to total non-accidental deaths (McMichael *et al*. 2008; Stafoggia *et al*. 2006), to cause-specific mortality (Barnett 2007; Hertel *et al*. 2009), an increase in mortality (Basu and Samet 2002 in Nag *et al.* 2009) and to other health outcomes such as emergency department visits and hospitalisations (Knowlton *et al*. 2009; Wang *et al*. 2009). Heat increases the vulnerability of persons with cardiovascular, respiratory, and/or cerebrovascular diseases (Langkulsen *et al*. 2010). In fact, extreme heat is the biggest cause of weather-related fatalities in many cities, responsible for more deaths annually than any other form of extreme weather (Luber and McGeehin 2008; WHO 2009a). The IPCC indicates that hot weather is likely to increase future heat-related mortality (IPCC 2007a).

What is important to consider in this context is that with changing climate patterns, frequent heat episodes may impact areas currently not affected by extreme heat. The population in those areas might be at a greater risk, due to an insufficient physiological adaptive capacity and lack of awareness of associated risks and mitigation measures (Haines *et al*. 2006 in Nag *et al*. 2009).

1 *The 17th Conference of the Parties (COP 17) to the United Nations Framework Convention on Climate Change (UNFCCC).*

The aim of this study is to use a case study of outdoor workers in Da Nang, Vietnam, to increase awareness of the relationship between the health of workers and the changing climate, particularly rising temperatures. The study examines the coping mechanisms and adaptive capacity of outdoor workers who are most vulnerable to heat stress, as well as their knowledge and awareness of risks and impacts posed by working in extreme heat.

The findings show that heat exposure in the workplace is prevalent and serious, with the vast majority of respondents reporting working in very hot conditions. Impacts from heat stress include physical symptoms combined with losses in productivity and financial strain. Almost all the participating workers lack the appropriate knowledge to respond in the event of heat events, and adaptive behaviour in the workplace was limited. At home, they employ coping rather than adaptive measures. Barriers to suitable adaptation include a clear absence of measures to address heat stress by employers and authorities – despite relevant legislation, with a lack of resources and regulation being key.

These findings demonstrate that climate change impacts can affect the well-being of workers, as well as their productivity in the workplace. Appropriate interventions to protect workers in the workplace are recommended, with a particular role for employers and the relevant government agencies, as well as mass organisations (state-sponsored mass membership social organisations such as the Women's Union) and civil society organisations. At the same time, the adaptive capacity of workers should be enhanced through health education. In this way, the impacts of climate change on temperatures in urban areas should pose less of a threat to the well-being and productivity, and hence livelihoods, of vulnerable groups.

1.2 Heat stress in occupational settings

Heat is an environmental and occupational hazard. In occupational settings, global temperature changes will increase direct heat exposure in many working places around the world (Kjellström *et al*. 2009b), in particular in developing countries (Holmér 2010; Nilsson and Kjellström 2010), where workplaces may be without cooling systems (Hyatt *et al*. 2010).

The main industrial sectors in hot countries that are directly affected by increasing average heat exposures include agriculture, fisheries, forestry and construction work, with indirect impacts on tourism, health and finance/insurance sectors. Almost two billion of the world's farmers are vulnerable to impacts from climate change, mainly in Africa and Asia (Nilsson and Kjellström 2010). Better information on the probability of extreme heat occurrences will also increase the accuracy of projections concerning the health impacts of climate change (Gawith *et al*. 2009)

Heat-related illness is caused by an inability to maintain normal body temperature, because of excess heat production or decreased heat transfer to the environment. Heat stroke arises when cellular injury is caused by excess body temperature. When body temperature exceeds 39°c, acute heat disorders (heat strokes) may occur; above 40.6^{o}c, life-threatening severe hyperpyrexia or thermal injury starts to occur (Leithead and Lind 1964). Even before injury takes place, an individual may suffer transient mental and physical impairment, which is called heat exhaustion. Heat stroke is a medical emergency that is associated with a mortality of approximately 12 per cent in adult patients (Jardine 2007). In addition to heat exhaustion and heat stroke, there are a range of illnesses related to exposure to heat, including heat cramps, heat rash, heat oedema and heat syncope (dizziness and fainting, due to dehydration, vasodilation, cardiovascular disease and certain medications) (National Health Service 2012).

Heat stress at work is a real threat. Heat stress on workers depends on four environmental factors: air temperature, humidity, mean temperature of the surrounding area, and air movement (Srivastava *et al*. 2000). When levels of physical activity are high in a hot working environment, the worker is at risk of increased core body temperature (above 38°c), diminished physical work capacity (Kerslake 1972; Bridger 2003), diminished mental task ability (Ramsey 1995), increased accident risk (Ramsey 1983) and eventually heat exhaustion or heat stroke (Hales 1987). The main factor underlying these effects is the increased core body temperature, but dehydration due to sweating and inadequate liquid intake is also of major importance. Symptomatic exhaustion and clinical diseases, particularly kidney disease (Schrier *et al*. 1970) can be the result of excessive dehydration (Bridger 2003).

Information from the National Health Service (2012) shows that outdoor workers in cities can be vulnerable to exposure to urban heat island effects. Urban heat islands may arise due to increased absorption and reflection of the sun on concrete compared with green or brown spaces; reduced cooling from breezes due to buildings; and increased energy production from houses, industry, businesses and vehicles. High temperatures are also linked to poor air quality, with high levels of ozone which are formed more rapidly in strong sunlight. Small particles (PM10s) also increase in concentration during hot, still air conditions. Both are associated with respiratory and cardiovascular mortality. Additionally, there may be increases in emissions from power stations due to an increase in energy use for air conditioning.

Kjellström *et al*. (2008) find that climate change, particularly increased temperatures and duration of warm weather in Asia, may impair health and productivity for millions of working people. Workers may need to work longer hours to achieve the same output. Lin and Chan (2009) also identify that outdoor workers are at risk of morbidity and fatality. Heat stress also increases the possibility of work-related morbidity and injuries (Cortez 2009); higher heart rate and blood pressure (Nainate *et al*. 2006; Biswas *et al*. 2011); and the aggravation of several chronic diseases, including cardiovascular and respiratory diseases (Langkulsen *et al*. 2010).

Exposure to extreme heat presents a health hazard to all who are physically active, particularly outdoor workers in low- and middle-income tropical countries who are involved in heavy physical work, working in strong light, and with minimal access to cooling systems while working (Hanna *et al*. 2011, Kjellström *et al*. 2009a). To protect workers from excessive heat, a number of heat exposure indices have been developed. One that is commonly used in occupational health is the Wet Bulb Globe Temperature (WBGT). The work capacity rapidly reduces as the WBGT exceeds 26–30°c and this can be used to estimate the impact of increasing heat exposure as a result of climate change in tropical countries (Kjellström *et al*. 2009a). Internationally, the WBGT as a heat stress index is empirical and widely recognised (Holmér 2010). A regional map of heat exposure found that the high WBGT values (particularly in South Asia) have already caused excessive occupational heat exposures during the three hottest months over 1975–2000. If continued climate change increases WBGT by 3°C, the maps identify areas where occupational heat stress in non-cooled workplaces will be extreme (Hyatt *et al*. 2010).

Measurement of heat stress risk and the health impacts of heat is also of growing concern from a public health perspective (Kjellström *et al*. 2009b; Luber and McGeehin 2008; Hanna *et al*. 2011; Hyatt *et al*. 2010). A number of studies have been carried out to explore the heat stress in tropical countries, particularly in Asia (Srivastava *et al*. 2000; Lin and Chan 2009; Cortez 2009; Langkulsen *et al*. 2010; Kalpana *et al*. 2010). A study of Thai industries reported that heat problems existed in 24 per cent of small enterprises (Yunibhand *et al*. 1991). Another study in Korea found that heat is greater when working in an outdoor environment (Lee 2012). Langkulsen *et al*. (2010) explored the impact of climate change in occupational settings in Thailand and revealed that productivity as perceived by the workers in the construction and pottery industry fell by 10 to 60 per cent, with the outdoor WBGT highest at 34.6°c between noon and 1.00pm. A recent study further found that upwards of 28 per cent of workers employed in multiple processes were at risk of heat stress-related health impairment (Ramalingam *et al*. 2009). Kalpana *et al*. (2010) carried out a case study on heat stress-related perceptions in different industrial sectors in southern India, and found that there was a noticeable disconnect between worker's perceptions and their ability to secure workplace improvements from management in relation to heat stress.

To date, many studies have found the association between extreme heat, health impacts and productivity in both developed and developing countries. But more research is needed on the impacts of heat stress on outdoor workers, particularly in developing countries (Kovats and Hajat 2008; Lin and Chan 2009; Langkulsen *et al*. 2010; Nilsson and Kjellström 2010; Ramalingam *et al*. 2009; Huang *et al*. 2011a; Nag *et al*. 2007; Kjellström 2009; Balogun *et al*. 2010). The linkages between thermal loads and physiological consequences have been widely studied in non-tropical developed country settings (Kalpana *et al*. 2010). In many developing countries like Vietnam, despite the widespread recognition of the problem, limited attempts have been made to estimate health impacts related to occupational heat stress – and fewer yet to link heat stress with potential productivity losses, particularly among outdoor workers. This is reflected in the ubiquity of workplaces with limited or no controls to reduce heat exposure (Ramalingam *et al*. 2009). Therefore, further research on the impacts of heat stress on workers will help decision makers in planning adaptation strategies and communicating the future health risks of extreme heat to the public generally and to outdoor workers particularly.

1.3 Adaptation methods

To reduce the health impact of heat, a number of methods can be introduced to reduce morbidity and mortality for workers. These included hazard avoidance, physical avoidance, thermo-regulatory behaviour and seeking medical attention (Wolf *et al*. 2008). However, effective preventive measures or adaptive measures will reduce occupational heat stress, but may be more difficult in an outdoor environment than in an indoor one. This study examines the coping and adaptive capacity of outdoor workers in response to situations of extreme heat. In this instance, coping measures can be regarded as immediate, short-term responses, while adaptive measures are taken with a longer-term, planned perspective.

In developing countries, public health adaptation essentially can operate at two levels, namely, adaptive capacity building and implementation of adaptation actions (Huang *et al*. 2011b). Adaptation methods include acclimatisation, increased use of air conditioning, modified behaviour patterns, improved building designs and better urban planning and land-use patterns (Huang *et al.* 2011b; Luber and McGeehin 2008; Younger *et al*. 2008). Particularly for outdoor workers, heat-related illnesses and deaths are largely preventable through behavioural adaptations, including increased fluid intake.

Research on understanding adaptation to heat stress has been undertaken in other contexts. For Europe, Kovats and Jendritsky (2006) list health education, heat early warning systems, building design, cooling and ventilation, the provision of shade in urban environments and seeking of shade as some forms of adaptive response to heat stress. There can also be a mix of individual, social and organisational forms of adaptation. Nevertheless, the work by Wolf *et al*. (2009) underlines how far there is to go, even in high-income countries, if the vulnerability of key groups such as the elderly is to be reduced in the face of rising climate risks.

Other adaptation measures include heat emergency plans, warning systems and illness management plans. One heat stress assessment among workers found that productivity improved with new rehydration measures (Cortez 2009). In this project, workers were provided with more rehydration solutions and water during their work schedule. As a result, awareness among workers concerning heat stress prevention was increased. The implementation of heat-related health warning systems is becoming more widespread, and these systems may reduce the health risks from heat waves (Ebi and Schmier 2005). Heat stress is likely to be common during hot seasons, but culturally accepted methods to reduce impacts on health and work capacity are generally considered effective in avoiding serious health impacts (Kjellström *et al*. 2009b).

To protect workers from the effects of heat exposure, protective guidelines have been developed in both developed and developing countries (Ramsey and Bernard 2000). Some mitigation programmes have been introduced to reduce heat-related problems, for example in Thailand. These include the Work Improvement in Small Enterprise (WISE) initiative which aims to improve workers' productivity (Krungkraiwong 2005; Krungkraiwong *et al*. 2006) and the Work Improvement in Neighbourhood Development (WIND) initiative for farmers (Arphorn *et al*. 2006).

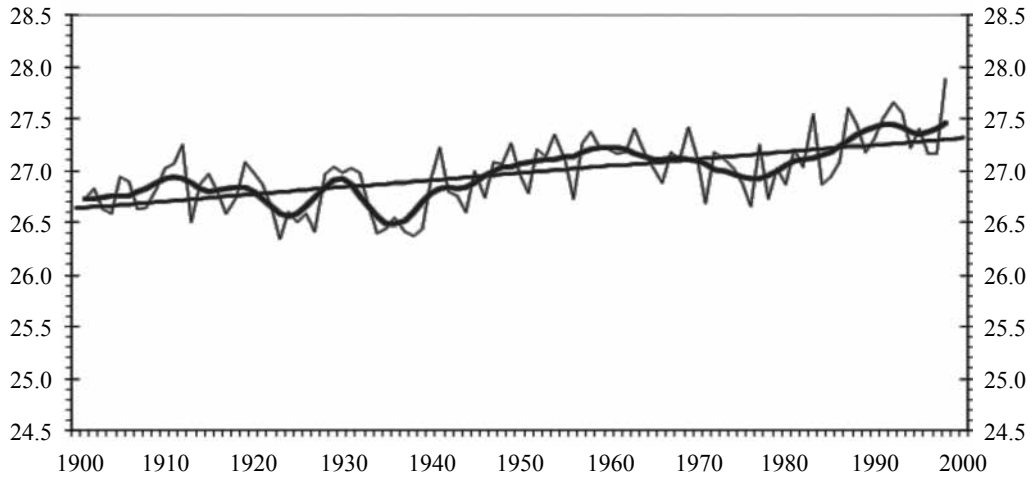
The management of heat stress in the workplace requires efforts from all stakeholders, without placing the burden only on employees. However, the impact of heat on workers' health has not been considered as a priority by decision makers. In addition, there is lack of awareness with regards to policy concerning maximum heat exposure at work in developing countries (Langkulsen *et al*. 2010).

1.4 Rationale for this study in Vietnam

Vietnam has already experienced climate change with average temperatures increasing by between 0.5 to 0.7°c in the past 50 years (MONRE 2011). The average estimated temperature for Vietnam is projected to increase by 2.3°c in 2100 (baseline period 1980–1999), although the changes vary across the country (MONRE 2009; UN 2011) (see Figure 1 below). Reports of climate change indicate that heat stress is affecting human health and placing stress on health services, as well as affecting agricultural yields, which impacts on livelihoods and food security. MONRE reported a 10–20 per cent increase in hospital admissions of young and elderly patients. During a heat wave in 2009, the National Geriatric Hospital admitted nearly 200 patients, double the daily average. MONRE also reported crop losses due to persistent hot weather,

with some provinces experiencing up to a 15 per cent loss. While not causing immediate health impact, the loss of crops limits food production and impacts nutrition after heat wave events.

Figure 1. Climate change in Vietnam – average summer temperatures (1901–1998)



Source: Dirk Schaefer 2003

Regulations and preventive actions for heat relief in developing countries are difficult to enforce due to the lack of equipment for measuring environmental conditions and a lack of awareness of potential hazards and strict time constraints imposed on workers (Lin and Chan 2009). Despite this, there is an urgent need to systematically and comprehensively assess the impact of a warming climate on workers' health and productivity. This should provide effective prevention strategies for a better working and living environment. The aims of this study are therefore to:

- explore the impacts of heat stress and the coping mechanisms and adaptive measures to respond to heat stress of poor unregistered migrants and outdoor workers in the city of Da Nang;
- examine the knowledge, awareness and perceptions of heat wave risks of the most vulnerable groups;
- identify the factors influencing local people's coping actions and perceptions;
- analyse key government policies and basic health services that can support the enhancing of the adaptive capacity of the most vulnerable groups; and
- provide recommendations to various stakeholders to enhance the adaptive capacity of those vulnerable to heat stress in the city.

These research questions are explored using both qualitative and quantitative tools to interview outdoor workers, migrants, and key stakeholders in the relevant ministries and NGOs in one of Vietnam's growing cities, Da Nang, on the coast of central Vietnam.

In 2009, a hazards, vulnerability and capacity assessment (HCVA) in Da Nang was conducted by British-based charity Challenge to Change (CtC), under the aegis of the Asian Cities Climate Change Resilience Network (ACCCRN). The HCVA results and the city's resulting Da Nang Resilience Action Plan showed that disasters and climate change have serious impacts on local people's health and lives (Challenge to Change 2009). Poor outdoor workers, including women-headed households and unregistered migrants (from rural areas and other provinces) are affected by climate events due to their exposure. Their vulnerability may be increased by the fact that they often work outdoors and reside in poorly constructed or cheap rented housing, with limited access to healthcare services, due to their lack of official paperwork. There is limited understanding of how these groups are coping with the increasing heat, what their perceptions are of future heat risks, and what influences their actions and adaptive capacity in both the short and long term.

2 Study design

2.1 Case study background

Da Nang is the largest city in central Vietnam and one of the country's most important ports. It is the fifth most populated city in Vietnam, with an area of 1255km² and a population of 887,069 according to the 2009 census. As of 2009, 87 per cent of Da Nang's population lived in urban areas; average annual urban population growth was 3.5 per cent. Da Nang has a tropical monsoon climate with two seasons: a typhoon and wet season (lasting from September to March) and a dry season (lasting from April to August). Temperatures are typically high, with an annual average of 25.9°c. Temperatures are highest between June and August (averaging 33–34°C), and lowest between December and February (averaging 18–19°C). The annual average humidity is 81 per cent, with highs between October and December and lows between June and July.

Data from the stations in Da Nang over the last ten years (2000–2010) shows that the maximum temperature has tended to increase at around 0.1°c per year, and the number of hot days (over 35°c and over 37°c) are increasing. In 2009, the hot period appeared early from mid-April, with maximum daily temperature of 37–38.3°c and the temperature difference during the day ranging from 10.2–12.7°c.

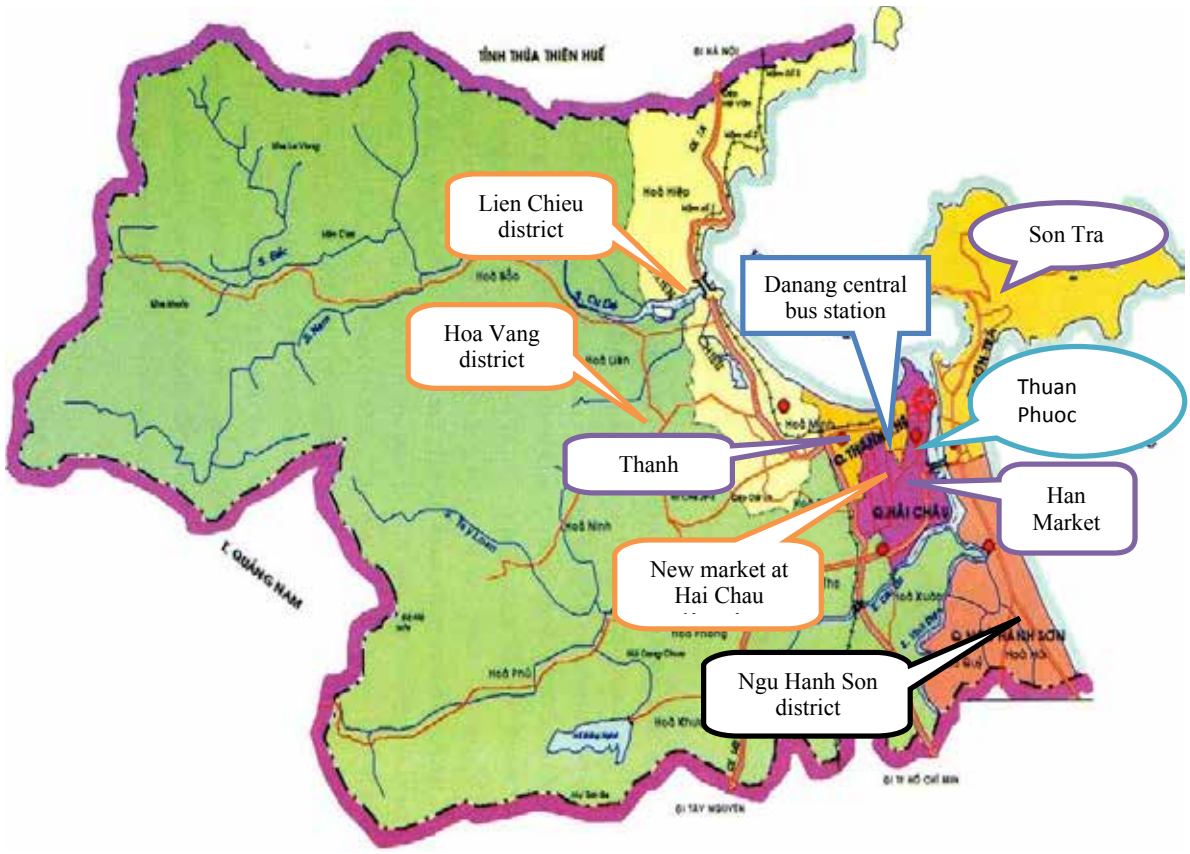
2.2 Methodology

Focusing on outdoor workers, and more specifically on migrant outdoor workers, this study uses a combination of quantitative and qualitative methods to ascertain the views of different groups in relation to their working and living conditions. This is combined with a review of existing policies and interventions regarding extreme heat, heat stress and adaptation plans in response to climate change in both Da Nang and the whole country. A more detailed account of the guiding documents and checklists can be found in the annexes.

As there is no complete of list of outdoor or freelance outdoor workers in Da Nang available, a convenient sampling method was applied to recruit subjects to participate in our study. To avoid any conflict of interest, all interviews in the survey were done anonymously. A total of 319 respondents agreed to participate and the sampling was carried out via several steps.

The research team worked with a local partner, the Preventive Medicine Centre, to list all major outdoor occupation groups in Da Nang. After this process, five major outdoor worker groups were identified, which included construction workers, fishery workers, farmers, freelance outdoor workers and porters. The locations for these groups were identified and mapped (see Figure 2). These were: Han market in Thanh Khe District, Da Nang central train station, new Han market in Hai Chau District, Da Nang bus station, Thuan Phuoc fishing port, construction sites in Lien Chieu, Son Tra and Hai Chau districts, and the stone-engraving village in Ngu Hanh Son District.

Figure 2. Sample sites



Source: Preventive Medicine Centre, July 2012

2.2.1 Quantitative surveys

A cross-sectional study with migrant outdoor workers in Da Nang was carried out using a pre-designed questionnaire via face-to-face interviews. The aims was to study:

- the socio-economic status of the respondents;
- occupational risks in the workplace under conditions of (extreme) heat;
- perceptions and understanding of extreme heat, heat stress and adaptation measures to heat in the workplace;
- impacts on health and other impacts when exposed to (extreme) heat in the workplace; and
- recommendations for appropriate interventions to improve adaptation capacity to heat exposure in the workplace.

The questionnaire was developed with reference to Centers for Disease Control and Prevention (CDC) guidance about heat stress and adaptive measures applied while working in hot conditions. Before data collection, this questionnaire (Annex 1) was tested with selected respondents in Da Nang and with health staff at the Preventive Medicine Centre to check that questions were understandable and answerable, using local terms that would be familiar to local people. The quantitative survey was carried out by a research team and health staff from the Preventive Medicine Centre. Before fieldwork commenced, data collectors were trained by the research team regarding interview procedures and how to approach respondents. The purpose of the study was clearly explained to all respondents and they were asked to sign a consent form

if they agreed to join the study. Qualitative studies with selected respondents were carried out by the research team. All interviews, IDIs and FGDs were recorded and transcribed for further analysis.

Excel STATA (version 11.0) was used to transcribe and analyse the data.[2] A number of descriptive statistical analyses (Chi square and logistic regressions) were performed to analyse the results of the surveys.

2.2.2 In-depth interviews

A qualitative study with key informants in Da Nang was also carried out (Table 1) in order to get in-depth information about occupational risks under conditions of heat exposure in the workplace; health and other impacts when exposed to extreme heat; and coping strategies of migrant outdoor workers (Annex 2 provides the checklist for interviews). Leaders of related sectors involved in protecting the health of workers were interviewed about current policies and regulations to protect the health of outdoor workers. They were also interviewed about the city's resilience plan in response to the impact of climate change and suggestions for the improvement of current policy and/or regulations in order to better protect the health of outdoor workers. Employers of selected enterprises and companies were asked questions regarding the occupational risks present in the workplace when working under conditions of (extreme) heat. They were also questioned about the health impact on their workers, their adaptive actions to protect the health of their workers, and recommendations for the development of policies and/or interventions to promote the protection of outdoor workers' health. The purpose of the in-depth interviews (IDIs) and focus group discussions (FGDs) was explained to all respondents, who signed a consent form before being interviewed.

Table 1. Participants in in-depth interviews (IDIs) and focus group discussions (FGDs)

	Number of people participating in IDIs	**Number of FGDs**	**Number of people participating in FGDs**
Migrant/low-income outdoor workers	14	2	19
Senior occupational health officers	4	1	7
Senior officer from Department of Labour, Invalids and Social Affairs (DOLISA)	1	0	0
NGOs staff	1	0	0
construction site employers	2	0	0
Total	**22**	**3**	**26**

All IDIs and FGDs were recorded and transcribed for coding and analysis based on topics of interest. The research team started with a set of general codes (e.g. heat stress events, impacts, vulnerability, responses, management, adaptation needs or healthcare), then developed a set of logical sub-theme codes according to the topics that emerged from the transcripts. The transcripts were then annotated with coding, and then similarly coded sections from different interviews collated and compared.

2 *Excel STATA is a data analysis and statistical software. See www.stata.com.*

2.2.3 Policy review

A review of current policies and/or regulations to protect the health of outdoor workers working in hot conditions and the city's existing resilience to climate change plan was carried out. This review aimed to understand the current policies and/or programmes at national and city level.

2.3 Study population characteristics

2.3.1 Socio-economic characteristics

Out of a total 319 people interviewed, male participants account for 58 per cent of total respondents.[3] The majority of respondents are aged between 25 and 49 and only 4 per cent are over 65 years old. Nearly 70 per cent of respondents are married and 25% are single. Most respondents have a low educational level with 73 per cent at secondary level and lower. There are significant gender division differences among the different occupation groups; while construction workers are mainly men, service providers are largely women. The women who participated in the study are significantly older than the men. There are also differences in age structure among occupation groups; construction workers are the youngest with over 81 per cent under 50 years of age, while under 50s are also the majority in service sector and other jobs. Men have a higher education than women; there are also significant differences in education levels among occupation groups, with those working in service provision having a lower education level than construction workers and others.

Regarding monthly income levels, 55 per cent of the respondents have an income in the range of US$100–250 and 34 per cent have an income level of US$50–100. Very few people have a very low income level of less than US$50 or more than US$250. A significantly higher percentage of men have a high-income level compared to women. Among occupation groups, construction workers earn the highest income, with most earning over US$100, while the majority of service providers earn under US$100. While some groups of workers seem to be above the government poverty level for income *per capita*, they also have to provide for dependents. Many of the respondents are living in rented accommodation in the city, with both its associated high cost-of-living and commuting expenses incurred while travelling back and forth from their provinces. Additionally, many freelance workers have unstable incomes, which fluctuate if they cannot work.

Only 36 per cent of the respondents are local residents of Da Nang. There is a significant difference in residential status among the occupation groups. While 69 per cent of people with other jobs in fishing or farming are local residents, the majority of construction workers and service providers are people from other provinces (henceforth referred to here as migrant workers).

2.3.2 Occupational characteristics

Respondents belong to four main occupational categories:[4] service providers and construction workers account for largest percentage of the whole survey sample (33 and 30 per cent respectively), followed by farmers (14 per cent) and porters (13 per cent). Very few respondents belong to other occupation groups, e.g. fishery workers and waste collectors (at 4 per cent and 6 per cent respectively).

Three-fifths of respondents have been working outdoors for more than three years, of which 27 per cent have been doing so for over 10 years. Only 26 per cent of respondents have participated in this work for less than one year.

Half of the respondents are freelance outdoor workers, and there are differences in gender distribution across job categories. Women are more likely to work in agriculture and service provision, while men work in construction and as

3 *See Annex 3 for detailed data.*

4 *See Annex 4 for detailed data.*

porters. More men are likely to have a salary, while the majority of women are self-employed, with no stable monthly income (97 per cent of service providers are self-employed).

2.3.3 Health status

Two-thirds of respondents regard themselves as having reasonably good health, though over 18 per cent think they have poor or very poor health, particularly among the women.[5] This is reflected in the fact that more of those working in service provision felt their health to be poor compared to those in construction.

The most common existing illness reported by respondents was hypertension, at 9 per cent, followed by cardiovascular and respiratory diseases. Nearly 20 per cent of respondents have other types of illness such as back pain, hypotension or headaches. Gender analysis shows that significantly more women have cardiovascular disease, hypertension and other illnesses than men do.

2.3.4 Access to public services and other social welfare programmes

The study's respondents have limited access to public welfare services and other social support programmes in Da Nang.[6] Slightly more than half of participants have health insurance, which is combined with social insurance and paid for either by the employers or by themselves. A higher percentage of men have health insurance compared to women, though there is no variation across occupation groups. Meanwhile, the accessibility and utilisation of other social support is very limited. More than 91 per cent of respondents have no access to any of other social support programme provided by the local authorities or mass organisations such as the Women's Union. Very few people have access to livelihood support programmes, job placement programmes and other types of support.

Health insurance is provided for employees by companies that have registered their business as required by the Vietnam Law of Health Insurance, regardless of whether they are local residents or migrant workers from other provinces. Freelance workers or farmers are encouraged to self-pay for their health insurance, so it can be inferred that all of those who do not have health insurance are freelance workers such as street vendors. Interviews with freelance outdoor street vendors revealed that many of them want to buy voluntary health insurance. However, they cannot because they are migrants without a temporary residential permit for Da Nang. The procedure to buy health insurance for migrant workers is more complicated than it is for local people. In addition, the health insurance premium is regarded as being too high (about US$25 annually).

> I can only buy insurance for the two children and my husband, as he is often sick with high blood pressure, to save the cost, but I cannot afford to buy insurance for myself.
>
> (IDI, female street ventdor)

Local freelance street vendors reported that they can get other forms of social support from local authorities and mass organisations, such as free health insurance or gifts every traditional New Year for the poor, or support from micro-finance or income-generation programmes. But migrant outdoor street vendors reported being excluded by local authorities and mass organisations, despite having lived in Da Nang for many years. Interviews with the city's labour, social welfare and invalid leaders show that migrant workers working for registered enterprises can enjoy better social support, compared to freelancers. Local respondents also reported they received benefits from local mass organisations such as the Women's Union or the Veteran's Union. In comparison, migrant freelance street vendors often have no access to local mass organisations such as these.

However, migrant workers tend to form their own informal networks, with people coming from the same province and working in the same jobs in Da Nang. The support provided through this informal network includes helping each other

5 *See Annex 5 for detailed data.*

6 *See Annex 6 for detailed data.*

when ill, sharing useful information about business or life in Da Nang, sharing experiences of treating common illnesses and providing small loans to each other (see e.g. Winkels 2008; 2012).

> We try to meet up among ourselves, only women. We agree on one date, so that all of us can come home earlier than usual, and try to buy some food to share. The group sometimes goes up to hundreds of people, meeting often once a year before the New Year break, and then each of us goes back to our provinces (…). We often share all sorts of information with each other, especially bad cases so that we can warn each other while working, lending each other money for children's school fees, and share guidance on various diseases and healthcare among each other…
>
> (FGD in Da Nang)

3 Risks related to heat stress

3.1 Risk of heat stress at work

Almost all respondents reported work under direct sunlight (95 per cent).[7] Quantitative data collected show that almost all of the respondents subjectively regard their workplace as hot or very hot – only 10 per cent think the temperature in their workplace is in the normal range. Very few people think their workplace is cool or very cool. While there are no gender differences regarding how hot men or women perceive their workplace to be when working under direct sunlight, there are differences in the subjective assessments of temperature in the workplace between men and women, with more men viewing their workplace as hot or very hot.

Reasons mentioned for increased heat exposure in the workplace include working in direct sunlight (73 per cent), the nature of their work (90 per cent) and clothing (38 per cent). Other explanations included work that requires carrying heavy loads. Nearly half of the participants reported working more than nine hours per day, which exceeds the limit set by the Law of Labour of Vietnam. More women have to work over eight hours per day than men. There is also a significant difference among occupation groups regarding working hours; while the large majority of people working in fishery, farming or other jobs and nearly 66 per cent of service providers have to work over eight hours daily, only 27 per cent of construction workers have to do so.

A fishmonger describes the conditions at her workplace, a common example for many other freelance outdoor workers/vendors in Da Nang:

> I wake up at 2am to withdraw fishing nets until 6am, then I bring fishes to market for selling in a place under direct sunlight. There is lots of sunlight, it burns me as well as the fishes and it makes me feel very tired… There is not only heat, there is also a bad smell from sewage and dead fishes…I sit in that place until I sell all the fishes, sometimes until after lunch time…
>
> (IDI with fishmonger)

The majority of respondents also regard their workplace as hotter than their home, mainly because of work under direct sunlight. This perception is particularly so among men – 64 per cent of respondents who are paid workers reported being provided with heat protective measures by employers (with a higher percentage of women workers compared to men).

7 *See Annex 7 for detailed data.*

3.2 Risk of heat stress at home

Half of the respondents live in rented accommodation, with women more likely to do so than men.[8] More than two-thirds of these houses have corrugated iron roofs and more women live in this type of house compared to men. Interviews indicate that 64 per cent of them subjectively assess their home as hot or very hot, and women are more likely to view their home as thus. Respondents felt that the reasons for their homes being hot in evenings were the corrugated iron roof, which absorbs heat during the day and retains the heat during the evening. Another reason was the lack of financial resources available to mitigate the heat in their homes, such as installing air conditioner or renovating walls or roofs to better insulate their homes.

> My house has a corrugated iron roof. In the summer, it is extremely hot inside the house. It is so hot that you cannot stand such heat levels. It is hot all day and night-time, even at 10 pm. It is so hot that I cannot sleep in my bed – I have to sleep directly on the floor.
>
> (FGD, freelance street vender)
>
> My house is of grade 4, which is a ground, brick house with corrugated roof. We have three fans, yet in the summer months, with the Laos wind, it is still so hot. When it is too hot, we cannot sleep, so we often clean up the floor with water, and sleep on the floor. I have to sleep much later, as it is cooler then, but I still have to get up in the morning for work at normal hour, which is rather tiring.
>
> (IDI, stone engraver)
>
> Those who sell lottery tickets coming from the same province, they often stay in one lodging with a group of 10–15 people, accommodated by the lottery owner. This is often of poor condition, especially in the summer.
>
> (IDI, street vendor)

3.3 Experiences of heat stress in the workplace

Forty-seven per cent of respondents reported experiences of heat stress-related signs and/or symptoms during the last 3 months, with 67 per cent of women reporting such symptoms compared to 33 per cent of men. This is reflected in the fact that service providers were most likely to experience symptoms (59 per cent) compared to construction workers (26 per cent).

The univariate analysis found that the likelihood of suffering heat stress-related symptoms during the previous summer was associated with socio-economic factors. Self-employed women aged over 50, with an income of less than US$100 and people with poor health are most likely to develop heat stress-related signs or symptoms while working in the summer in Da Nang, compared to other groups. Hot conditions both at work and at home are also related to the chance of developing health problems among outdoor workers.

Interestingly, in the multivariate analysis, self-employment status tends to become a protective factor. Statistically, self employed workers are less likely to suffer from health problems. However, after controlling for the confounding effect of a hot workplace or home, it appears that the groups most likely to experience heat stress-related symptoms are women and outdoor workers who profess to already having poor health. This finding is confirmed by the IDIs and FGDs, when women reported having more heat stress-related signs and/or symptoms than men. Women also tend to regards their homes as hotter than men do. The most common signs and/or symptoms that respondents usually or sometimes experience include headaches, dizziness, poor diet and insomnia (Figures 3–6).

8 *See Annex 8 for detailed data.*

Figure 3. Experiences of heat stress-related symptoms while working in hot conditions during the last 3 months (%)

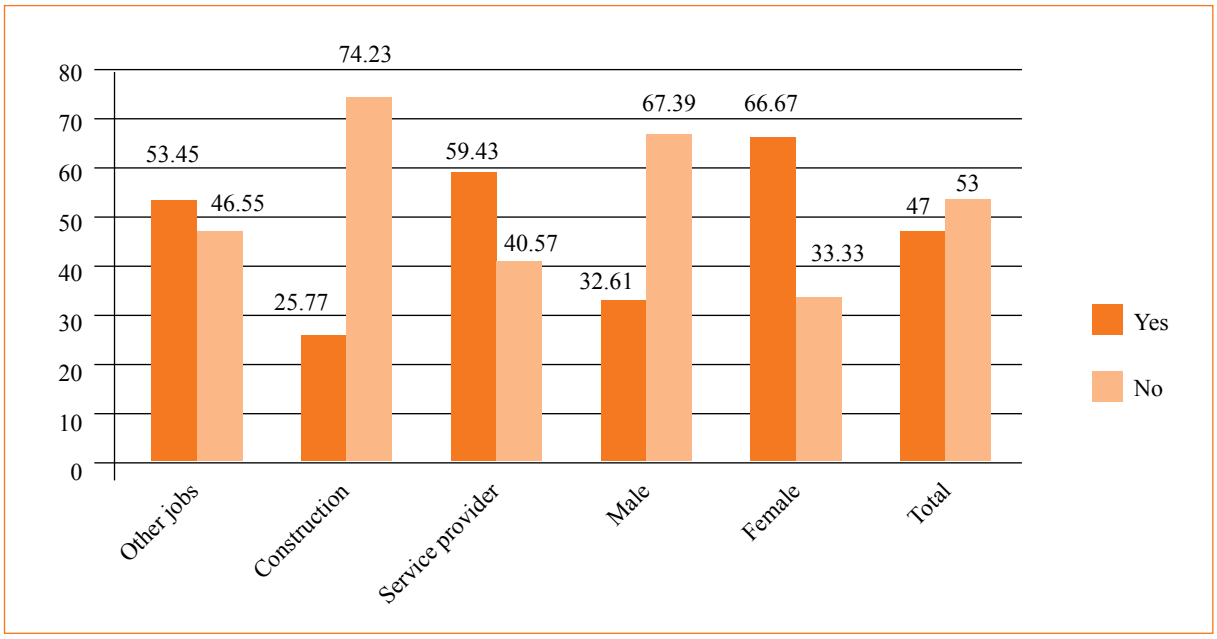


Figure 4. Common symptoms of heat stress (%)

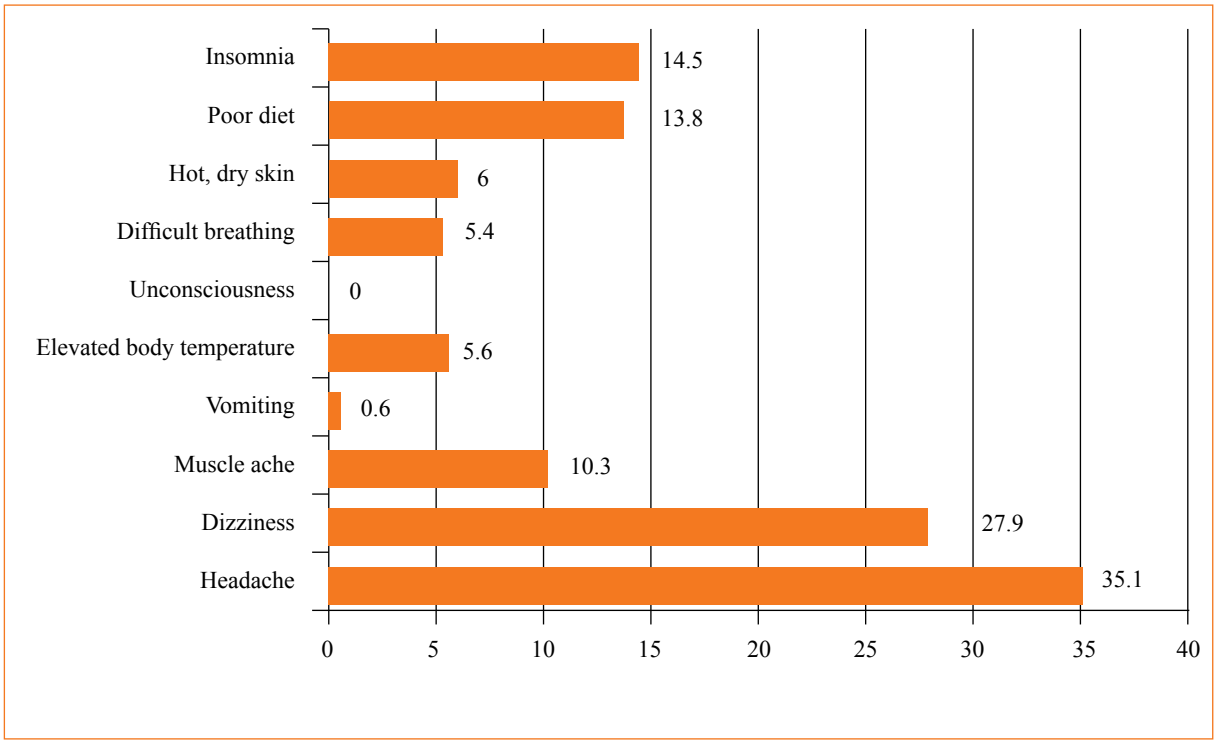


Figure 5. Other impacts of heat stress by gender (%)

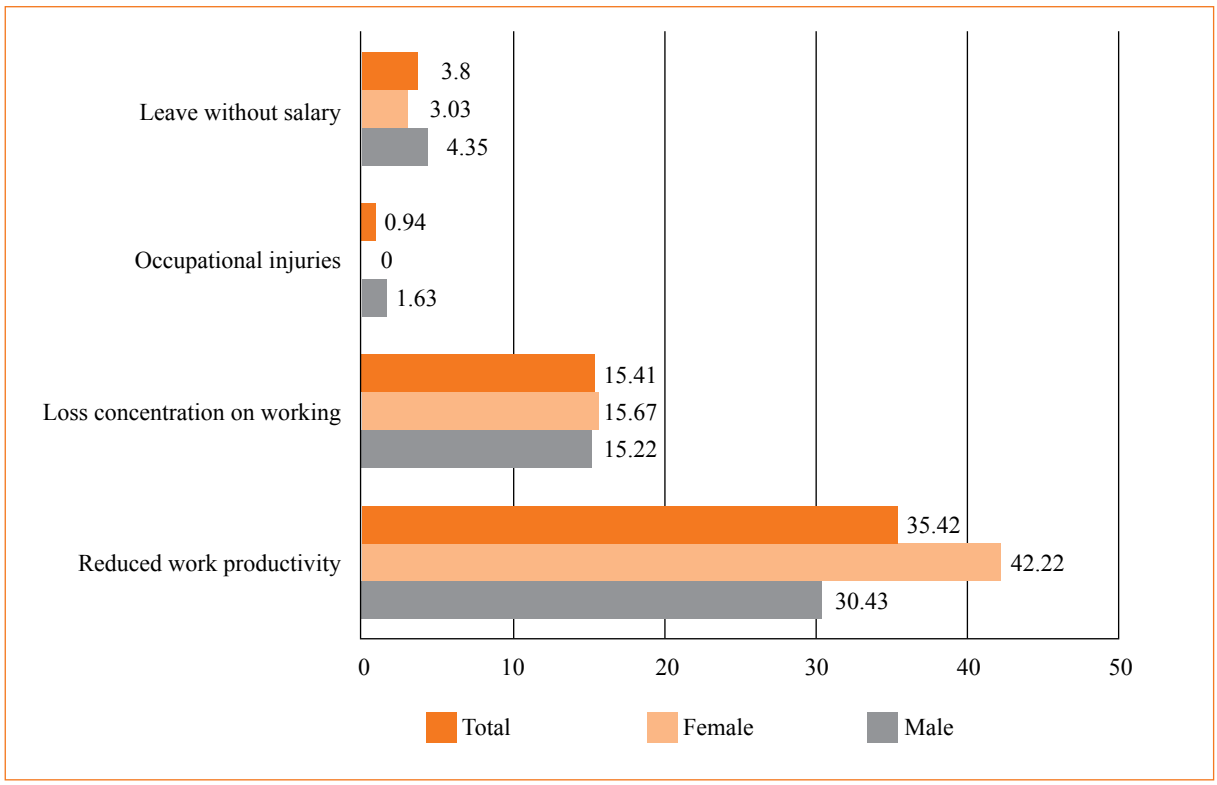
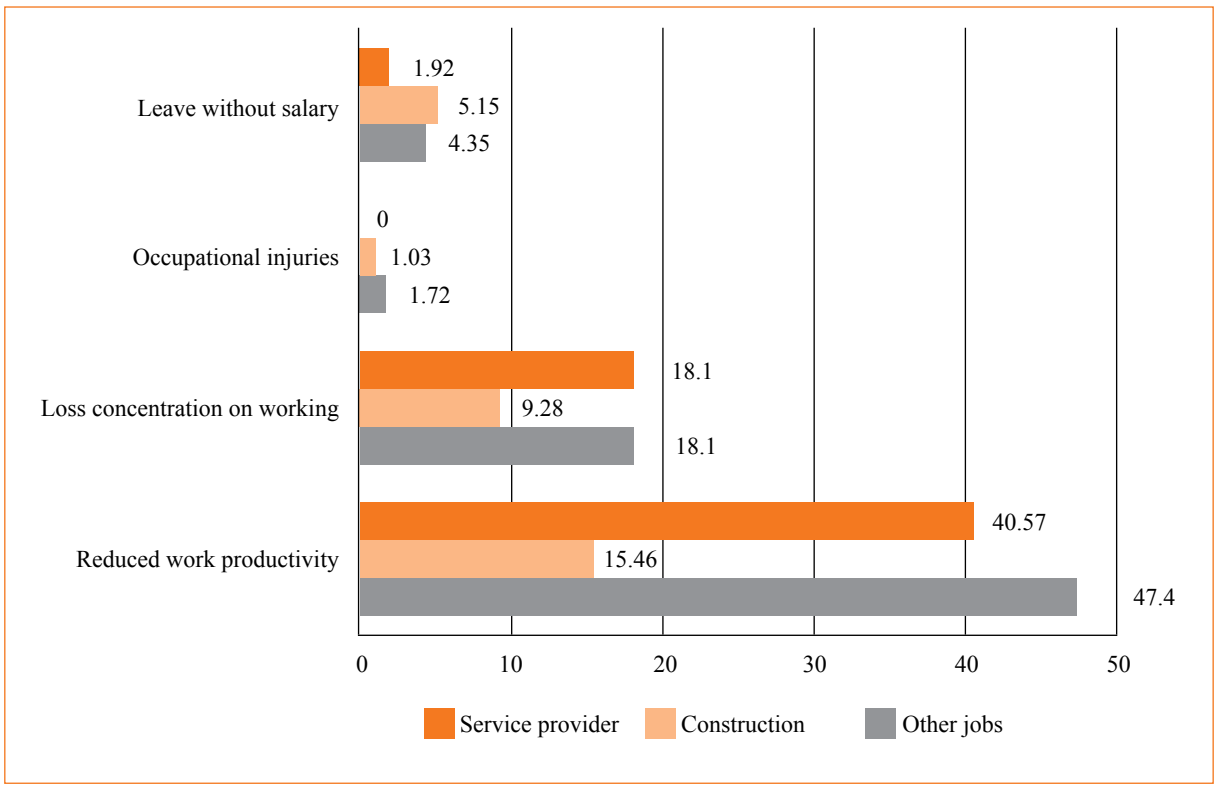


Figure 6. Other impacts of heat stress by occupation (%)



Besides heat stress-related signs, respondents also reported other impacts such as reduced work productivity, loss of concentration while working , occupational accidents and some people having to take sick leave without payment. More women experienced a reduction in work productivity than men (about 42 per cent of women compared 31 per cent of men) and construction workers are least affected by reduced work productivity. For most of those self-employed workers or those who work for small-scale businesses, illness can mean going without pay for days, with adverse impacts on family incomes, school fees, food supplies and additional costs such as for medicine.

> Once I was sick, off work… I did not have enough money for my children's school fees.
>
> (IDI with outdoor female worker)

> If I am sick, I have to have a day off, and during that day, I would not have money to spend, as I would have no pay. I would borrow the money to buy food and medicine.
>
> (IDI with outdoor female worker)

> If it is too hot and sunny, it causes sparkling against the white stones and against our eyes. This makes it much harder for us to work on the minute details of the statues, therefore affecting the quality of the statues.
>
> (IDI with stone engraver)

4 Measures to adapt to heat stress

In climate change literature, attempts at clearly defining the distinctions between coping and adaptation, and coping capacity and adaptive capacity in relation to climate change impacts have been varied, as noted by Pelling (2011). As the application and definition of the two terms is very context specific, it is therefore important to identify how the two concepts have been treated in this study.

'Coping' here has been used as a term which describes the reactive actions taken by participants in response to being impacted by extreme temperatures – the measures taken are short-term and reactive, with a focus on survival. 'Adaptation' has been used to reflect the actions taken by participants which are more accurately described as 'planned' measures to protect an individual from the known negative impacts of extreme temperatures. Adaptation measures are applied with a longer-term livelihoods orientation, by identifying and applying alternative options, including the use of both traditional and new strategies and knowledge.

4.1 Adaptation to heat exposure in the workplace

Respondents who are workers for registered employers reported that they were provided with some adaptive measures to reduce the risk of heat stress in the workplace (see Table 2). A very high percentage of respondents reported being sufficiently provided with drinking water by their employers, as well as being sufficiently provided with heat protective clothing or personal protective equipment. However, less than half of respondents reported that employers allowed workers to have sufficient short breaks during their working shift or longer lunchtimes, to avoid hot weather. Men are provided heat protective measures more frequently than women.

During focus group discussions, construction workers also reported that only big construction companies (government-owned or foreign-owned) provide their workers with water and protective clothing and equipment as required by labour laws (see Table 2). Small or private companies do not. Some of these companies/household enterprises provide water for drinking, but there can be uncertainty about the safety of the bottled water.

Table 2. Adaptive measures provided by employers in the workplace

Measure taken	Sufficient	Insufficient
Heat protective clothing	36 (41%)	51 (59%)
Personal protective equipment	47 (56%)	37 (44%)
Drinking water	86 (93%)	7 (8%)
Suitable short breaks scheduled to avoid the heat during working hours	29 (41%)	41 (59%)
Long lunch break to avoid the noon heat	31 (45%)	38 (55%)
Working schedule changed	5 (8%)	62 (93%)

The majority of freelance self-employed workers who were interviewed reported that they buy or get given protective hats, clothes and masks. As many of them are poor, they are often given their clothes, which might be of darker colours or made with unsuitable materials and thus ineffective in reducing heat.

However, in-depth interviews with employers show that all employers allow their workers to have breaks if it is too hot, changing the working schedule. Workers will be required to work early in the morning, i.e. at 6.00am or 6.30am and finish the morning session at about 10.30am; they will return to work late in the afternoon at about 2.00pm or 2.30pm and will stay at work until 6.00pm or 6.30 pm.

Although breaks are often allowed for those who work in small-scale enterprises, in-depth interviews show that workers still only take moderate breaks. This is because the employers are always present, and dislike their workers taking too many breaks, especially if they are busy with deadlines.

Big enterprises (with more than 500 staff) also employ health workers. They provide primary and immediate care in emergencies that might happen in the workplace. Severe cases are referred to the local health centre or nearby hospitals, either by the health workers or other company employees.

4.2 Adaptive measures to extreme heat used by outdoor workers in the workplace

Figure 7. Adaptive actions by outdoor workers by gender (%)

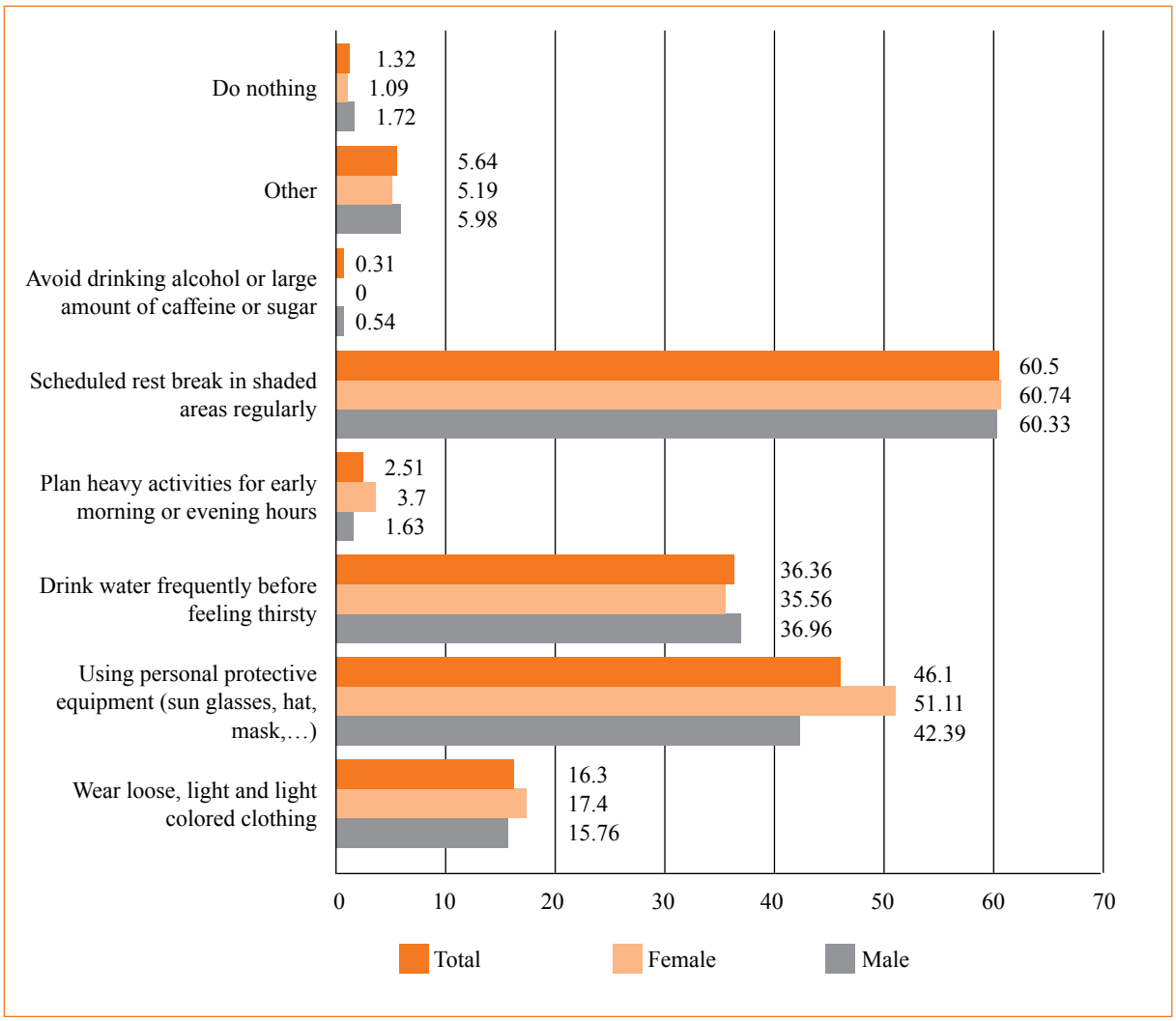
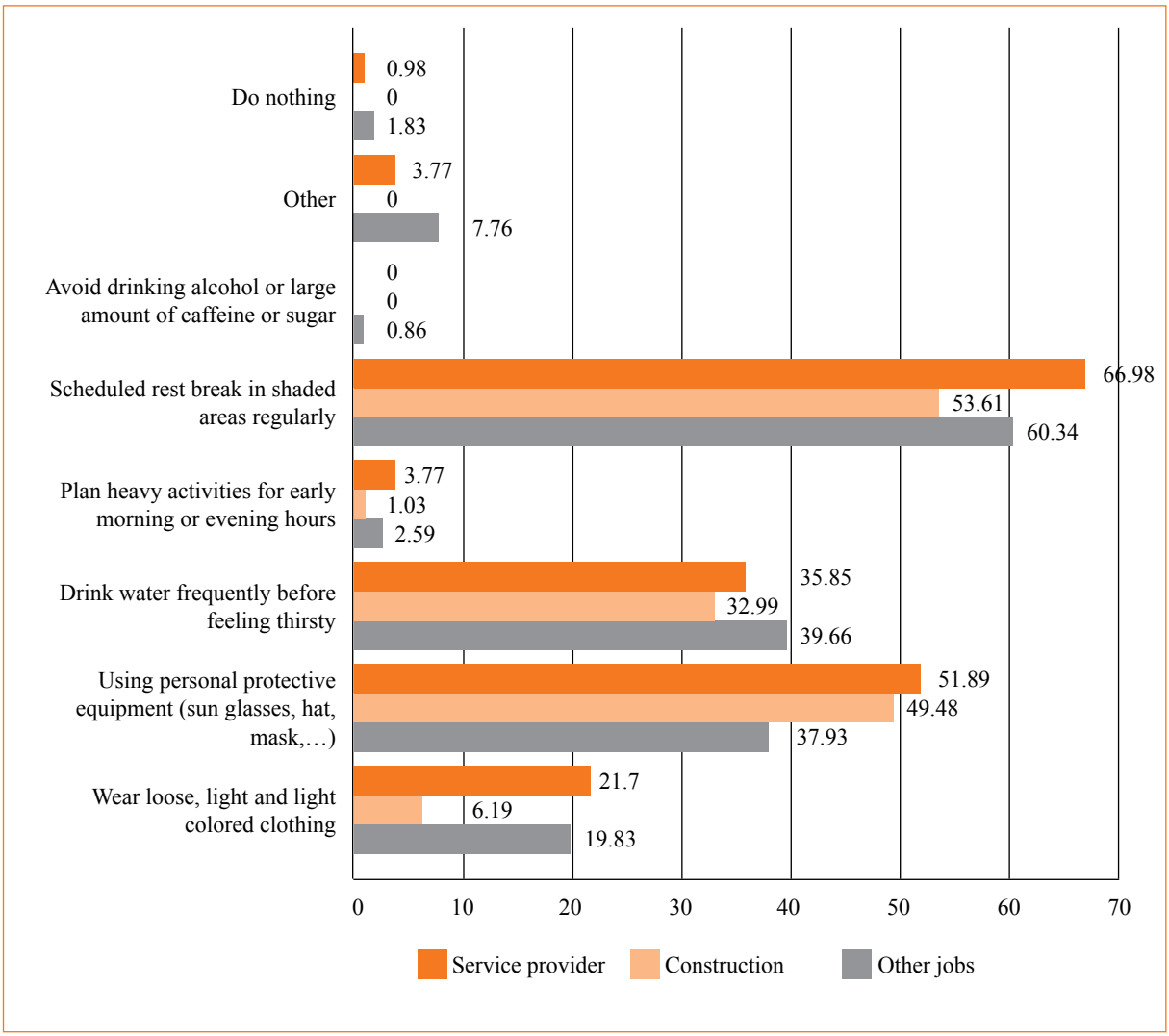


Figure 8. Adaptive actions in the workplace by occupation (%)



The most common methods that outdoor workers use while working in conditions of extreme heat are regularly scheduled short breaks in shaded areas, drinking water frequently, using personal protective equipment (sunglasses, hats and masks) and wearing loose, light and light-coloured clothing (see Figures 7 and 8). Women tend to use the latter means, while men are more likely to drink before feeling thirst. Service providers tend to apply these measures more often than the other occupation groups. However, the differences between gender and occupation are not significant. When scoring the level of adaptive behaviour to extreme heat, it appears that almost all of the respondents have poor, very poor or insufficient levels of adaptive behaviour (99.37 per cent) (data not shown). This low level of knowledge is consistent across all socio-economic groups. Self-employed outdoor workers are more likely to practice adaptive behaviours than hired employees. People who have heard about heat exhaustion are more likely to practice adaptive behaviours than those who have not (annex 9).

I have to work continuously over lunch time in order to sell lottery tickets... because people go to restaurants or beer pubs at that time so that I can sell lots of tickets… If I cannot sell the lottery and do not return the remaining tickets to the boss, I will lose my money. That's why I have to wander the streets…

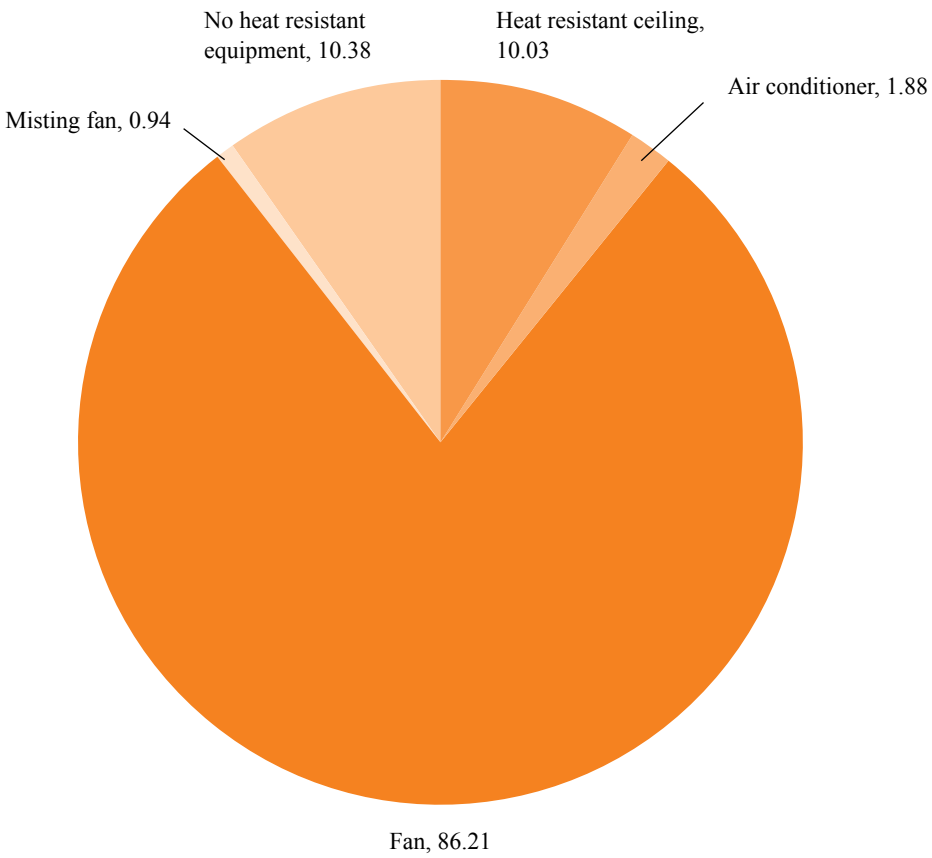
(FGD, freelance street lottery seller)

4.3 Coping and adaptive mechanisms at home

At home, people have limited options to reduce heat (Figure 9). The majority turn on fans. About 10 per cent have installed heat-resistant ceilings and a similar number use heat-minimising equipment. Very few of them use costly methods such as air conditioner or misting fans. About 10 per cent of respondents do not have any equipment to reduce heat at home, of which many are women and service providers. Via in-depth interviews and focus groups discussions, people also reported using other methods to cool their homes, such as opening the window to allow airflow, pouring water onto the floor to lower the temperature, hanging a sheet over the walls facing sunlight during day time, or placing a pot of water in front of the fan. Because indoor heat hampers their sleep, they choose to sleep directly on the floor after cooling it with water.

In-depth interviews with freelance street vendors revealed that they spend more money during the summer, due to increased energy use when running fans at home. Additionally, they use more water for cooling the house or for bathing. As a consequence, electricity and water costs nearly double during the summer time. This can affect family life as people have to reduce spending on food to supplement spending on electricity and water.

Figure 9. Coping and adaptive strategies for extreme heat at home (%)



5 Knowledge and perceptions of heatwave risks and adaptation measures

5.1 Perceptions and knowledge of heat stress

More than three-fifths of interviewed respondents perceived a temperature increase during the past five years.[9] Forty-three per cent of respondents also thought heat events have become more frequent in the area during the past few years; though 12 per cent thought they were less common now and 17 per cent perceived no change in the frequency of heat events. More people in fishery or farm work perceived temperature increases compared to construction workers and service providers. Likewise, a significantly higher percentage of them felt that heat events have become more common in Da Nang compared with people in the other two groups. Information from IDIs and FGDs showed that local residents in Da Nang perceive that the weather has become hotter during the last five years and there have been more serious storms during the last few years. Migrant street vendors feel that Da Nang is hotter than their hometown because there are fewer trees in Da Nang to help to regulate temperatures and provide cooling shade. A typhoon five years ago destroyed many large trees in the city, and in addition, the city council made the decision to prune all of the trees before the typhoon season.

During in-depth interviews, respondents showed a moderate understanding and knowledge about climate change. They reported having heard about climate change and global warming on TV or in the newspapers, describing it as a phenomenon leading to increased temperatures, more heat events and abnormal and more frequent storms or floods. People also cited some causes of climate change as arising from human activities such as transportation, production and consumption which generates waste. A high percentage of respondents perceive that extreme heat can cause serious health problems (78 per cent) and only 3.8 per cent said they did not know if it does or not (Annex 11). When asked about the association between heat waves and mortality rates, 42 per cent of them agreed with the statement though 24 per cent thought there was no link and the remainder were unsure. A significantly higher percentage of men and service providers thought extreme heat can cause serious health problems.

Only one-third of respondents reported having heard about heat stroke, and this lack of knowledge occurs across both gender and occupation groups (Annex 12). Logistic regression indicates that almost all socio-economic independent variables are not significantly associated with knowledge of heat stroke, except for resident status and education level. It appears that migrant outdoor workers tend to have a lower level of knowledge of heat stroke compared to local residents of Da Nang, and people with lower education levels have less knowledge compared to people with a high-school education and above (Annex 13). Of those who already know about heat stroke, 80 per cent display a fairly good understanding about the signs and symptoms of heat stroke.

9 *See Annex 10 for more information.*

Forty-three per cent of respondents have some knowledge of heat exhaustion. The logistic analysis reveals that knowledge of heat exhaustion is associated with a number of socio-economic variables, including age group, income level, resident status and occupation status. Older people, people with incomes under US$100 and migrant workers are more likely to have a lower level of knowledge of heat exhaustion. Meanwhile, self-employed workers tend to have better knowledge than hired employees (Annex 14).

Among those who have heard of heat exhaustion, the level of knowledge of the signs of heat exhaustion is relatively high – about 70 per cent. The level of knowledge concerning signs of heat exhaustion is not associated with most socio-economic factors, except for income level, with those earning less than US$100 having less knowledge.

Interviews with freelance outdoor workers confirmed the results of the quantitative survey. Very few people can list the most common heat stress symptoms. However, when asked about the health consequences of working in hot conditions, many respondents could list common signs of negative health impacts such as headaches, dizziness, sweating, thirst or having a dry mouth. However, it was noted that many people think heat stress signs are related to hypocalcemia as people regard fainting, fatigue or dizziness as related to a reduction of calcium in the blood.

5.2 Coping measures and knowledge of adaptive strategies to heat stress.

This research looked into the following with regard to heat stress and outdoor workers:

- past coping measures used by workers to address heat stress symptoms; and
- knowledge of adaptive measures that can be used to address heat stress.

Here, ‘coping measures’ specifically refers to actions previously taken by workers in response to heat stress symptoms: these actions are generally reactive. ‘Adaptive measures’ specifically refers to actions which could be taken by workers in the future to address heat stress and can either be reactive or anticipatory. To identify coping measures, the participants were asked about the actions they or their colleagues have taken in response to heat stress symptoms To identify their knowledge of adaptive measures they were asked about the actions they could take or plan to take in the future to protect themselves from heat stress. As questions in both categories looked at reactive measures to address heat stress, there is some overlap in the questions asked and the answers received.

Firstly, when the participants were asked about their past experience of coping with heat stress, most demonstrated coping measures by self-treating symptoms or receiving treatment from others (see Figures 10 and 11). Two-thirds of respondents moved into cool or shady areas and nearly half drank plenty of water. About one fifth of respondents reported buying medications to treat themselves or their friends and/or colleagues. However, 17 per cent of respondents reported doing nothing while experiencing heat stress symptoms in the workplace and continued to work. Further analysis shows that a significantly higher percentage of women bought medication to treat themselves than men did, and service providers were most likely to buy medication. Those who work in fisheries and farming drank more water and were more likely to go to healthcare centres than construction workers or service providers. When scoring the level of coping behaviours to mitigate heat stress conditions, it appeared that almost all participants use poor, very poor or insufficient measures to cope with heat stress conditions (data not shown). This is constant across all socio-economic variables such as gender, age groups, income levels, educational levels, residential status and occupational status.

Figure 10. Coping with heat stroke by gender groups (%)

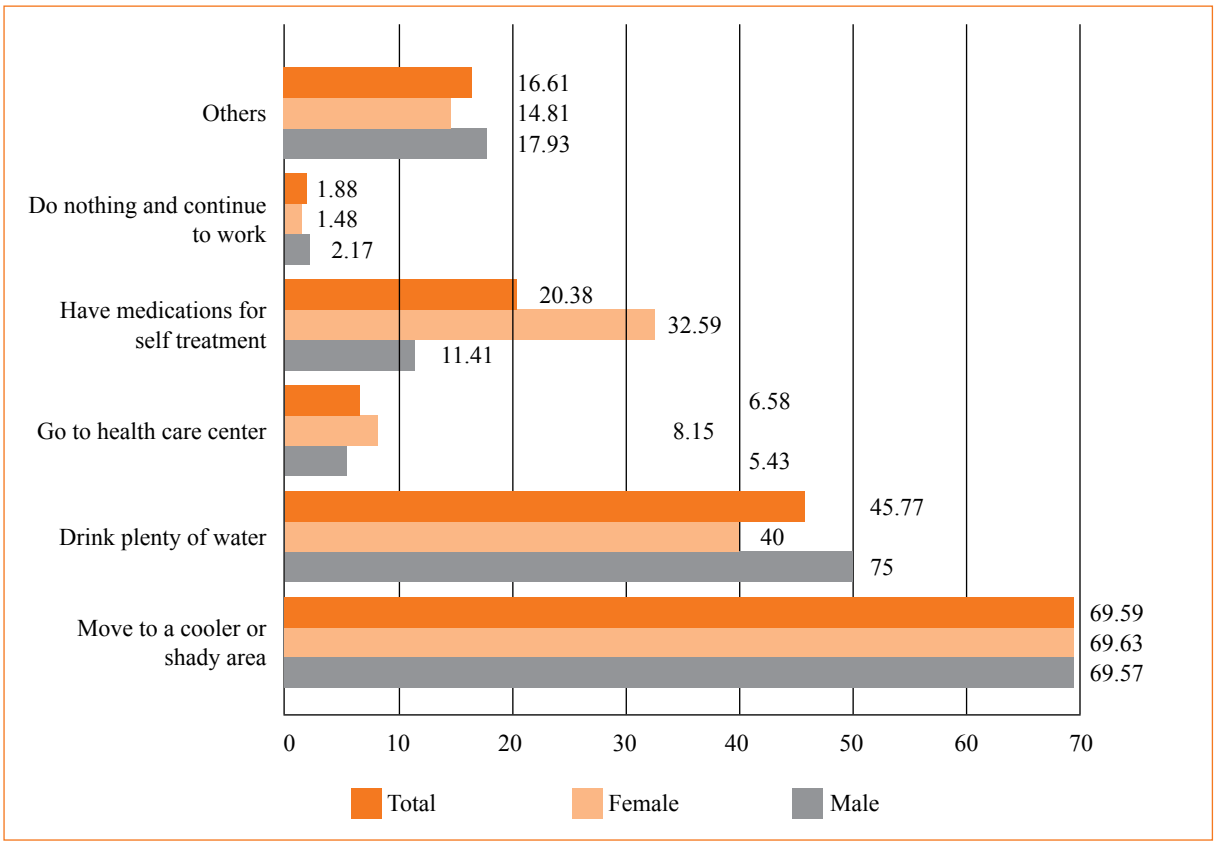
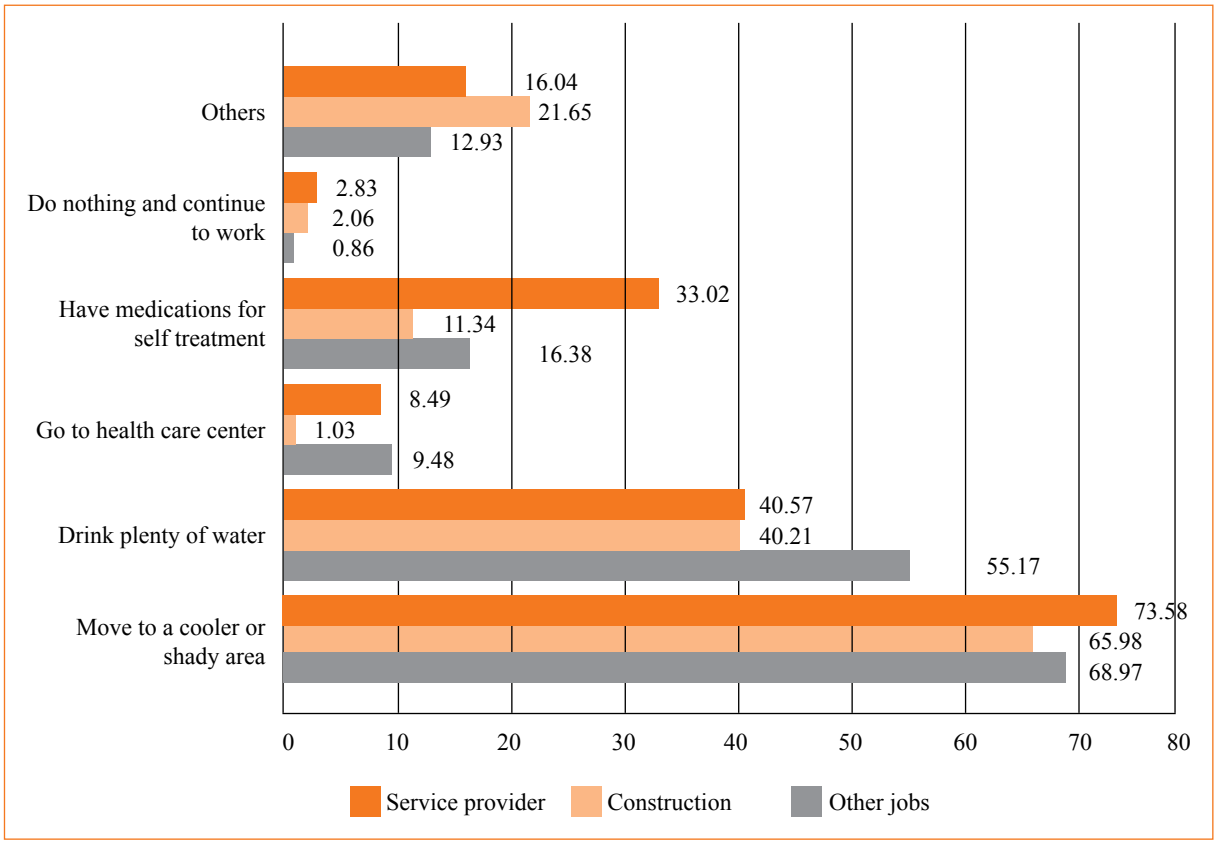


Figure 11. Coping with heat stroke by occupation (%)



When experiencing symptoms at work, respondents explained that they are usually helped on site by their colleagues and are only transferred to the company health centre or to local health facilities when experiencing severe symptoms. Besides resting in a shady and cool area, drinking plenty of cool boiled or mineral water, their colleagues also fan them, loosen their clothing, and apply cold towels to their forehead. Most will then return to work after a short break. Many people also said they use traditional methods to cope with heat stress, like applying medicated oil, taking a herbal sauna or drinking lemon juice. Additionally, some respondents also reported that if they feel severely ill, they will go to a private pharmacy to buy vitamin, calcium and other supplements to treat themselves. Only very severe cases will go to hospital for treatment or take time off work. Respondents also reported using traditional medicines aimed at reducing the impact of heat on the body (see Box 1 below).

Box 1. Traditional medicine used for treating heat stress conditions

Some respondents reported using treatments acquired from either traditional medicine shops in the market or from traditional medicine centres. Methods used to reduce the symptoms of heat stress while at work include steaming with herbs, oils, or drinking fruit juices or tea.

In Vietnam, traditional medicine including herbal plants (roots, leaves and fruits), both fresh and dried, are used as drinks or in food dishes for treating common heat-related ailments such as a high temperature, skin rashes, insomnia, headaches, and others. The most popular plants and herbs are *Rau má* (*Centella asiatica*), *Rễ Chanh* (the root of *Citrus limonia*), *Cam thảo* (*Glycyrrhiza sp.*), *Bạc Hà* (*Mentha arvensis*), *Nhân Trần* (*Adenosma caeruleum*), *Chó đẻ* (*Phyllanthus Urinaria*), *Lá Giang* (*Aganonerion polymorphum*), *Cúc Hoa* (*Chrysanthemum Sinense Sabine*), *Cây Cối xay* (*Abutilon Indicum*) and *Đỗ Tất Lợi* (Vietnam herbal plants and treatments). **Many of these aim to provide an 'internal cooling' effect. These are very popular for cooking or using as drinks in the summer months.**

Interviews with some street vendors show that few of them manage to brew tea to drink during their working day. Interviews at some herbal shops in the downtown markets show that although local people have been using a variety of herbs (locally produced in Da Nang or imported from other provinces), it is not so common for many poor outdoor workers to use them. The main reasons are the limited awareness of the health benefits of these medicinal plants (particularly for heat stress), the cost of buying these plants/herbs (even they are usually very cheap), and the time required to prepare them, as outdoor workers do not normally have the time due to intensive working conditions.

Many respondents in the IDIs or FGDs said that they dare not take sick leave because of the loss of income if they stay at home. This is true for both service providers and workers at small and private companies/enterprises, as it affects the life of their families.

> If I cannot go to work, I cannot earn money. If I can go out to work, I can earn some money and can buy food for my whole family, but if I have to stay at home, I have no money to buy food… There are also school fees for my children. I have to give my child's school about 3 million to 4 million [about US$145–195] at the beginning of the school year (early September), so I have to try to work (even if I feel sick). I can only stay at home when I feel extremely sick, if I have medium or mild sickness, I still go to work.
>
> (FGD, freelance street vendor)

Secondly, awareness of and behavioural change to avoid heat stress was identified as an adaptive measure. There does not appear to be a good understanding by outdoor workers in Da Nang about measures to adapt to extreme heat exposure (see Figures 12–17). Only 56 per cent of respondents know that they should take regular breaks in the shade or cool areas while working in the heat. Only 39 per cent of respondents know that they should drink water frequently and use personal

protective equipment to lower the risk of heat. Only 14 per cent of respondents are aware that wearing light-coloured, loose-fitting clothing can help them cope with hot weather. Very few people know that drinking caffeine or alcohol while working in hot conditions can cause dehydration. While there was no significant gender difference, service providers were most likely to know that wearing loose, light-coloured clothing could help. However, those working in fishing or farming were most likely to know about the importance of drinking water frequently. Consequently, one can conclude that the level of knowledge of adaptive measures to reduce heat stress among outdoor workers in Da Nang is very low. The majority of respondents have poor, very poor or no knowledge at all of adaptive measures (nearly 86 per cent), and this does not appear significantly linked to any socio-economic factors.

Figure 12. Knowledge of adaptive strategies for heat waves by gender (%)

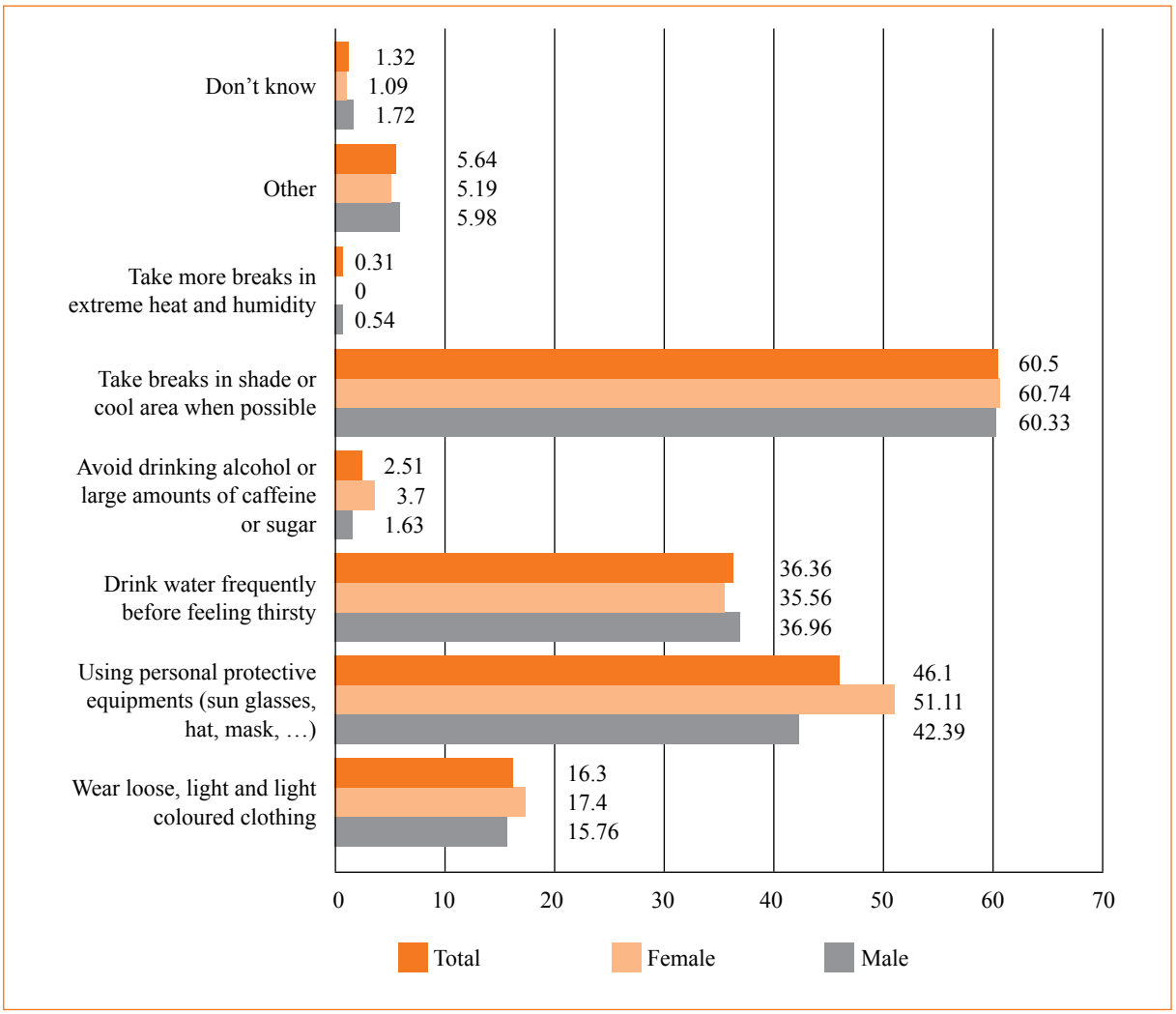


Figure 13. Knowledge of adaptive strategies for heat waves by occupation (%)

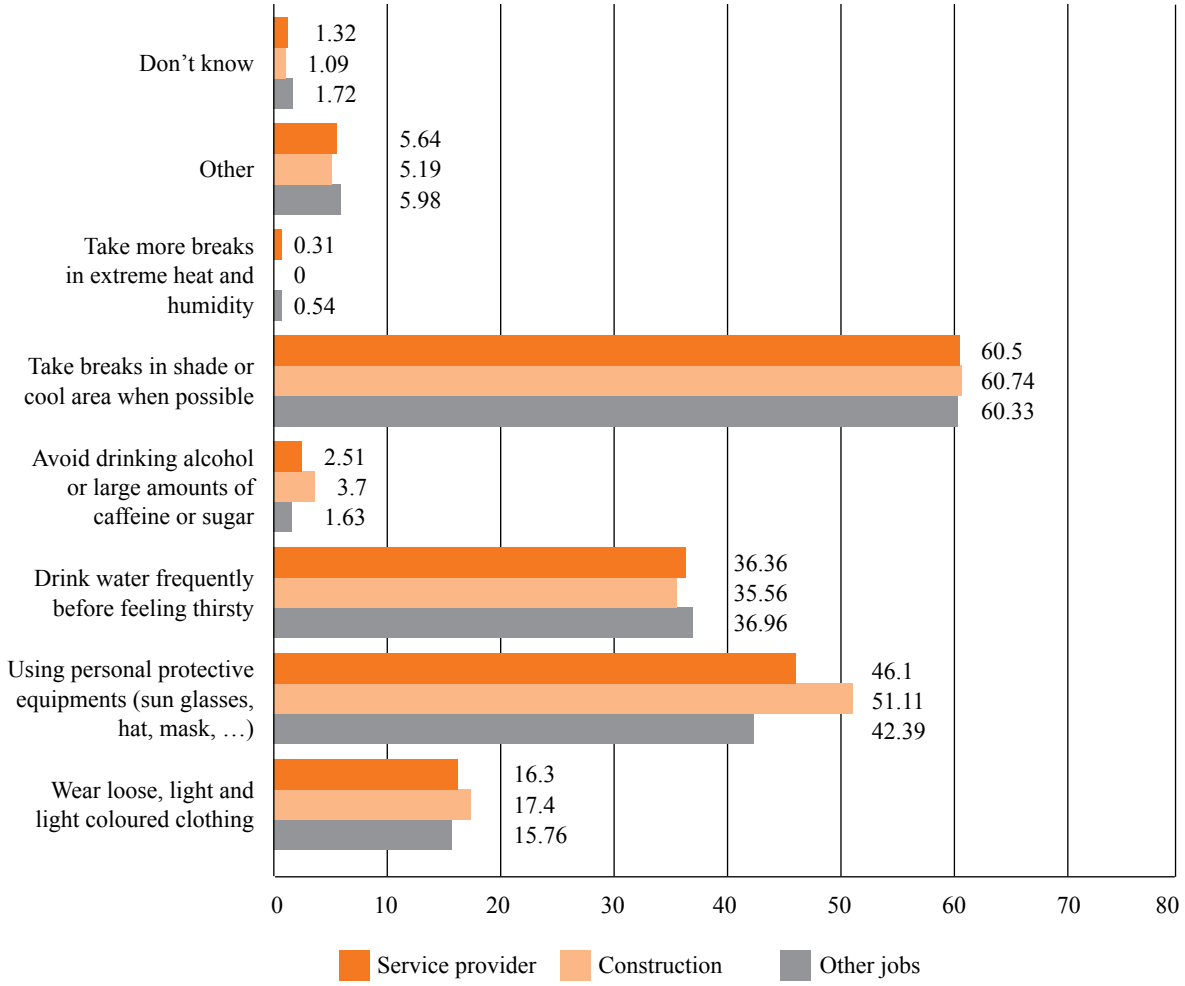


Figure 14. Knowledge of heat stress by gender (%)

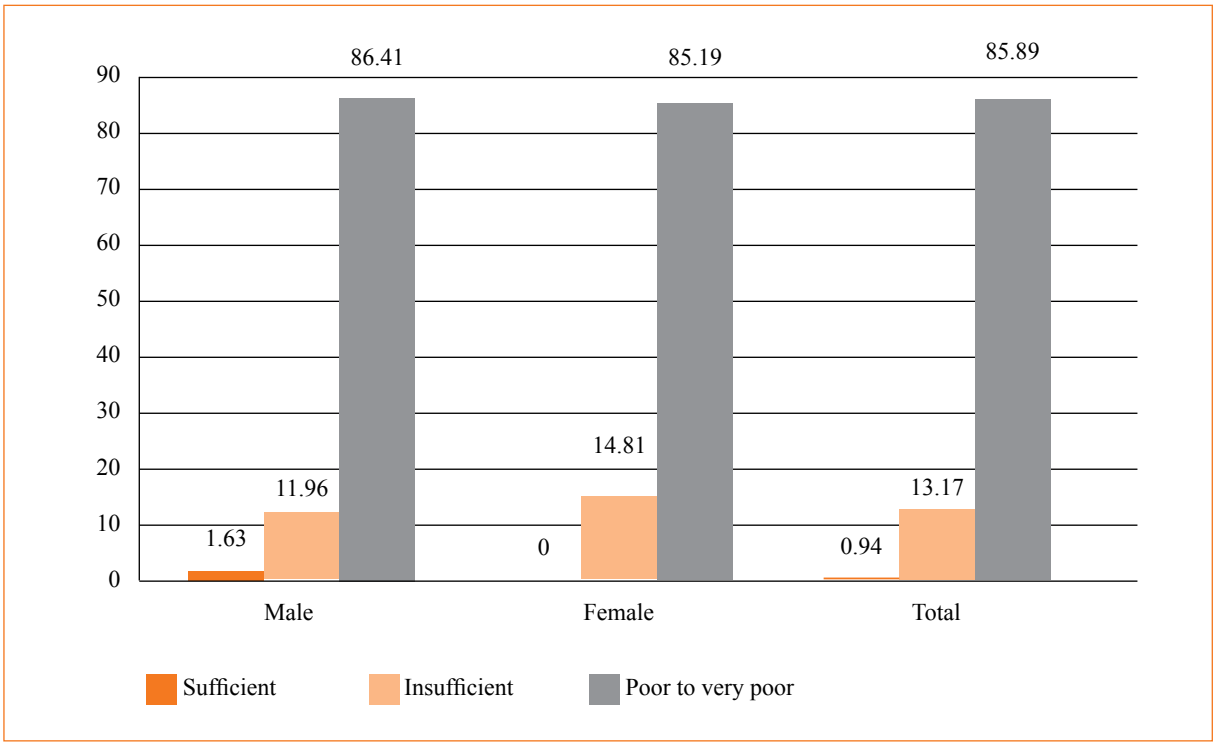


Figure 15. Knowledge of heat stress by occupation (%)

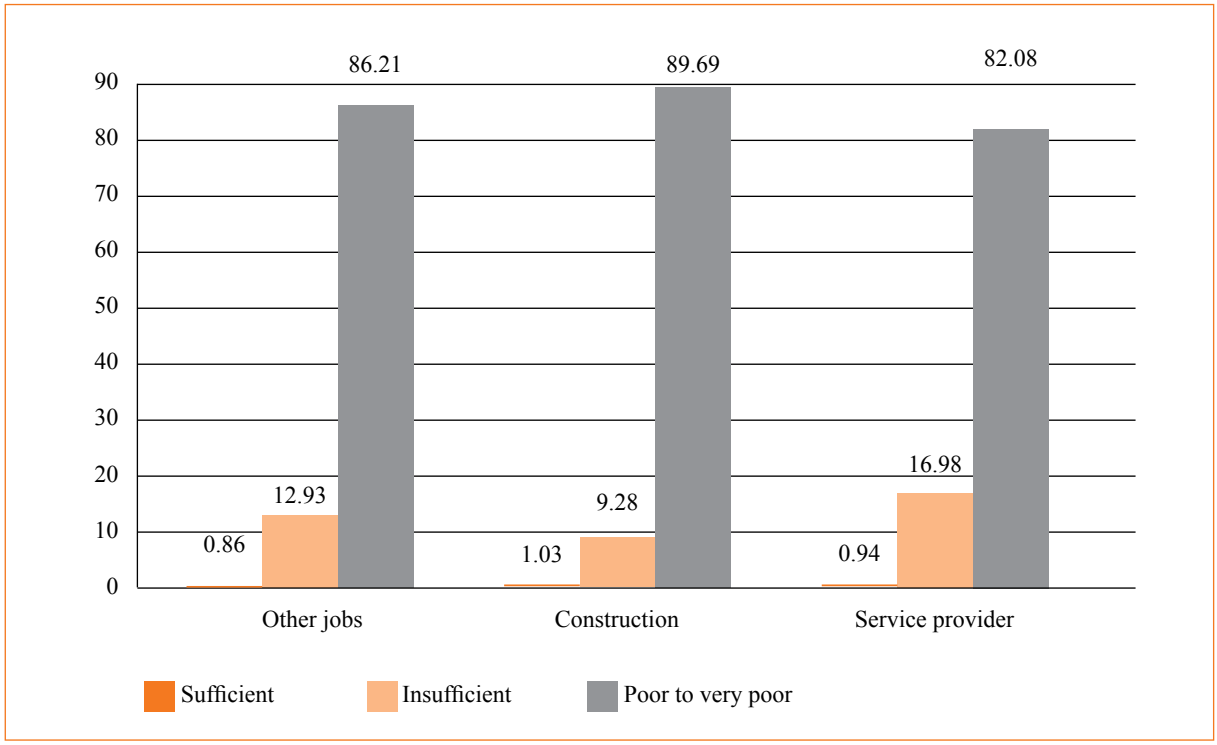


Figure 16. Knowledge of coping measures for heat stroke by gender (%)

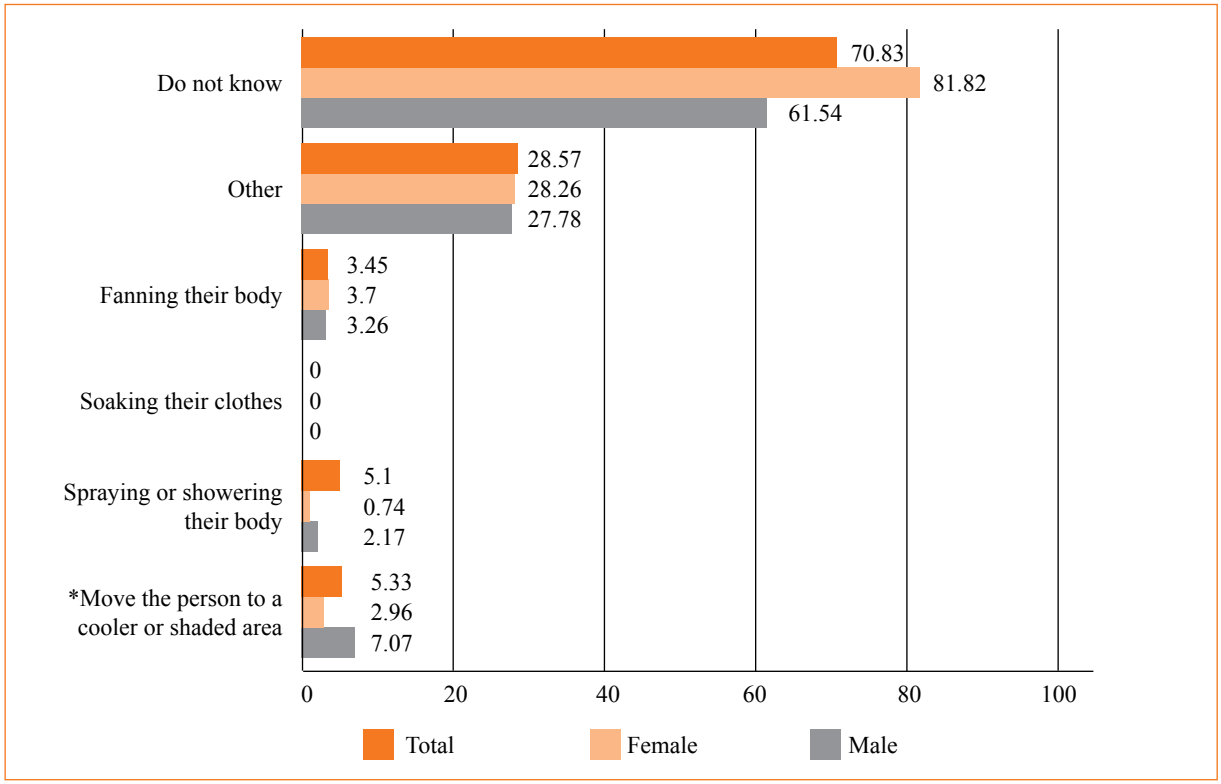
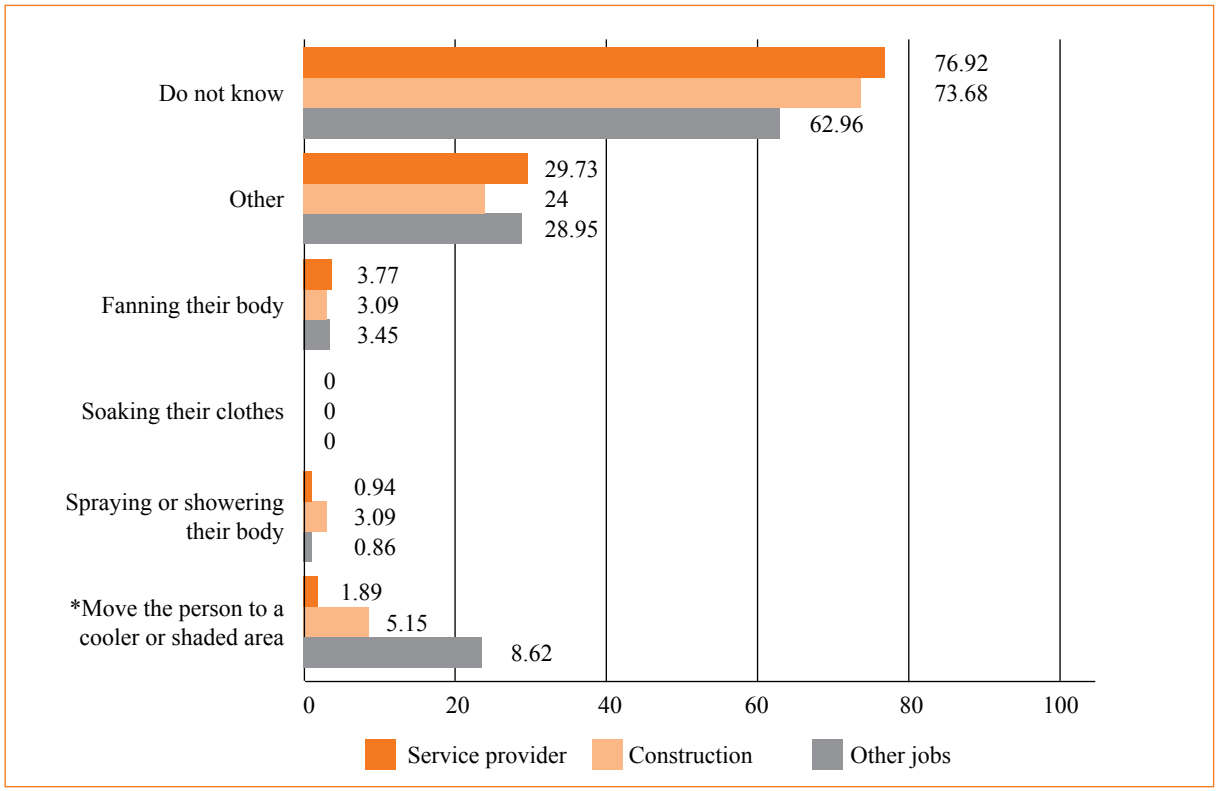


Figure 17. Knowledge of coping measures for heat stroke by occupation (%)



Respondents' knowledge of first aid provision for people suffering from heat stroke is also limited, and may draw on their own coping measures when experiencing symptoms in the past (see Figures 18 and 19). About 65 per cent of total respondents do not have any knowledge of what measures to take when a person suffers from heat stroke. Women and construction workers appear to have less knowledge than men and other occupation groups. Some basic emergency measures should be taken when a person suffers from heat stroke, such as moving the person to a cooler or shady area, fanning them and spraying them or soaking their clothes with water. However, these were known by only a few of the participants in the study. Only about 5 per cent know that they should move the person to a cooler or shady area and spray them with water; 3 per cent know that they should fan them. About 30 per cent of respondents reported using other methods, mostly giving the person water. However, all of these differences are not significant. All other socio-economic factors such as age, income level, residential status and type of occupation are not significantly associated with knowledge of coping measures to heat stroke.

Figure 18. Knowledge of coping with heat stress by gender (%)

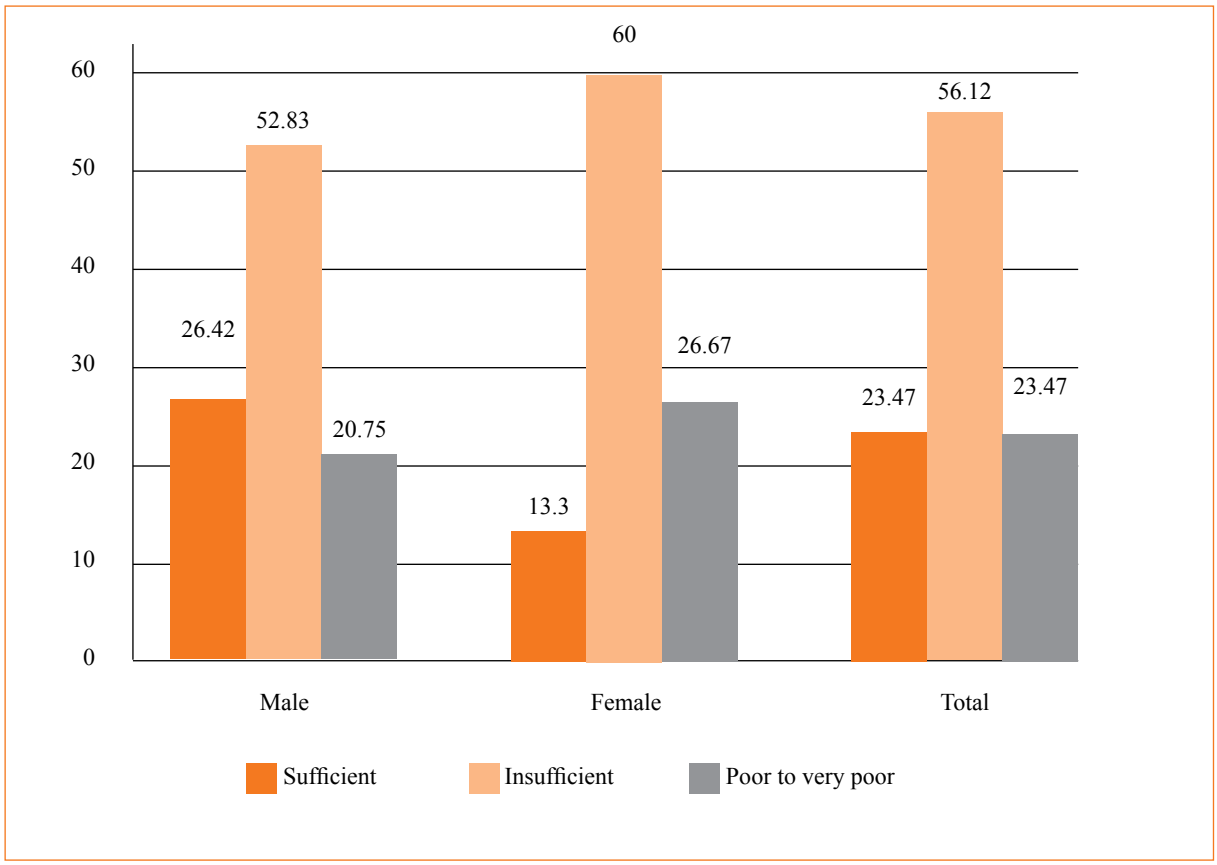
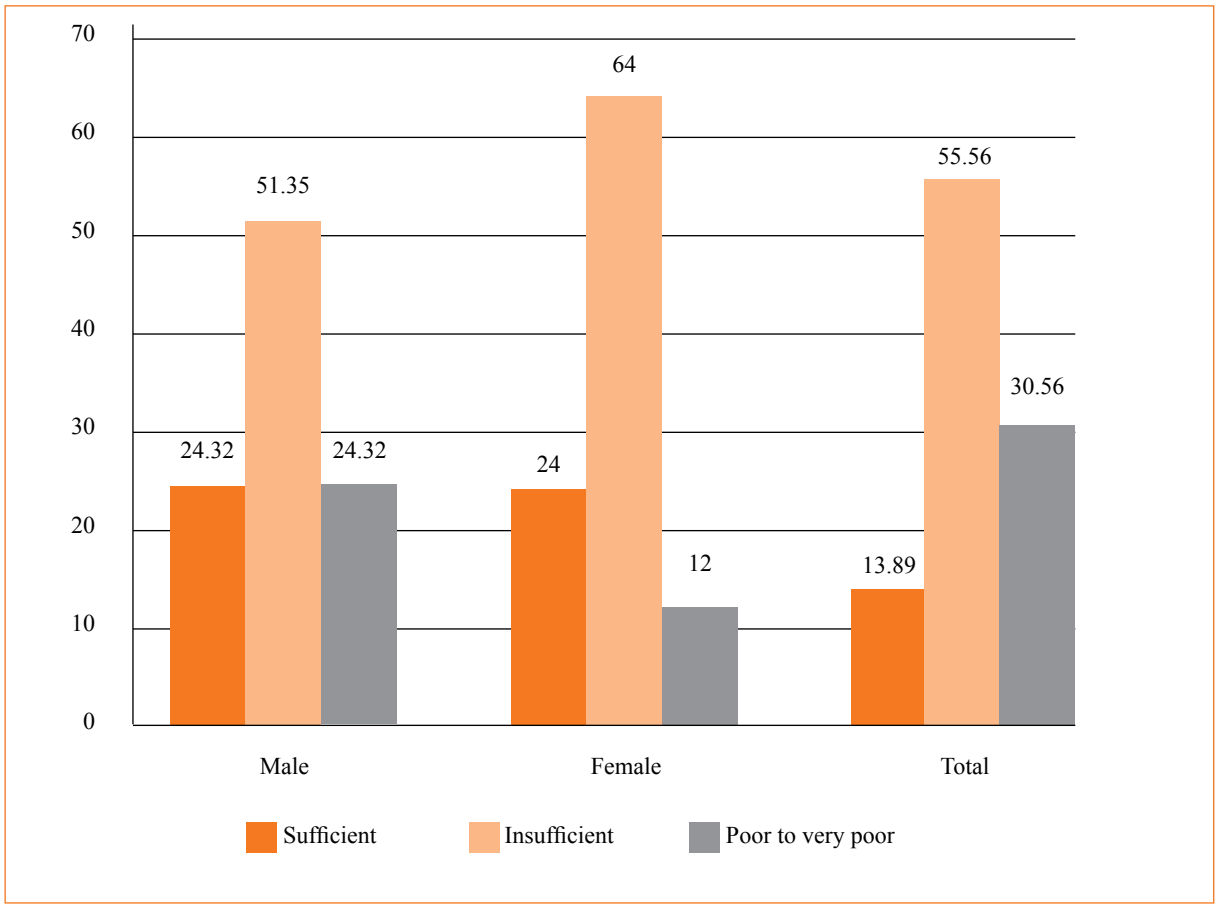


Figure 19. Knowledge of coping with heat stress by occupation (%)



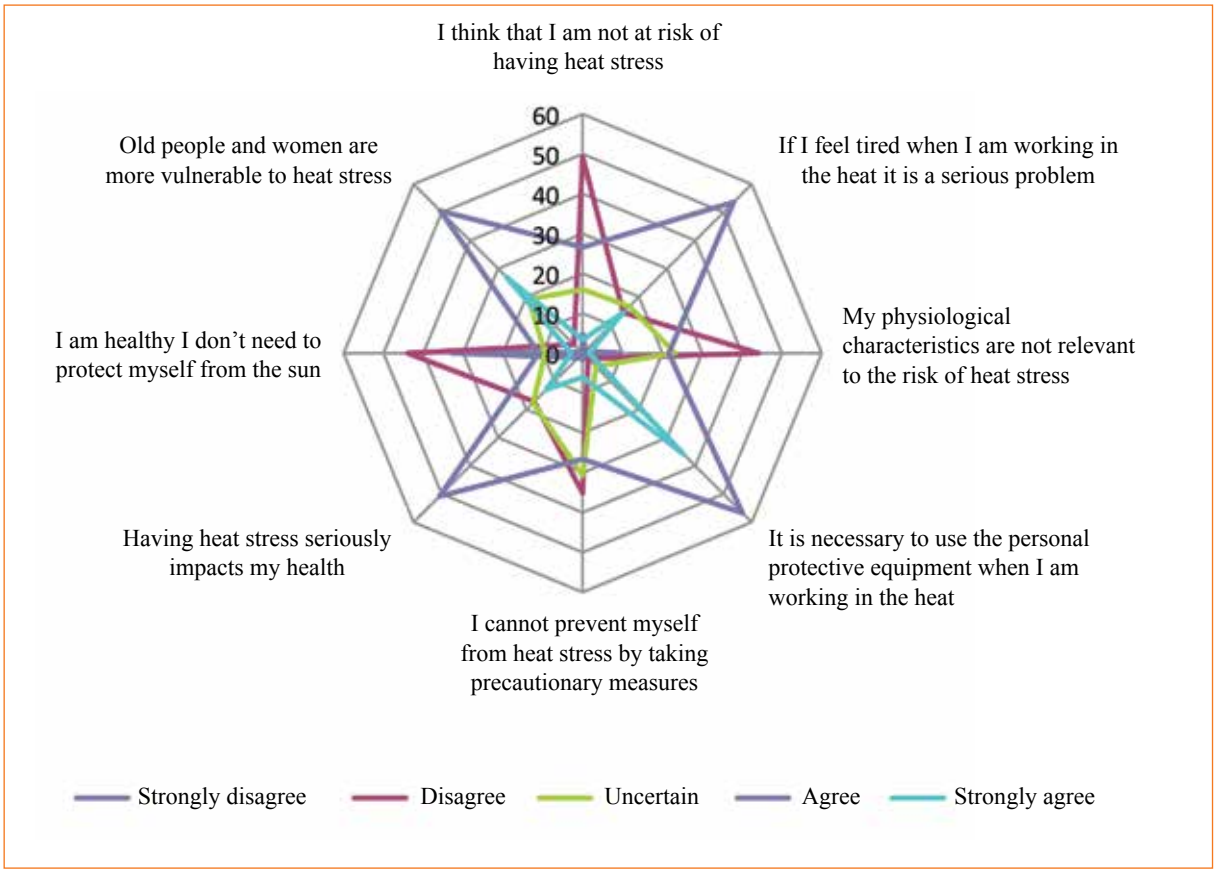
5.3 Perception of heat stress risks

Most respondents in the study have moderate to good perceptions of their heat stress risks (Figure 20). More than 90 per cent of them perceive that it is necessary to use heat protective equipment while working in hot conditions. They also pay attention to their health, agreeing that feeling tired while working in the heat is a serious health problem and that heat stress could seriously affect their health (approximately 50 per cent). Sixty per cent also perceived that women and the elderly have a greater risk of suffering from heat stress than other groups.

Nearly 60 per cent of respondents disagree with the statement that they do not need to protect themselves from heat stress because they are healthy, that they are not at risk of suffering from heat stress, or that their physical characteristics do not make them more vulnerable to heat stress. However, while about 35 per cent of respondents disagree with the statement that they cannot protect themselves from heat stress, a similar number of them are uncertain about the effectiveness of adaptive measures to heat stress.

Qualitative data shows that almost all respondents think women, older people and children are more vulnerable. However, respondents think that both sexes are at equal risk of suffering from heat stress, depending on the nature of their work and their health, saying that regardless of gender, if they have to work in the same conditions, and if they have existing health problems, both men and women will be affected similarly by heat stress.

Figure 20. Perceptions of risk of heat stress



5.4 Awareness and actions of official organisations

In-depth discussions with NGO representatives in Da Nang, who often play a key role in reaching the most vulnerable groups including the poor in the city, revealed that none of the NGOs working in public health in Da Nang has worked with these outdoor workers on the issue of heat stress. Currently, there is a network of around 50 NGOs representatives and other stakeholders including donor agencies, government agencies, research institutes and community-based groups, working on disaster risk reduction and climate change adaptation in the central provinces including Da Nang. This newly established network holds regular meetings once every two months in Da Nang or in Hue, however heat stress and other health implications related to climate change in general have not yet been discussed in this network.

The Women's Union of Da Nang has a strong mandate and holds regular monthly working meetings with various technical departments, including DOLISA and the Preventive Health Centre. However, in-depth interviews with their staff show that currently, they lack an understanding of heat stress and its impacts on the most vulnerable groups in the city. In particular, they have not had much experience of reaching out to poor migrants groups. Their projects focus on storm-resistant housing, latrine construction and climate change awareness raising, and do not yet integrate measures for vulnerable groups to deal with heat stress both at work and at home. Limited budgets, staff capacity and awareness were raised as key constraints.

During the research in Da Nang, examples of private sector entrepreneurs providing free bottled water to outdoors street workers were found. However, this is not yet a popular practice in the city, and these are not the employers of the outdoor workers.

6 Discussion

This is the first study examining the heat stress risk of outdoor workers in Da Nang and in Vietnam in general. It provides insights into the risks of heat stress in the workplace and the knowledge and behaviour of outdoor workers in Da Nang, in relation to their adaptive and coping strategies.

6.1 Exposure and impacts

This study shows that outdoor workers in Da Nang risk heat stress both in the workplace and at home. Almost all outdoor workers have to work in direct sunlight all day and most of them report that it is hot or extremely hot in their workplace. The lack of provision of protective measures by employers for hot conditions further contributes to this risk, as does poor housing conditions. Outdoor workers working for government-owned or big, foreign investment companies are less exposed to the risks of heat stress in the workplace, compared to those who work for medium-, small-scale or private companies and freelance outdoor workers. They are provided with water, protective clothing and altered working hours, as well as health and social insurance.

Women, freelance service providers and those who regard themselves as having poor health are the groups most vulnerable to being sick while working in conditions of extreme heat. Data also indicates that a higher percentage of women experience negative health impacts from working in hot conditions. Besides health impacts, high heat levels can negatively affect workers' productivity and work quality. This is most serious in occupations such as agriculture, stone engraving, the extractive industries, construction and fisheries. In-depth interviews with employers, particularly those who are running small-scale enterprises, show that they lack awareness of the negative impacts of extreme heat and heat stress on workers' health, productivity and safety.

6.2 Differentiated vulnerability

The study highlights the differentiated vulnerabilities to heat stress. Poverty is considered to be one of the main factors that heighten vulnerability, and in this study we can see it as a cross-cutting factor that inter-relates gender, occupation and migrant status.

Our study shows that female outdoor workers are one of the most vulnerable groups. A higher percentage of women work as freelance street vendors, and this difference in socio-economic status makes them more vulnerable to various occupational hazards. They also have limited accessibility to health insurance and other social services.

Freelance outdoor migrant workers and street vendor are particularly vulnerable in urban areas of Vietnam. These groups have limited access to public services, social support and healthcare services. This lack of accessibility and their low living standards are related to their unregistered migrant status, their self-employed status, and poverty. Poor access to social support and services provided by local government and social organisations also result in a lack of knowledge of healthcare and protection. Many migrant workers working in Da Nang reside in poor-quality housing in cramped conditions, and work in waste collection, in factories, or selling lottery tickets and therefore they are more susceptible to

heat exposure both at home and at work. Poverty also forces migrant freelance outdoor vendors, who are mostly women, to work longer hours with limited breaks in order to earn money, even when ill.

In addition to those who work as freelance street vendors, those who work in a hazardous environment, such as construction, stone engraving and stone extraction, long-term fishing (men) and rubbish collection (mostly women) are highly vulnerable to heat stress, which exacerbates the impacts of current serious levels of noise, air and dust pollution, and dangerous working conditions.

6.3 Range of adaptive responses

Our results indicate that the outdoor workers and their employers adopt a mixture of both proactive and reactive adaptation measures to reduce the impacts of heat stress on their health, both at home and at work. Many are proactive in taking some actions at work, such as requesting modified working hours, bringing water bottles with them to work or wearing hats, masks and appropriate clothes. These actions demonstrate their adaptive capacity to heat exposure. However, due to poverty and limited understanding, not all have the right clothes, partly due to cost and availability. The key concern here is that for many workers, the need to earn a daily income outweighs the risks posed by their occupation.

Local workers identified proactive adaptation measures to be provided by the government, such as planting more trees in the streets to provide shading. Provision of public toilets was also mentioned, to enable access to these services during their work, which would enable them to drink more frequently.

Most outdoor workers live in poor-quality housing, and where they have thought of installing heat resistant roofings and air conditioning, they normally cannot afford such measures. Apart from taking a few measures such as covering walls facing the sun during the day or buying more fans, they tend to react to high heat by opening the windows at night, sleeping on tile floors, or sleeping later hours. These can be considered as coping measures, while adaptive actions such as ensuring their homes have adequate ventilation, planting trees outside or having plants inside their homes or using reflective paint, are rarely mentioned.

Though knowledge of coping with heat stroke is very low, coping measures used when a person suffers from heat stroke are relatively similar to conventional guidelines. Very few respondents seek healthcare services at health facilities, and many workers, especially freelance outdoor workers and female street vendors, keep working even when they are ill as a result of heat stress. Promoting better health insurance coverage, especially for migrant freelance outdoor workers, would better protect their health and welfare.

6.4 Barriers to responding adequately to heat stress

Outdoor workers in Da Nang generally have to provide their own adaptive measures to protect their health, because of a lack of provision by their employers. However, their capacity to do so is hampered by low levels of knowledge of heat adaptive strategies. While 86 per cent of respondents express having poor or very poor knowledge of effective adaptive measures for mitigating heat at work, the actual application of responses was slightly better, ranging from taking breaks in the shade, using personal protective equipment, wearing loose, light-coloured clothing and drinking water frequently. However, limited access to toilets for those working outdoors means some respondents limit their water intake. Additionally, many women believe that wearing several layers of shirts will prevent them from overheating in hot weather, but instead this practice risks dehydrating them.

Finally, **poverty** is an overarching barrier to adapting to heat stress, as it forces people to work longer hours, continuously and without a break in order to secure their income. This is particularly true for freelance street vendors. This highlights the importance of addressing the underlying drivers of vulnerability which lead to people working in conditions where they are exposed to the possibility of heat stress.

6.5 Actions taken by employers

Our results show that adaptive measures provided by enterprises or employers in the workplace are limited. Large, government-own enterprises or foreign companies are more likely to provide adaptive measures and provide social and health insurance for their workers. Our study indicates that there should be awareness-raising interventions for employers regarding their role in providing adaptive, protective measures in the workplace. Additionally, there is no formal government guidance regarding how employers should protect workers' health in the context of heat wave/hot conditions in the workplace.

Workers, especially low skilled ones, are found to have low bargaining power with employers, a lack of labour unions in the workplace, and limited associations. It is hard for workers to request adaptive measures if they are less than 10 staff. Although workers cited experiences of uniting themselves in order to request a better working environment (such as providing fans and shade in the work place) it is more commons where there is considerably larger number of workers in one enterprise. Social networks among outdoor workers were also mentioned. While these might not be the best source of advice on how to cope or adapt to heat stress at work, they may be better at providing support to the workers in other aspects of their lives.

6.6 Policy, legislation and guidance

Regarding existing policies to regulate the protection of health and safety in the workplace, we found in place a **very comprehensive set of different legislative documents from laws, guiding decrees, inter-ministerial circulars, decisions and occupational hygiene standards.** However, the implementation of these policies does not work as intended. Government agencies lack the human and financial resources to provide assessments and inspections of occupational hygiene, safety standards and healthcare provision for workers. Secondly, because the legislative framework is so comprehensive, it sometimes causes misunderstandings of who is responsible for implementing which piece of legislation, and where different stakeholders are required to be involved, so this can be difficult to coordinate. Thirdly, where small and medium private enterprises do not adhere to the law and violate the rights of their workers, it can be difficult to track them because of lack of monitoring, assessment and inspection.

There is no guidance from MOH and/or MOLISA for enterprises and employers on adaptive measures specific to heat stress and other climate change impacts. There are no regulations for training and sharing information with the most vulnerable self-employed groups such as street vendors, farmers, and migrant workers. There should be advocacy efforts for the development and institutionalisation of this policy at ministerial level, with inputs from related stakeholders, including employers and workers.

Lastly, the technical capacity of health systems in providing guidance on heat stress prevention, care and treatment is limited. Our study results indicate the need for development of formal guidance from MOH regarding adaptation to, care and treatment of heat stress conditions, and technical capacity building for health staff at the primary-care level, so that they can provide guidance and health education to the community, including outdoor workers.

The Preventive Medicine Centre of Da Nang has a remit to tackle disease prevention and campaign to improve the health of the city's population, from the city-wide to the ward levels. However, because of a lack of budget, of staff knowledge and skills, and of instruction at the central level, they have not been able to deliver results effectively.

6.7 Areas for further research

While this study recommends interventions at the community level as well as policy advocacy at the central level, some limitations remain. As the study only included six occupational groups (mainly construction workers and service providers), it is difficult to generalise our study results to the whole population of outdoor workers in Da Nang. In particular, we were unable to recruit a large number of fishery workers into our study, because most of them spend several months out at sea. Other factors which may affect the underlying vulnerability of respondents to heat stress, such as diet, were not examined.[10] It is also important to recognise that the sampling method used to recruit respondents might not be fully representative of the occupation groups, particularly with regard to construction workers, as it was easier to access construction workers working on large sites than those working for small employers. If such workers had been included, we could expect more negative results regarding the risks of heat stress, health consequences, and knowledge of adaptive and coping strategies.

In-depth research about vulnerability and capacity of migrant workers, especially those working in the processing factories and industrial zones in Da Nang, could be a valuable next stage. This would provide timely support to any government actions to support these groups, particularly as the city is also planning to enhance its focus on these groups of people who are important to the future development of Da Nang city. This could be combined with research on urban planning measures to support the resilience of the most vulnerable groups in the city.

Additionally, further research could be done on heat stress impacts on the elderly and children in Da Nang, as literature elsewhere indicates they are vulnerable to health impacts of climate change. This should include an examination of the social and health insurance issues that affect the well-being of the most vulnerable groups, particularly the elderly in the city. It would also be valuable to study the role of social networks of workers and how they are operating to facilitate their adaptation in the climate change contexts.

10 Some respondents reported that some heat stress symptoms that they suffered from were related to anorexia.

7 Recommendations and conclusion

7.1 Recommendations

In order to address the currently limited adaptive capacity present in workplaces, and the barriers to adaptation as identified above, a number of policy recommendations have been developed for action at the national ministerial level and city departmental level, as well as by private employers, mass organisations, civil society organisations and donor agencies. These actions should help to address the underlying drivers of vulnerability of workers at risk of heat stress, as well as support their adaptive capacity.

7.1.1 Action at the central level

We recommend that advocacy efforts should be made by responsible ministries, i.e. MOH and MOLISA regarding:

- The development of guidance for employers related to providing adaptive measures for outdoor workers who work in hot conditions, especially in the context of increased occurrences of heat waves.
- The development of micro-weather standards for outdoor workplaces, which are currently lacking in Vietnam.
- The development of technical guidance for healthcare workers regarding adaptation to, care and treatment of heat stress conditions.

The Climate Change Office of the Ministry of Health (MOH) is currently engaged in policy dialogues with many bilateral and multilateral donors as part of the Support Program to Respond to Climate Change (SPRCC), . Therefore it is highly recommended that the Climate Change Office of MOH, together with NGO representatives including COHED, use these research results as evidence in policy dialogues with donors to design specific policy actions in this area, and advocate for more climate change and health programmes/projects under SPRCC. National workshops with key government agencies and donors in Vietnam can also help to raise awareness of the implications of the direct health consequences such as heat stress on the most vulnerable and poor groups in the country. This will, therefore, require more climate change investments and joint implementation programmes (with NGOs, CBOs and the target groups) to help the most vulnerable in dealing with heat stress in urban contexts.

We recommend awareness-raising campaigns for policy makers at the central level, in the form of advocacy conferences, with scientific evidence of health and other impacts of heat waves on outdoor workers and their productivity. These campaigns could share best practices from other settings regarding the development and application of policy to protect the health of workers in the context of heat waves.

As many of the outdoor workers are low-income groups, one of the main target groups of MOLISA, it is highly recommended that the ministry reviews the research results, and integrates the issue of heat stress and adaptive

measures into their climate change programmes/projects into their action plan to respond to climate change. It is highly recommended that they work with national and local NGOs and civil society organisations to reach the poor and mobile outdoor workers in cities (including unregistered migrant workers) to strengthen the resilience of these groups in the long term.

7.1.2 Interventions by health and social systems at city level

Interventions at the city level should include those by the Department of Health, the Preventive Medicine Centre and the Department of Labour, Invalids and Social Affairs.

According to the central Ministry of Health, the following recommendations should be taken up by the city departments of Da Nang. The city authorities should develop a specific and feasible plan for dealing with heat waves, divided into different levels, depending on the severity of the heat wave. This action plan would allocate specific tasks and responsibilities to each authority, technical departments and communities.

A technical capacity-building programme should be developed for healthcare workers, from city to community level, especially those who work at the primary ward and community level, to:

- understand health and other impacts of heat stress;
- learn adaptive strategies to prevent heat stress; and
- provide methods to treat heat stress.

The training could be based on formal guidance developed by MOH and be customised according to local context.

As the Preventive Medicine Centre works in education and awareness-raising for the public, which includes working populations, heat stress and its adaptation measures should be part of these campaigns. The target groups should include those who are the most vulnerable outdoor workers in the city. Cooperation with private pharmacies, hospitals, private western and traditional medicine clinics, and traditional medicine shops in the markets might prove to be effective channels to inform the outdoor workers in the city about the risks associated with heat stress.

7.1.3 Interventions by the Climate Change Coordination Office of Da Nang

The Climate Change Coordination Office (CCCO) of Da Nang coordinates with the different departments in the city on climate change matters and on the implementation of the city's climate change resilience plan. It is therefore important for them to inform relevant departments, particularly the Department of Health (DOH) and the Department of Labour, Invalids and Social Affairs (DOLISA) on their policy actions, and to support these departments in obtaining more external and government support for their initiatives related to protecting the most vulnerable populations against risks associated with heat stress.

The CCCO of Da Nang should liaise with donors who are interested in investing in climate change programmes in the city. It is important that the management of the CCCO in Da Nang understands the serious implications of heat stress and extreme heat for its local population, especially among the poorest and most vulnerable groups. They should raise these issues with donors, advocating for further funding. There might be efforts to encourage donors to integrate heat stress into other project activities whenever relevant.

According to the MOH recommendations, it is important to have the wide engagement of various stakeholders in the city for the prevention of heat stress. Therefore, there is a potential role for the CCCO of Da Nang to integrate heat-related concerns across city-level activities.

In light of Da Nang's efforts to be a green city, work related to infrastructure, green and cooling living spaces, population density and residential density should bear in mind possibilities for reducing heat stress. These are indirect and long-term adaptation measures requiring the involvement of the Ministry of Construction, the Department of Construction, and the People's Committees at all levels.

- Efforts to tackle air pollution, which can lower the incidences of heat stress, should be implemented with the involvement of MONRE, DONRE, the Ministry of Transport and the Department of Transport.
- Timely weather early warning systems should be provided to the local population, with recommendations for health protection measures from meteorology agencies.
- There should be intersectoral coordination in this field.

7.1.4 Actions by the City Department of Construction and Urban Planning

There is an opportunity to further improve the heat resistance of new construction in the city, in both residential and public buildings. As the city has numerous planned support programmes for housing for the poor, housing planners and engineers should design new buildings and houses which are resistant to heat. At the same time, media communication such as TV programmes could be used to inform householders of measures they can take to adapt their homes to lower heat.

Although Da Nang city is pioneering tree planting and aiming to become a green city, it is recommended to consider planting more tree, especially in new streets, and in particular trees which provide extensive shade. Green spaces such as parks, ponds or lakes can mitigate urban heat effects and so urban planners should consider these in their urban planning strategies. It would also be worth re-examining the level of tree pruning during the summer months, to ensure that they still provide shading for local people. Instead, they can be pruned just before the typhoon season starts.

7.1.5 Interventions targeting employers

We recommend awareness-raising campaigns with employers, especially small-scale enterprises, highlighting the scientific evidence which demonstrates the impact of heat stress on workers' health, welfare and productivity, and the associated benefit for their enterprise of providing adaptive measures for workers in terms of productivity and lowering incidences of sick leave. Employers should be aware of their roles and responsibilities for ensuring occupational hygiene and safety, healthcare provision, and social and health insurance for their workers. They should be provided with instructions for protecting workers' health and/or applying adaptive measures in the context of extreme heat events. Good examples of low-cost measures used by private and state-owned enterprises could be shared. Special incentives from local government authorities could be used to reward positive actions taken by private employers, and the positive benefits of improved worker productivity should be emphasised when communicating with employers.

The Enterprise Association in Da Nang could cooperate with the Preventive Health Centre to run training courses to raise the awareness of employers about heat stress and its impacts on their workers' lives and production, and most of all to promote a safe environment for their workers and the application of mandated laws and regulations. Cooperation with DOLISA and some credible private producers should be made in providing good-quality protective gear to their workers. The Female Enterprise Association should also advocate for providing free water to outdoor street workers.

7.1.6 Interventions by mass organisations including the Women's Union

A key function of the Women's Union and other mass organisations such as associations for youth and the elderly is to care for the most disadvantaged members of the public. It is highly recommended that the Women's Union enhances their capacity for dealing with issues related to heat stress, and incorporates them into their educational programmes, particularly those related to climate change, or funded by climate change-related sources. The Women's Union should aim to enhance their outreach to migrant groups, particularly migrant women's groups which are not yet registered with the union, so that it can provide them with support. The Women's Union networks in all of Da Nang's markets could be used to disseminate information on heat stress and adaptation measures for many of those women street vendors. Where possible, the Women's Union and other mass organisations should also provide livelihood and housing support to the most vulnerable groups including migrant workers, so that they can access relevant services and programmes. The Women's Union of Da Nang is currently implementing some models of storm-resistant housing schemes for the poor, and it is recommended that they incorporate trials of heat-resistant housing within this, so as to enhance the resilience of local poor households.

7.1.7 Interventions by NGOs/CSOs and outdoor workers

There is an important role here for NGOs/CSOs to work with the key government agencies and mass organisations to provide direct capacity-building for outdoor workers, healthcare staff and other related services about the health impacts of heat stress, and to promote proactive adaptive strategies. Training methodologies used by NGOs/CSOs in other health and development projects/programmes over the years would be highly applicable.

NGOs and CSOs are well-placed to provide care and support for freelance migrant and other outdoor workers, who are most vulnerable to heat stress in the city. Diverse activities can be deployed to improve the knowledge and skills of freelance outdoor workers in protecting their health and applying appropriate proactive adaptive actions at work and at home. NGOs and CSOs would be well-placed to address behavioural factors and other barriers that constrain their adaptation in the long run. Health-specific support can be provided alongside other housing improvements, credit or livelihood support.

NGOs/CSOs could provide support to freelance migrant outdoor workers to establish or strengthen their own self-help groups or trade unions to facilitate information sharing, capacity-building activities and adaptive measures, as well as the provision of other care and support. CSOs and NGOs can play a role in providing knowledge and information of the regulations, labour laws and contracts, that the outdoor workers are aware of the need to protect their rights at work, enhance their bargaining power, and support their proactive adaptive actions.

7.1.8 Interventions by donor agencies

For donor agencies working on or investing in climate change, it is crucial for them to recognise the current and future impacts of extreme heat events and heat stress on the most vulnerable groups in Da Nang. They should therefore consider investing in these kinds of programmes, through direct support to the groups as well as enhancing the capacity of government agencies to deal with this risk.

For donors interested in health issues and investing in the healthcare system and sanitation in Da Nang, climate change adaptation could be mainstreamed into their current health programmes, especially capacity building and health actions at the grassroots level. This could involve supporting future programmes implemented by CSOs, NGOs, government agencies and the private sector in the city to deal with heat stress. The experiences of NGOs working with key government agencies and mass organisations in other development efforts can be utilised to provide further support to the most vulnerable groups in the city.

Addressing issues to with the adaptive capacity to workplace heat stress can be considered an opportunity for creating partnerships, especially with private enterprises. This can be implemented alongside efforts to make Da Nang a green city, with improvements in public transport, the more efficient use of energy, better green spaces in the city, providing adequate working conditions and healthcare for workers, and providing rewards and tax incentives. This would enhance the adaptive capacity of outdoor workers in particular and the population in general to heat stress in the longer term.

It is recommended that donor agencies replicate the lessons and approaches in improving the adaptive capacity to heat stress of the most vulnerable groups to other Vietnamese cities and provinces where they are also working, to maximise the impacts of their investments.

7.2 Conclusion

This study has identified the key vulnerable worker groups in the city, and has demonstrated that vulnerability is differentiated by gender, occupation and migrant status. It has highlighted that poverty is one of the key underlying drivers of vulnerability to heat stress, as the need to earn an income drives people to put their health at risk by working despite extreme heat. Limited income also means that the response of many respondents is limited to coping measures, rather than an ability to take a more forward-looking response in adapting their working and living conditions. However, awareness raising by CSOs, health agencies, community groups and mass organisations can play a large role in modifying behaviour and thus improving the adaptive capacity of workers, and this should go alongside measures by employers to provide the necessary equipment and working conditions, and by the government to enforce existing laws and regulations. While the recommendations above are based on a study in Da Nang, they are equally applicable to other urban areas in Vietnam.

As temperatures are projected to increase in the future, and climate change is likely to exacerbate extreme weather events including a higher frequency of hot days (CDKN 2012), this will put the most vulnerable populations at a high risk of heat stress. Therefore, this research aims to provide a timely contribution to policy, as well as the design of more appropriate interventions on the ground to support the most vulnerable groups in Vietnam. The results of this research can spark discussions among related stakeholders, and orient policy makers and civil society organisations to take further action to protect the health of the most vulnerable and poor groups in Vietnam's cities. The positive effects of implementing such measures on productivity, as well as the health and welfare of workers, should be emphasised.

References

Arphorn, S., Brooks, R., Permsirivanich, P. 2006. Chainat: A case study in occupational health and safety promotion for farmers. *Ind Health* 44, 98–100.

Balogun, A.A., Balogun, I.A., Adeyewa, Z.D. 2010. Comparisons of Urban and Rural Heat Stress Conditions in a Hot Humid Tropical City. *Global Health Action* 3.

Barnett, A.G. 2007. Temperature and Cardiovascular Deaths in the US Elderly: Changes over time. *Epidemiology* 18:3, 369–372.

Basu, R., Samet, J.M. 2002. Relation Between Elevated Ambient Temperature and Mortality: A review of the epidemiologic evidence. *Epidemiol Reviews* 24, 190–202.

Biswas, R., Samanta, A., Saha, P. 2011. Cardiac Strain of Confectionery Worker in Relation to Heat Exposure During Regular Work Shift. *Indian Journal of Occupational and Environmental Medicine* 15: 3, 120–6.

Bridger, R.S. 2003. *Introduction to Ergonomics*. 2nd edition. London: Taylor & Francis.

Challenge to Change, Dragon Institute, Mekong Rice Institute and Can Tho University. 2009. *HCVA in Can Tho*. Asian Cities for Climate Change Resilience Network (ACCCRN), supported by Rockefeller Foundation.

CDKN. 2012. *Managing Climate Extremes and Disasters in the Health sector: Lessons from IPCC*. Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (SREX). Climate and Development knowledge network (CKDN).

Confalonieri, U., Menne, B., Akhtar, R., Ebi, K.L., Hauengue, M., Kovats, R.S., Revich, B. and Woodward, A. (2007). Human health. In: M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, (Eds). 2007. *Climate Change 2007: Impacts, adaptation and vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge, UK, 391–431.

Cortez, O.D. 2009. Heat stress assessment among workers in a Nicaraguan sugarcane farm. *Global Health Action*.

Ebi, K.L., Schmier, J.K. 2005. A stitch in time: improving public health early warning systems for extreme weather events. *Epidemiol Review* 27, 115–121.
Ebi, KL. 2008. Healthy people 2100: modeling population health impacts of climate change. *Climatic Change* 88: 1, 5–19.

Fischer, E.M. and Schär, C. 2010. Consistent geographical patterns of changes in high-impact European heat waves. *Nature Geoscience* 3, 398–403.

Gawith, M., Street, R., Westaway, R., Steynor, A. 2009. Application of the UKCIP02 climate change scenarios: reflections and lessons learnt. *Global Environmental Change* 19:1, 113–121.

Haines, A., Kovats, R.S., Camphell-Lendrum, I. and Corvalan, C. 2006. Climate change and human health: impacts, vulnerability, and mitigation. *Lancet* 367, 2101–2109.

Hales, J.R.S. and Richards, D.A.B. 1987. *Heat Stress: Physical Exertion and Environment*. Excerpta Medica: Amsterdam.

Hales, S., Edwards, S. and Kovats, R.S. 2003. Impacts on health of climate extremes. In: McMichael, A., Campbell-Lendrum, D., Corvalan, C., Ebi, K., Githeko, A., Scheraga, J., Woodward, A. (Eds.) *Climate Change and Human Health: Risks and Response*. World Health Organization, Geneva, 79–102.

Hanna, E.G., Kjellström, T., Bennett, C., and Dear, K. 2011. Climate change and rising heat: population health implications for working people in Australia. *Asia-Pacific Journal of Public Health* 23: 2.

Hertel, S., Le Tertre, A., Jockel, K.H. and Hoffmann, B. 2009. Quantification of the heat wave effect on cause-specific mortality in Essen, Germany. *European Journal of Epidemiology* 24:8, 407–414.

Holmér, I. 2010. Climate change and occupational heat stress: methods for assessment. *Global Health Action* 3, 5719.
Huang, C., Barnett, A.G., Wang, X., Vaneckova, P., FitzGerald, G. and Tong, S. 2011a. Projecting future heat-related mortality under climate change scenarios: a systematic review. *Environmental Health Perspectives* 119: 12, 1681–90.

Huang, C., Vaneckova, P., Wang, X., Fitzgerald, G., Guo, Y. and Tong, S. 2011b. Constraints and barriers to public health adaptation to climate change: a review of the literature. *American Journal of* Preventive *Medicine* 40: 2, 183–90.

Hyatt, O.M., Lemke, B. and Kjellström, T. 2010. Regional maps of occupational heat exposure: past, present, and potential future. *Global Health Action* 3, 5715.

IPCC. 2007a. *Climate Change 2007: Impacts, adaptation and vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press: Cambridge.

IPCC. 2007. *Fourth Assessment Report*. Geneva, Intergovernmental Panel on Climate Change. Cambridge University Press: Cambridge.

Jardine, D.S. 2007. Heat illness and heat stroke. *Pediatrics in Review* 28, 249–258.

Balakrishnan, K., Ramalingam, A. Dasu, V., Stephen, J.C., Sivaperumal, M.R., Kumarasamy, D., Mukhopadhyay, K., Ghosh, S. and Sambandam, S. 2010. Case studies on heat stress related perceptions in different industrial sectors in southern India. *Global Health Action* 3, 5636.

Kerslake, D.M. 1972. *The stress of Hot Environments*. Cambridge University Press: Cambridge.

Kintisch, E. 2009. Global warming: projections of climate change go from bad to worse, scientists report. *Science* 323: 5921,1546–1547.

Kjellström, T, Gabrysch, S., Lemke, B. and Dear, K. 2009a. The 'Hothaps' programme for assessing climate change impacts on occupational health and productivity: an invitation to carry out field studies. *Global Health Action*.

Kjellström, T. 2009c. Climate change, direct heat exposure, health and well-being in low and middle-income countries. *Global Health Action.*

Kjellström, T., Holmer, I. and Lemke, B. 2009b. Workplace heat stress, health and productivity: an increasing challenge for low and middle-income countries during climate change. *Global Health Action.*

Kjellström, T., Kovats, S.R., Lloyd, J.S, Holt, T. and Tol, S.J. 2008. *The Direct Impact of Climate Change on Regional Labour Productivity*. Working Paper No. 260. International Archives of Occupational and Environmental Health.

Knowlton, K., Rotkin-Ellman, M., King, G., Margolis, H.G., Smith, D., Solomon, G, Trent, R. and English, P. 2009. The 2006 California heat wave: impacts on hospitalisations and emergency department visits. *Environmental Health Perspectives* 117, 61–67.

Kovats, R.S. and Hajat, S. 2008. Heat stress and public health: a critical review. *Annual Review of Public Health* 29, 41–55.

Kovats, S. and Jendritzky, G. 2006. Heat-waves and human health. In: Menne, B. and Ebi, K.L. (Eds.) *Climate Change and Adaptation Strategies for Human Health*. Darmstadt: Steinkopff.

Krungkraiwong, S., Itani, T. and Amornratanapaichit, R. 2006. Promotion of a healthy work life at small enterprises in Thailand by participatory methods. *Ind Health* 44, 108–11.

Krungkraiwong, S. 2005. Participatory work improvement in Thailand. *Asian-Pacific Newsletter on Occupational Health and Safety* 12, 68–70

Langkulsen, U, Vichit-Vadakan, N. and Taptagaporn, S. 2010. Health impact of climate change on occupational health and productivity in Thailand. *Global Health Action* 3: 5607.

Lee, N., Lee, B.K., Jeong, S., Yi, G.Y. and Shin, J. 2012. Work environments and exposure to hazardous substances in korean tire manufacturing. *Safety and Health at Work* 3:2, 130–9.

Leithead, C.S. and Lind, A.R. 1964. *Heat stress and heat disorders*. London: Cassell.

Lin, R.T. and Chan, C.C. 2009. Effects of heat on workers' health and productivity in Taiwan. *Global Health Action.*

Luber, G. and McGeehin, M. 2008. Climate change and extreme heat events. American Journal of Preventive Medicine 35:5, 429–435.

McMichael, A, Wilkinson, P., Kovats, S., Hajat, S., Pattenden, S., Armstrong, B. and O'Neill, M. 2008. International study of thermal stress and urban mortality in low- and middle-income countries. International Journal of Epidemiology 37:5, 1121–31.

McMichael, A., Campbell-Lendrum, D., Corvalan, C., Ebi, K., Githeko, A., Scheraga, J. and Woodward, A. (Eds.) 2003. *Climate Change and Human Health: Risks and responses.* World Health Organization, Geneva.

Meehl, G. and Tebaldi, C. 2004. More intense, more frequent, and longer lasting heat waves in the 21st century. *Science* 305:5686, 994–997.

MONRE. 2009. *Climate Change, Sea Level Rise Scenarios for Vietnam.* Vietnam Ministry of Natural Resources and Environment (MONRE).

MONRE. 2011. *National Climate Change Strategy*. Vietnam Ministry of Natural Resources and Environment (MONRE).

Nag, P.K, Nag, A. and Ashtekar, S.P. 2007. Thermal limits of men in moderate to heavy work in tropical farming. *Industrial Health* 45, 107–17.

Nag, P.T. and Nag, A. 2009. *Vulnerability to Heat Stress: Scenarios in Western India*. National Institute of Occupational Health.

Nainate, A. and Chaunchaiyakul, R. 2006. Cardio-respiratory responses during continuous exercise under heat stress in sedentary subjects. *Journal of Sports Science and Technology*, Thailand. 6, 33–47.

NHS. 2012. *Heat Wave Plan for England*. National Health Service (NHS).

Nilsson, M. and Kjellström, T. 2010. Invited Editorial: Climate change impacts on working people: how to develop prevention policies. *Global Health Action* 3: 5774.

Pelling, M. 2011. *Adaptation to Climate Change: From Resilience to Transformation*. Routledge Publishing, London.

Ramalingam, A., Sambandam, S., Paramasivan, R. and Kalpana, B. 2009. Work-related heat stress concerns in automotive industries: a case study from Chennai, India. *Global Health Action.*

Ramsey, J.D. and Bernard, T.E. 2000. Heat stress. In: Harris, R.L. (ed) *Patty's Industrial Hygiene*, 5th edition. New York: John Wiley and Sons, 925–84.

Ramsey, J.D., Burford, C.L., Beshir, M.Y. and Jensen, R.L. 1983. Effects of workplace thermal conditions on safe working behavior. *Journal of Safety Research* 14, 105–14.

Ramsey, J.D. 1995. Task performance in heat: a review. *Ergonomics* 38, 154–65.

Ren, C., Williams, G.M. and Tong, S. 2006. Does particulate matter modify the association between temperature and cardiorespiratory diseases? *Environmental Health Perspectives* 114, 1690–1696.

Schaefer, D. 2003. Recent climate changes and possible impacts on agriculture in Vietnam with regard to the RRD. German Vietnam Seminar, Hanoi, 27–30 October 2003. See www.staff.uni-mainz.de/dschaefe/pdf/Schaefer_Recent_Climate_Change_in_Vietnam.pdf

Schrier, R.W., Hano, J., Keller, H.I., Finkel, R.M., Gilliland, P.F., Cirksena, W.J., et al. 1970. Renal, metabolic, and circulatory responses to heat and exercise. *Annals of Internal Medicine* 73, 213–23.

Srivastava, A., Kumar, A., Joseph, E., and Kumar, A. 2000. Heat Exposure Study in the Workplace in a Glass Manufacturing Unit in India. *Annals of Occupational Hygiene* 44:6, 449–453.

Stafoggia, M., Forastiere, F., Agostini, D., Biggeri, A., Bisanti, L., Cadum E, de'Donato, F., De Lisio, S., De Maria, M., Michelozzi, P., Miglio, R., Pandolfi, P., Picciotto, S., Rognoni, M., Russo, A., Scarnato, C. and Perucci, C.A. 2006. Vulnerability to heat-related mortality: a multicity, population-based, case-crossover analysis. *Epidemiology* 17:3, 315–323.

United Nations. 2011. *Climate Change Fact Sheet: The effects of climate change in Viet Nam and the UN's Responses*. United Nations.

Wang, X.Y., Barnett, A.G., Hu, W. and Tong, S. 2009. Temperature variation and emergency hospital admissions for stroke in Brisbane, Australia, 1996–2005. *International Journal of Biometeorology* 53: 6, 535–541.

WHO. 2011. *Durban Declaration on Climate and Health*. World Health Organization. See www.climateandhealthcare.org/wp-content/uploads/2011/12/Durban-Declaration-on-Climate-and-Health-Final.pdf

WHO. 2009a. *Improving Public Health Responses to Extreme Weather Heat-Waves EuroHEAT*. Copenhagen: WHO Regional Offce for Europe.

WHO. 2009b. *Protecting Health from Climate Change: Global research priorities.* World Health Organization: Geneva.

Winkels, A. 2012. Migration, social networks and risk: the case of rural to rural migration in Vietnam. *Journal of Vietnamese Studies* 7:4.

Winkels, A. 2008. Rural in-migration and global trade: managing the risks of coffee farming in the Central Highlands of Vietnam. *Mountain Research and Development* 28:1.

Wolf, J., Lorenzoni, I., Few, R., Abrahamson, V. and Raine, R. 2008. Conceptual and practical barriers to adaptation: vulnerability and responses to heat waves in the UK. In: Adger, W.N, Lorenzoni, I. and O'Brien, K.L. (Eds.) *Adapting to Climate Change: Thresholds, values, governance.* Cambridge University Press: Cambridge.

Younger, M., Morrow-Almeida, H.R., Vindigni, S.M. and Dannenberg, A.L. 2008. The built environment, climate change, and health. American Journal of Preventive Medicine 35:5, 517–526.

Yunibhand, S., Intaranont, K. and Vanwonterghem, K. 1991. Ergonomic assessment of workload in Thai Industries. In: Quéinnec, Y. and Daniellou, F. (Eds) *Designing for Everyone.* Volume 2. Proceedings of the 11th Congress of the International Ergonomics Association.

Annex 1. Questionnaire

Research on heat stress and adaptive capacity of the unregistered migrants and low income outdoor workers and their families in urban area of Da Nang, Vietnam.

Respondents group:

Group A – Unregistered migrants
Group B – Registered migrants
Group C – Da Nang residents

General instructions for interviewer

For each question, place an X in the box that matches the respondent's answer or fill in the blank. Please pay special attention to the skip cues, which are indicated in the quotation marks, where relevant. For questions where there are multiple responses, respondents can choose more than one answer.

I. Demographic information

A1. Place of current residence:

A2. Gender

1. ☐ Male
2. ☐ Female

A3. Year of birth ☐☐☐☐ (note 99 if no answer)

A4. Where were you born?

A5. Current marital status

1. ☐ Single
2. ☐ Married
3. ☐ Widowed
4. ☐ Divorced/separated

99. No answer

A6. The highest level of education

1. ☐ No formal education
2. ☐ Primary school (Grade 1–5)
3. ☐ Secondary school (Grade 6–9)
4. ☐ High school (Grade 10–12)
5. ☐ Vocational school

6. ☐ College and higher levels
99. ☐ No answer

A7. When did you arrive in Da Nang? (Month, Year)

A8. Where did you live before coming to Da Nang?

A9. Did you migrate:

1. ☐ Alone
2. ☐ With friends
3. ☐ With family
4. ☐ Others (specify)

A10. Did you know anyone in Da Nang before arriving here?

1. ☐ Yes
2. ☐ No (skip to A12)

A11. Who did you know?

A12. Name three reasons for leaving your former residence.

A13. Do you send or receive money from home?

1. ☐ Send
2. ☐ Receive
3. ☐ Both
4. ☐ Neither receive nor send

A14. Are you the head of household?

1. ☐ Yes
2. ☐ No

A15. How many dependent people are there in your household (including: children, elderly without income, those with disabilities)?

A16. What was your main occupation at your former residence?

1. ☐ Agriculture
2. ☐ Construction
3. ☐ Porter
4. ☐ Fisher worker
5. ☐ Service provider
6. ☐ Others (specify)

A17. What is your main current occupation?

1. ☐ Agriculture
2. ☐ Construction
3. ☐ Porter
4. ☐ Fisher worker
5. ☐ Service provider
6. ☐ Others (specify)

A18. Numbers of year spent in current outdoor job (Month, Year).

A19. Have you ever had outdoor jobs before?

1. ☐ Yes
2. ☐ No (skip to A21)

A20. Numbers of years spent in those jobs.

A21. Average monthly individual income.

1. ☐ Less than VN$500,000 (US$25)
2. ☐ Over VN$500,000 to VN$1 million (US$25–50)
3. ☐ Over VN$1 million to VN$2 million (US$50–$100)
4. ☐ Over VN$2 million to VN$5 million (US$100–$250)
5. ☐ More than VN$5 million (US$250)
99. ☐ No answer

A22. What is your employment status?

1. ☐ Hired labour/employee
2. ☐ Self employed
3. ☐ Both

A23. Do you have a resident's permit for your current location?

1. ☐ Yes
2. ☐ No (skip to C25)

A24. What kind of permit do you have?

1. ☐ Long-term temporary residence card
2. ☐ Short-term temporary residence card
3. ☐ Household registration book
4. ☐ Other

A25. Were you aware of any environmental problems at your former residence?

1. ☐ Air pollution
2. ☐ Temperature increase
3. ☐ Increasing of natural disaster intensity and frequency
4. ☐ Increasing of extreme weather events
5. ☐ Other
6. ☐ No environmental problems

II. Personal health information

B1. Weight (kg)

B2. Height (cm)

B3. How would you assess your current health status?

1. ☐ Very poor
2. ☐ Poor
3. ☐ Reasonable
4. ☐ Good
5. ☐ Excellent
99. ☐ No answer

B4. Have you ever been diagnosed with the following illness? *(check all that apply)*

1. ☐ Cardiovascular diseases
2. ☐ Hypertension
3. ☐ Dermatology
4. ☐ Obesity

5. ☐ Respiratory diseases
6. ☐ Others (specify)
7. ☐ No illness
99. ☐ No answer

B5. Do you have health insurance?

1. ☐ Yes
2. ☐ No
99. ☐ No answer

B6. Have you ever received any of the following supports?

1. ☐ Health support
2. ☐ Livelihood support
3. ☐ Job support
4. ☐ Others
5. ☐ Have not received any support (skip to C1)

B7. Where have you received these supports?

No	Sources	Health support	Livelihood support	Job support	Others
B7.1	Local authorities				
B7.2	Mass organisations (Women's Union, Youth Union)				
B7.3	Local healthcare services				
B7.4	Trade union				
B7.5	NGOs				
B7.6	Association of fellow-countrymen				
B7.7	Others				

III. Heat stress risk assessment

C1. Do you work under direct sunlight?

1. ☐ Yes
2. ☐ No
99. ☐ No answer

C2. How do you assess your workplace conditions in summer?

C2.1	Temperature	☐ Very hot	☐ Hot	☐ Normal	☐ Cool	☐ Very cool
C2.2	Humidity	☐ Very humid	☐ Humid	☐ Normal	☐ Dry	☐ Very dry

C3. Is your workplace hotter than your home?

1. ☐ Yes
2. ☐ No (skip to C5)
99. ☐ No answer

C4. Why is your workplace hotter than your home?

1. ☐ Close to fire
2. ☐ Close to welding
3. ☐ Close to hot surfaces
4. ☐ Close to hot machinery
5. ☐ Others

C5. Does your type of work make you feel hotter than when you are at rest?

1. ☐ Yes
2. ☐ No (skip to C7)
99. ☐ No answer

C6. Why do you feel hotter than when you are at rest?

1. ☐ Carrying heavy load
2. ☐ Fast pace of work
3. ☐ Others

C7. What kind of clothing do you usually wear?

1. ☐ Protective clothing
2. ☐ Light, loose clothing
3. ☐ Dark-coloured clothing
99. ☐ No answer

C8. Does the type of clothing you wear at work make you hotter?

1. ☐ Yes
2. ☐ No (skip to C9)
99. ☐ No answer

C9. How many hours per day do you have to work? *(Excluding breaks)* (Hours, minutes)

C10. Have you ever been provided with heat/sun protective measures by your employers?

1. ☐ Yes
2. ☐ No (skip to C12)
99. ☐ No answer (skip to C12)

C11. If yes, which measures have you been provided with? *(check all that apply)*

	Items	**Sufficient**	**Insufficient**
1	Heat protective clothing		
2	Personal protective equipments (sunglasses, sun cream, gloves, masks)		
3	Drinking water		
4	Suitable short breaks scheduled during working hours to avoid the heat		
5	Long lunch break to avoid the noon heat		
6	Changes to your scheduled working hours		

C12. How often do you usually drink water during work?

1. ☐ Every hour
2. ☐ Every 20 minutes

3. ☐ When I feel thirsty
4. ☐ Other
99. ☐ No answer

C13. What kind of housing are you living in?

1. ☐ Private house
2. ☐ Rented house
3. ☐ Subsidised house
4. ☐ Other

C14. What type is your house?

1. ☐ Tiled-roof house
2. ☐ Corrugated-iron roof house
3. ☐ Flat-roof house
4. ☐ Tenement house
5. ☐ Other

C15. What heat-resistant equipment do you have in your house? *(check all that apply)*

1. ☐ Heat-resistant ceiling
2. ☐ Air conditioning
3. ☐ Fan
4. ☐ Misting fan
5. ☐ Other (specify)
6. ☐ No heat-resistant equipment

C16. Do you normally feel hot when you are at home?

1. ☐ Very hot
2. ☐ Hot
3. ☐ Normal
4. ☐ Cool

IV. Knowledge of heat waves and heat stress

D1. In the last five years, has the normal/everyday temperature in your area increased?

1. ☐ Yes
2. ☐ No
99. ☐ Don’t know

D2. In the last five years, how have heat events been in your area?

1. ☐ More common
2. ☐ Less common
3. ☐ No change
99. ☐ Don’t know

D3. Can heat waves cause serious health problems?

1. ☐ Yes
2. ☐ No
99. ☐ Don’t know

D4. Extreme heat waves can contribute to a high mortality rate.

1. ☐ True
2. ☐ False
99. ☐ Don't know

D5. Have you ever heard about heat stress?

1. ☐ Yes
2. ☐ No (skip to D8)

D6. What contributes to heat stress? *(check all that apply)*

1. ☐ Temperature
2. ☐ Direct sun
3. ☐ Barometric pressure
4. ☐ Humidity
99. ☐ Don't know

D7. What is the most serious form of heat stress?

1. ☐ Sunstroke
2. ☐ Heat exhaustion
3. ☐ Heat stroke
99. ☐ Don't know

D8. Have you ever heard of heat stroke?

1. ☐ Yes
2. ☐ No (skip to D11)

D9. What are the **common** symptoms of heat stroke *(check all that apply)*

1. ☐ Having hallucinations
2. ☐ Having an increased body temperature and feeling hot
3. ☐ Dry skin
4. ☐ Confusion/dizziness
5. ☐ Chills
6. ☐ Other (specify)
99. ☐ Don't know

D10. What is the best form of first aid for someone suffering from heat stroke? *(check all that apply)*

1. ☐ Move the person to a cooler or shaded area
2. ☐ Spray or shower them with water
3. ☐ Soak their clothes
4. ☐ Fan their body
5. ☐ Other (specify)
99. ☐ Don't know

D11. Have you ever heard of heat exhaustion?

1. ☐ Yes
2. ☐ No (skip to D13)

D12. What are the **common** symptoms of heat exhaustion? *(check all that apply)*

1. ☐ Heavy sweating
2. ☐ Extreme weakness or fatigue
3. ☐ Dizziness, confusion

4. ☐ Nausea
5. ☐ Other (specify)
99. ☐ Don't know

D13. If you are working in a hot area, what should you do to adapt to the heat?*(check all that apply)*

1. ☐ Wear light-coloured, loose-fitting, breathable clothing (cotton)
2. ☐ Use personal protective equipments (sunglasses, hat, mask)
3. ☐ Drink water frequently before feeling thirsty
4. ☐ Avoid alcohol, large amount of caffeine or sugar
5. ☐ Take breaks in the shade or a cool area when possible
6. ☐ Take more breaks in extreme heat and humidity
7. ☐ Other (specify)
99. ☐ Don't know

D14. What do you know about climate change? *(check all that apply)*

1. ☐ Temperature increasing
2. ☐ Increasing of natural disaster intensity and frequency (floods, storms etc.)
3. ☐ Occurs because of increasing greenhouse gas emissions
4. ☐ Increasing of extreme weather events
5. ☐ Other
99. ☐ Don't know

V. Perceptions of heat waves and heat stress

No	Statements	Strongly disagree	Disagree	Uncertain	Agree	Strongly agree
E1	I think that I am not at risk of having heat stress.					
E2	If I feel tired when working in the heat, it is a serious problem					
E3	My physiological characteristics are not relevant to the risk of heat stress					
E4	It is necessary to use personal protective equipment when I am working in the heat					
E5	I cannot prevent myself from suffering from heat stress by taking precautionary measures					
E6	Having heat stress seriously impacts my health					
E7	I am healthy and don't need to protect myself from the sun					
E 8	Old people and women are more vulnerable to heat stress					

VI. Practices/behaviors

F1. How have you protected yourself from the heat when working outdoors on a hot day?

1. ☐ Wearing loose, light and light-coloured clothing
2. ☐ Using personal protective equipments (sunglasses, hat, mask)
3. ☐ Drinking water frequently before feeling thirsty
4. ☐ Planning heavy activities during the early morning or evening hours
5. ☐ Scheduling rest breaks in shaded areas regularly
6. ☐ Avoiding drinking alcohol or large amount of caffeine or sugar
7. ☐ Other
8. ☐ Don't do anything

99. ☐ No answer

F2. If you don't do anything to protect yourself from the heat, please explain why *(check all that apply)*

1. ☐ Inconvenience
2. ☐ Unnecessary
3. ☐ Unprotectable
4. ☐ Unsuitable
5. ☐ Insufficient
6. ☐ Others (specify)_____

F3. Have you ever become ill when you were working in the heat in the last 3 months?

1. ☐ Yes
2. ☐ No *(Skip to F5)*

F4. If yes, what are the illnesses/symptoms that you have suffered?

No	Symptoms	Usually	Sometimes	Rarely
1	Headache			
2	Dizziness			
3	Muscular ache			
4	Vomiting			
5	Elevated body temperature			
6	Unconsciousness			
7	Difficulty breathing			
8	Hot, dry skin			
9	Poor diet			
10	Insomnia			
11	Other (specify)			

F5. What problems have you suffered from while working in the heat in the last 6 months?

Problem	Usually	Sometimes	Rarely	Never
Reduced work productivity				
Loss of concentration while working				
Occupational accidents				
Sick leave without pay				
Others(specify)				

F6. What did you do when you experienced health problems because of working in hot conditions?

1. ☐ Moved to a cooler or shady area
2. ☐ Drank plenty of water
3. ☐ Went to the healthcare centre
4. ☐ Took medication (self treatment)
5. ☐ Did nothing and continued to work.
6. ☐ Others
99. ☐ No answer

F7. If you continued to work, please explain why.

F8. Have you ever applied folk/traditional health treatments for problems related to heat waves?

1. ☐ Yes
2. ☐ No *(Skip to F10)*

F9. Please describe the folk/traditional treatments

F10. Have you ever sought support when suffering from health problem related to heat waves?

1. ☐ Friends/colleagues/neighbours
2. ☐ Mass organisations
3. ☐ Employer
4. ☐ Trade union
5. ☐ Healthcare providers
6. ☐ Others
7. ☐ No need supports from others

F11. What problems do you experience when seeking medical treatment?

1. ☐ Don’t have health insurance
2. ☐ Don’t have resident’s permit
3. ☐ Cannot afford the treatment
4. ☐ Don’t know where I should go for treatment
5. ☐ Other
6. ☐ Have not experienced problems

F12. Where did you find information on heat waves and heat stress?

No.	Resources	Information on heat waves/ hot days	Information on heat stress and heat-related illness
F12.1	Healthcare provider		
F12.2	Friends/colleagues		
F12.3	Family members		
F12.4	TV		
F12.5	Radio		
F12.6	Household meeting at ward level		
F12.7	Newspapers/magazines		
F12.8	VNGOs/INGOs		
F12.9	Loudspeaker at ward level		
F12.10	Employers		
F12.11	Others		
F12.12	What is the best resource *(fill in the code of above resources)*		
F12.13	Have not received any information		
F12.99	Don't know		
F12.88	Don't remember		

Annex 2. Checklists for stakeholder interviews

Note: The guidelines focus on different points for different stakeholders .

A2.1 Policy makers (DOLISA, DOFA):

- Labour and Health Protection Laws related to labour conditions (heat-related and outdoor environment); labourers' rights and benefits; responsibilities of employers; specific questions related to the adaptation measures taken by the workers: men and women (and women with small children under 12 months); working conditions; protective measures; breaks; sick leave; maternal care; compensation when sickness occurs; flexible hours; health and social insurance; compensation for illnesses due to heat stress; and employers' actions and responsibilities to support the workers against heat stress.
- Existing policies and/or regulations to regulate public services for migrant workers especially those with unregistered status – normally the poor in the city (temporary residence registation; access to and use of health insurance for themselves and for their children; education for children; participation in mass organisations, ward meetings or occupational trade unions etc.).
- Implementation level of these laws and decrees (specific regulations) by the employers (small enterprises and others) in Da Nang – key challenges and solutions.
- Monitoring missions by these agencies, in cooperation with other mass organisations, people's councils and people's committees.
- Forms of support provided to self-employed groups of farmers, unregistered migrants and poor groups of the population and to fishing-related traders and labourers (not belonging to small and medium enterprises).
- What are the action plans of the health sector in Da Nang, which have a heat stress focus?
- Recommendations to other stakeholders.

A2.1.1 Healthcare service providers (Preventive Health Centre at city and district levels; commune-level health stations; some hospitals)

- What are the specific healthcare and other services/programmes that the centre and other related health-service providers provide to any of the following groups in the city? Unregistered migrants, poor outdoor workers (fishermen, labourers, farmers, petty traders, self-employed motorbike drivers etc.) What training courses, information

dissemination, health checks, treatment programmes for related diseases caused by heat stress, prevention campaigns, advice are available?

- What are the challenges faced by unregistered migrants in accessing healthcare services, including the accessibility to health insurance programmes, for themeselves and their children?
- Is heat stress (heat stroke, heat exhaustion, etc.) included in the list of occupational diseases in Vietnam? If yes, is it covered by health insurance?
- What is the capacity of the hospital in dealing with heat stress-related diseases? (facilities and human resources).
- Are you monitoring impacts on vulnerable populations? Trends?
- What additional support is needed?
- Recommendations?

A2.1.2 Checklist for NGOs, mass organisations such as the Red Cross, associations for the elderly, and the Women's Union

- What are the current public health programmes related to heat stress and its diseases?
- What current programes focus on small-scale farmers, ethnic minorities (working in farming), migrants, the elderly or poor women (particularly those who are working outdoo,rs in Da Nang)?
- What are the key health challenges for these groups and why? What support is provided by these organisations?
- Are you monitoring working conditions and labourers' rights in the workplace in cooperation with other government agencies?
- What is your capacity for working with these groups in the city, particularly related to education, awareness-raising, prevention, first aid and support for workers' groups in the wards, particularly in the poorer settlement areas of the city (to improve both working conditions and home conditions)?
- Are there any opportunities for integrating these issues into your current programmes?
- Recommendations

A2.1.3 Checklist for discussions with unregistered migrants and outdoor workers (mixed groups and women-only groups – with certain occupations)

We can consider using some visual tools (e.g. mapping of health services that they often access; matrices of coping and adaptation measures; mapping of information channels related to early warning service; etc.) to stimulate discussions among the members with the following questions:

- What type of work are you doing outdoors?
- Could you please tell a bit about your understanding about climate change, heat and heat stress? What information sources do you use to hear of heat waves in the city? Are there any?
- Who do you think are most affected by heat stress? Why do you think so?
- Do you think women are more vulnerable and most impacted by heat stress? Why do you think so? In what ways?
- Can you describe the working conditions at your workplace (temperature, humidity, dust, noise, chemical, etc.), i.e. every detail about working conditions.

- How do you feel when you are working in the heat outdoors? (Thirsty, tired, dry mouth, dizziness, headaches, muscle cramps, etc.)
- How do you adapt to heat at work? What local indigenous knowledge and practices do you use to deal with heat? (Your own and those of family members and others).
- Which measures worked? And which did not? Why?
- What kind of clothes do you wear (colour, fabric)? Why do you do so?
- Do you take breaks during your working day? If not, why not? If yes, how long? Where? What do you do while you take your breaks?
- Do you drink water while you are working? If yes, how often? If not, why?
- Do you change your working times (e.g. begin earlier, take longer lunches etc.)?
- Have you and/or your colleagues ever suffered from heat stress? If yes, what did you/your colleagues do immediately on site? Why did you do so? Who told you to do so? Did you have to seek any treatment? If yes, where and why did you choose that service? Did you use your health insurance? If yes, what kind of service did your health insurance provide? If no, why not?
- Have you and/or your colleagues ever had to take a day off work because of heat stress? If yes, what affect did it have on your life? (E.g. did not get paid for those days, had to be cared by another, could not take care for your family?)
- Does you employer provide you with any protective equipment or ensure appropriate working conditions for your work outdoor in the context of heat waves? If yes, what?
- Have you ever asked your employers to provide you with the above? If yes, how did they react?
- Do you think it is your employer's responsibility to provide you with appropriate working conditions/equipment so you can adapt to the heat? Why do you think so?
- Are there any trade unions or any groups represented at your work place? Are you and your colleagues teaming up to raise issues with your employer? How successful have you been?
- Please tell us a bit about your family. What is the status of your home (do you own your house, is it rented or a friend's house)? What kind of house is it?
- Is your house hot in the summer? If yes, how do you make it cooler? What does it cost you to do so? Does covering expenses for cooling the house affect other family expenses?
- Do you receive or do you know of other forms of social support that exist in Da Nang? (e.g. micro finance, income generation, occupation training and placements, health education etc.) If yes, who provides this support? If no, why? Does your migrant status prevent you in accessing any of these programmes?
- Do you belong to any organisations or unions (e.g. Vietnamese mass organisations, occupational unions, your home-town alumni etc.) If no, why? If yes, what are their activities and what kind of support do you receive from them?
- What social networks do you belong to? How can these networks help you in dealing with heat stress? How useful are they?
- Have you register your temporary residence status with the local authority? If not, why? If you have not registered, does it affect your ability to access public services or other support services in Da Nang? Why do you think so?
- Do you have any recommendations about how to improve your adaptive capacity to heat stress and access to public services? (e.g. health and education services).

A2.2 Detailed checklists

A2.2.1 Checklists for DOLISA, DOFA

Introduction: Heat waves are associated with climate change. Heat waves can have a negative impact on the health of workers, especially outdoor workers. Protection of outdoor workers' health in the context of heat waves has been of concern to policy makers in many countries. In Vietnam, migrant outdoor workers are the most impacted group because of their vulneribility. Da Nang is one of the cities in Vietnam affected by climate change. This interview is part of COHED research on the impact of heat waves on migrant outdoor workers in Da Nang. The focus of the interview is to explore current policies and regulations of the Government of Vietnam that regulate the role of employers in providing neccesary conditions to protect outdoor workers' health and promote their adaptation to heat waves. We hope you agree to take part in this interview. The interview will take between 30 minutes and an hour.

i) Knowledge and awareness of key government officials: climate change and heat waves, heat stress and risks

- Knowledge, understanding of climate change, heat stress and heat wave history in Da Nang and future trends? Reports on the impact on population groups of interest to DOLISA and DOFA in Da Nang.
- Are you aware that the national action plan for the health sector to respond to climate change also includes issues relating to heat waves?
- Is there such an action plan for the health sector in Da Nang?
- What are the levels of interest and investment of Da Nang government agencies? (DONRE, DARD, Department of Planning and Investment, Health Services, People's Committees, OCCA office for investment in health and climate change.) If limited, why is this?
- Which groups and occupations in Da Nang city are most at risk to heat waves and heat stress? Why? What are the impacts? Are they different for men and women?

ii) Key programmes, policies and projects

Could you please provide some facts about migrant workers (both registered and unregistered) in Da Nang (number of people, number of people managed, occupations). If no data is available, why?

- What are the issues related to illegal/unregistered migrants in the city currently? What are the causes, solutions and future trends?
- Who are the key agencies responsible for migrant people, poor people and outdoor workers? Key tasks/ responsibilities? If none, why? And how to address this?
- Who is working on local migrant issues in the city of Da Nang: NGOs or any other agencies?
- Are there any government-funded or foreign-funded projects, research or national target programmes related to the poor, migrants and outdoor workers, particularly in labour safety and health issues in the city?
- Definition of poor households, and locations of poor settlements in the city where the majority of the poor, outdoor workers and migrants reside; how is the government tackling challenges, causes and solutions? What worked and what did not?
- Do you see any links between the illnesses of poor outdoor workers and migrants? Do the health costs worsen the poverty status of these families? Why?
- Are there any current government laws, decrees or any other directives on the safety of outdoor working conditions for labourers in small and medium enterprises, stage enterprises, or for the self-employed? How does this compare to international labour practices regulations?
- How do government agencies enforce laws and what monitoring and evaluation is done? How can shortcomings of implementation be tackled?

- What are the existing policies and/or regulations to regulate public services for migrant workers especially those with unregistered status (e.g. temporary residence registation; access to and use of health insurance for themselves and for their children; education for children; participating in mass organisations, ward meetings, or occupational trade unions, etc.)
- Are there any specific policies and/or regulations about outdoor working-condition standards in Vietnam?
- If yes, how those policies/regulations regulate the roles of employers in providing an enabling environment and equipment for outdoor employees to adapt to and minimise the impacts of heat waves?
- How are those policies and/or regulations applied? What are the monitoring and evaluation mechanisms?
- Female outdoor workers may be more vulnerable to the negative impacts of heat waves, but also have capacity to deal with these. Do you think we should have specific regulations to protect them in the context of heat waves?
- What health services are available to groups most vulnerable to heat stress and heat waves in the city, if any? (e.g. health centres, hospitals, women's hospital or other health mobile services) What is the level of quality? Shortcomings and strengths?

iii) Recommendations

- What actions by government agencies including your own and others could support illegal/unregistered migrants, the poor and outdoor workers to adapt to heat waves and heat stress caused by climate change, in terms of policies, services and regulations for small-scale enterprise employers?
- Recommendations to other stakeholders?
- Research in other countries shows that heat waves are associated with health disorders and other negative impacts such as productivity reduction and occupational injuries. Regarding managing working-condition standards within companies/enterprises, do you think that we should have regulations which explicitly ask employers to ensure appropriate working conditions for outdoor workers and to provide support for employees to adapt to heat wave?
- If such regulations should be developed, what should be included?
- Note: Ask for copies of all the relevant reports, documents, or projects from the interviewees.

A2.2.2 Checklists for officials of Da Nang Preventive Medicine Centre (also possibly the Women's Hospital and the district/commune health stations)

- Introduction: Heat waves are associated with climate change. Heat waves can have a negative impact on the health of workers, especially outdoor workers. Protection of outdoor workers' health in the context of heat waves has been of concern to policy makers in many countries. In Vietnam, migrant outdoor workers are the most impacted group because of their vulneribility. Da Nang is one of the cities in Vietnam affected by climate change. This interview is part of COHED research on the impact of heat waves on migrant outdoor workers in Da Nang. The focus of the interview is to explore current policies and regulations of the Government of Vietnam that regulate the role of employers in providing neccesary conditions to protect outdoor workers' health and promote their adaptation to heat waves. We hope you agree to take part in this interview. The interview will take between 30 minutes and an hour.

i) Knowledge and awareness of key healthcare officials of climate change and heat waves, heat stress and risks.

- Knowledge, understanding of climate change, heat stress and heat wave history in Da Nang and future trends? Reports on the impact on population groups of interest to DOLISA and DOFA in Da Nang.
- Are you aware that the national action plan for the health sector to respond to climate change also includes issues relating to heat waves?

- Is there such an action plan for the health sector in Da Nang?
- What are the levels of interest and investment of Da Nang government agencies? (DONRE, DARD, Department of Planning and Investment, Health Services, People's Committees, OCCA office for investment in health and climate change.) If limited, why is this?
- Which groups and occupations in Da Nang city are most at risk to heat waves and heat stress? Why? What are the impacts? Are they different for men and women?

ii) Key programmes, policies and projects

- How much do you know about migrant workers in Da Nang? (number of people, number of people registered to work in Da Nang, their occupations).
- What types of healthcare and other services/programmes does your centre and other related health service providers provide to these groups in the city? (Unregistered migrants, the poor, outdoor workers?)
- With regards to unregistered migrants in the city, what kinds of health services does your agency, hospitals, commune- and district-level health centres and other mobile healthcare services provide?
- In term of protecting the health of outdoor workers, are there any policies and/or regulations about their access to and utilisation of health services, including access to health insurance programmes, for themeselves and their children?
- Is heat stress (heat stroke, heat exhaustion etc.) is included in the list of occupational diseases in Vietnam? If yes, is it covered by health insurance?
- Do you know of any specific policies and/or regulations about outdoor working-condition standards in Vietnam?
- If yes, how do these policies/regulations regulate the role of employers in providing an enabling environment and protective equipment for outdoor employees to adapt to and minimise the impact of heat waves?
- How are those policies and/or regulations applied? What are the monitoring and evaluation mechanisms?
- Do you provide any health communication programmes to outdoor health workers about adaptation to heat waves? If no, why? If yes, how?
- Literature shows that female outdoor workers are more vulnerable to the negative impacts of heat waves. Do you think we should have specific regulations to protect them in the context of heat waves?

iii) Recommendations

- What actions should government agencies (including your own agency and others) take to support illegal/unregistered migrants, the poor and outdoor workers to adapt to heat waves and heat stress caused by climate change, in terms of policies, services and regulations?
- Recommendations to other stakeholders?
- Research in other countries shows that heat waves are associated with health disorders and other negative impacts such as productivity reduction and occupational injuries. In terms of managing workers' health, do you think we should have regulations which explicitly ask employers to ensure appropriate working conditions for outdoor workers and provide support for employees to adapt to heat waves?
- If such regulations should be developed, what should be included?

A2.2.3 Checklist with employers

- Introduction: Heat waves are associated with climate change. Heat waves can have a negative impact on the health of workers, especially outdoor workers. Protection of outdoor workers' health in the context of heat waves has been of concern to policy makers in many countries. In Vietnam, migrant outdoor workers are the most impacted group because of their vulneribility. Da Nang is one of the cities in Vietnam affected by climate change. This interview is part of COHED research on the impact of heat waves on migrant outdoor workers in Da Nang. The focus of the interview is to explore current policies and regulations of the Government of Vietnam that regulate the role of employers in providing neccesary conditions to protect outdoor workers' health and promote their adaptation to heat waves. We hope you agree to take part in this interview. The interview will take between 30 minutes and an hour.
- Are you aware of the impacts of climate change in Da Nang? (e.g. trend of temperatures increasing over the last 30 years). Have you heard of heat waves and heat stress, as a result of cliamte change? Who are most at risk according to you, and why?
- During hot periods in the summer, how does this affect your workers? (e.g. health, productivity, health of the family members, sick leave ect.).
- What are the costs to your business associated with the reduced productivity of your workers? (e.g. economic, social, opportunities ect.). How do you minimise these costs?
- Do you know of any specific policies and/or regulations about outdoor working-condition standards in Vietnam?
- If yes, how are these policies and/or regulations applied in your company/enterprise?
- Are you aware of any other policies applied to other enterprises in the same industry in the city?
- Do you provide any support to your outdoor employees to enable them to adapt to the heat? Please provide reasons why you do so.
- Do you provide any training for your outdoor employees about ways to adapt to the heat? Please provide reasons why you do so.
- Have any of your employees been sick because of heat? What happended and what did you do?
- Do you have employees who have been sick in your company/enterprise? How do you support them to adapt to the heat?
- Research in other countries shows that heat waves are associated with health disorders and other negative impacts such as productivity reduction and occupational injuries. As manager of your company/enterprise, do you think that we should have regulations which explicitly ask you to ensure appropriate working conditions for outdoor workers and to provide support for employees to adapt to heat wave?
- If such regulations were to be developed, what should be included?
- Do you offer specific support to your female outdoor workers?
- What is their capacity to deal with heat compared to male workers?
- What are their special needs for further support, in terms of their roles in their families (income earning, caring for family members and other roles)?

Annex 3. Socio-economic characteristic of study's respondents

	Sex n (%)		**Occupation groups N (%)**			
Variables	**Male**	**Female**	**Other job**	**Construction**	**Service provider**	**Total N (%)**
Gender (n=319)			p=0.000			
Male	75 (64.66)	79 (81.44)	30 (28.30)	184 (57.7)		
Female	41 (35.34)	18 (18.56)	76 (71.70)	135 (42.3)		
Age group (n=317)	p=0.000	(p=0.001)				
15–24 years old	39 (21.20)	4 (3.01)	14 (12.07)	24 (24.74)	5 (4.81)	43 (13.6)
25–49 years old	109 (59.24)	77 (57.89)	65 (56).03	55 (56.70)	66 (63.46)	186 (53.3)
50–65 years old	30 (16.30)	44 (33.08)	28 (24.14)	17 (17.53)	29 (27.88)	74 (8.7)
Over 65 years old	6 (3.26)	8 (6.02)	9 (7.76)	1 (1.03)	4 (3.85)	14 (4.4)
Marital status (n=319)	p=0.000		p=0.000			
Single	70 (38.04)	9 (6.67)	31 (26.72)	38 (39.18)	10 (9.43)	79 (24.7)
Married	109 (59.24)	114 (84.44)	79 (68.10)	57 (58.76)	87 (82.08)	223 (69.9)
Widowed	1 (0.54)	7 (5.19)	1 (0.86)	2 (2.06)	5 (4.72)	8 (2.5)
Divorced/separated	3 (1.63)	2 (1.48)	3 (2.59)	0 (0.0)	2 (1.89)	5 (1.6)
No answer	1 (0.54)	3 (2.22)	2 (1.72)	0 (0.0)	2 (1.89)	4 (1.3)

	Sex n (%)		**Occupation groups N (%)**			
Variables	**Male**	**Female**	**Other job**	**Construction**	**Service provider**	**Total N (%)**
Educational level (n=319)	p=0.000		p=0.006			
No formal education	4 (2.17)	4 (2.96)	5 (4.31)	2 (2.06)	1 (0.94)	8 (2.5)
Primary school	25 (13.59)	51 (37.78)	28 (24.14)	12 (12.37)	36 (33.96)	76 (23.8)
Secondary school	85 (46.20)	64 (47.41)	43 (37.07)	53 (54.64)	53 (50.00)	149 (46.7)
High school	62 (33.70)	14 (10.37)	34 (29.31)	26 (26.80)	16 (15.09)	76 (23.8)
Vocational school	4 (2.17)	0 (0.0)	3 (2.59)	1 (1.03)	0 (0.0)	4 (1.3)
College/university and higher level	3 (1.63)	1 (0.74)	2 (1.72)	2 (2.06)	0 (0.0)	4 (1.3)
No answer	1 (0.54)	1 (0.74)	1 (0.86)	1 (1.03)	0 (0.0)	2 (0.6)
Resident status (n=319)			p=0.000			
Local resident	63 (55.26)	51 (44.74)	80 (68.97)	5 (5.15)	29 (27.36)	114 (35.74)
Migrant	121 (59.02)	84 (40.98)	36 (31.03)	92 (94.85)	77 (72.64)	205 (64.26)
Monthly income (n=319)	p=0.000		p=0.000			
Less than US$25	0 (0.0)	2 (1.48)	1 (0.86)	0 (0.00)	1 (0.94)	2 (0.6)
US$25–50	3 (1.63)	15 (11.11)	14 (12.07)	0 (0.00)	4 (3.77)	18 (5.7)
US$50–100	32 (17.39)	78 (57.78)	34 (29.31)	8 (8.25)	68 (64.15)	110 (34.5)
US$100–$250	135 (73.37)	39 (28.89)	62 (53.45)	79 (81.44)	33 (31.33)	174 (54.5)
More than US$250	14 (7.61)	0 (0.00)	4 (3.45)	10 (10.31)	0 (0.00)	14 (4.4)
No answer	0 (0.0)	1 (0.74)	1 (0.86)	0 (0.00)	0 (0.00)	1 (0.3)

Annex 4. Occupation characteristics

	Gender n (%)		Occupation groups n (%)			
Variable	**Male**	**Female**	**Other jobs**	**Construction**	**Service provider**	**Total n (%)**
Current occupation (n=319)	p=0.000					
Agriculture	17 (9.24)	27 (20.00)	44 (37.93)			44 (13.8)
Construction	79 (42.93)	18 (13.33)	0 (0.00)	97(100.00)		97 (30.40
Porter	39 (21.20)	2 (1.48)	41 (35.34)			41 (12.9)
Fisher worker	6 (3.26)	7 (5.19)	13 (11.21)			13 (4.1)
Service provider	30 (16.30)	76 (56).30	0 (0.00)		106 (100.00)	106 (33.2)
Other: waste collector	13 (7.07)	5 (3.70)	18 (15.52)			18 (5.6)
Number of years spent in current outdoor (n=316)	p=0.000		p=0.03			
Less than 1 year	19 (10.33)	17(12.59)	15 (12.93)	13 (13.40)	8 (7.55)	82 (26.3)
1–3 years	33 (17.93)	26 (19.26)	16 (13.79)	22 (22.68)	21 (19.81)	49 (15.8)
3–5 years	34 (18.4)	14 (10.37)	19 (16.38)	17 (17.53)	12 (11.32)	41 (13.3)
5 –10 years	62 (33.70)	22 (16.30)	32 (27.59)	29 (29.90)	23 (21.70)	54 (17.4)
Over 10 years	36 (19.57)	56 (41.48)	34 (29.31)	16 (16.49)	42 (39.62)	85 (27.2)
Employment status (n=319)	p=0.000		p=0.000			
Hired labor	129 (70.11)	27 (20.00)	60 (51.72)	93 (95.88)	3 (2.83)	156 (48.9)
Self-employed	53 (28.80)	107 (79.26)	54 (46.55)	3 (3.09)	103 (97.17)	160 (50.2)
Both	1 (1.09)	1 (0.74)	2 (1.72)	1 (1.03)	0 (0.00)	3 (0.9)

Chi square/Fisher exact test; *: $p<0.05$; **: $p<0.01$; ***: $p<0.001$

Annex 5. Health status of study respondents

	Gender n (%)		Occupation groups n (%)			
Variable	**Male**	**Female**	**Other jobs**	**Construction**	**Service provider**	**Total n (%)**
Current health status	p=0.000		p=0.000			
Very poor	1 (0.54)	0 (0.00)	0 (0.00)	0 (0.00)	1 (0.31)	1 (0.30)
Poor	14 (7.61)	43 (31.85)	26 (22.41)	1 (1.03)	30 (28.30)	57 (17.9)
Reasonable	141 (76.63)	87 (64.44)	75 (64.66)	83 (85.57)	70 (66.04)	228 (71.5)
Good	26 (14.13)	5 (3.70)	14 (12.07)	13 (13.40)	4 (3.77)	31 (9.7)
Excellent	2 (1.09)	0 (0.0)	1 (0.86)	0 (0.00)	1 (0.94)	2 (0.6)
Diseases						
Cardiovascular diseases	2 (1.09)	13 (9.63)***	5 (4.31)	1 (1.03)	9 (8.49)*	15 (4.7)
Hypertension	10 (5.43)	19 (14.07)**	12 (10.34)	3 (3.09)	14 (13.21)*	29 (9.1)
Dermatology	1 (0.54)	2 (1.48)	1 (0.86)	1 (1.03)	1 (0.94)	3 (0.9)
Respiratory diseases	7 (3.80)	5 (3.70)	7 (6.03)	2 (2.06)	3 (2.83)	12 (3.7)
Other: back pain, hypotension, headaches, dizzy, arthritis	17 (9.24)	46 (34.07)***	16 (13.79)	9 (9.28)	38 (35.85)***	63 (19.6)

ChiSquare/Fisher exacttest; *: $p<0.05$; **: $p<0.01$; ***: $p<0.001$

Annex 6. Acccessibility to public services and other social support programmes

Variable	Gender n (%)		Occupation groups n (%)			Total n (%)
	Male	Female	Other jobs	Construction	Service provider	
Health insurance status	p=0.02					
Has health insurance	69 (59.48)	53 (54.64)	43 (41.35)	100 (54.35)	65 (48.14)	165 (51.72)
Does not have health insurance	47 (40.52)	44 (45.36)	61 (58.65)	84 (45.65)	70 (51.86)	154 (48.28)
Receiving support						
Healthcare support	7 (6.03)	6 (6.19)	6 (5.66)	10 (5.43)	9 (6.67)	19 (5.96)
Livelihood support	0 (0.00)	1 (1.03)	3 (2.83)	1 (0.54)	3 (2.22)	4 (1.25)
Job support	0 (0.00)	1 (1.03)	1 (0.94)	2 (1.09)	0 (0.0)	2 (0.63)
Other: housing support, tuition fees for children, vaccinations for children	1 (0.86)	0 (0.00)	3 (2.83)	0 (0.0)	4 (2.96)	4 (1.25)
Never received support	108 (93.91)	89 (91.75)	93 (90.29)	171 (92.93)	119 (90.84)	290 (92.06)

Annex 7. Risks of heat stress in the workplace

	Gender n (%)		Occupation groups n (%)			
Variable	**Male**	**Female**	**Other jobs**	**Construction**	**Service provider**	**Total n (%)**
Working under direct sunlight						
Yes	111 (96.52)	92 (94.85)	101 (95.28)	174 (97.57)	130 (96.30)	304 (95.3)
No	4 (3.48)	5 (5.15)	5 (4.72)	9 (4.92)	5 (3.7)	14 (4.7)
Assessment of humidity in the workplace (n=319)	p=0.005					
Very humid	3 (2.59)	1 (1.03)	0 (0.00)	3 (1.63)	1 (0.74)	4 (1.3)
Humid	15 (12.93)	5 (5.15)	7 (6.60)	19 (10.33)	8 (5.93)	27 (8.4)
Normal	5 (47.41)	73 (75.26)	66 (62.26)	109 (59.24)	85 (62.96)	194 (60.8)
Dry	42 (36.21)	18 (18.56)	33 (31.13)	52 (28.26)	41 (30.37)	93 (29.2)
Very dry	1 (0.86)	0 (0.00)	0 (0.00)	1 (0.54)	0 (0.0)	1 (0.3)
Assessment of heat conditions in the workplace (n=319)	p=0.02					
Very hot	35 (30.17)	24 (24.74)	32 (30.19)	48 (26.09)	43 (31.85)	91 (28.5)
Hot	72 (62.07)	53 (54.64)	67 (63.21)	109 (59.24)	83 (61.48)	192 (60.3)
Normal	6 (5.17)	19 (19.59)	7 (6.60)	23 (12.50)	9 (6.67)	31 (10.0)
Cool	2 (1.72)	1 (1.03)	0 (0.00)	3 (1.63)	0 (0.0)	3 (0.9)
Very cool	1 (0.85)	0 (0.00)	0 (0.00)	1 (0.54)	0 (0.0)	1 (0.3)
Workplace hotter than home (n=319)	p=0.001		p=0.01			
Yes	106 (91.38)	70 (72.16)	87 (82.08)	143 (77.72)	120 (88.89)	263 (82.4)
No	10 (8.62)	27 (27.84)	19 (17.92)	41 (22.28)	15 (11.11)	56 (17.6)

	Gender n (%)		Occupation groups n (%)			
Variable	**Male**	**Female**	**Other jobs**	**Construction**	**Service provider**	**Total n (%)**
Reasons why work place is hotter than home (n= 262)						
Close to fire	1 (0.94)	0 (0.00)	0 (0.00)	0 (0.0)	1 (0.84)	1 (0.38)
Close to hot surface	6 (5.66)	1 (1.43)	2 (2.33)	7 (4.9)	2 (1.68)	9 (3.44)
Close to hot machinery	2 (1.89)	0 (0.00)	0 (0.00)	2 (1.4)	0 (0.0)	2 (0.76)
Working in direct sunlight	98 (92.45)	69 (98.97)	83 (96.51)	134 (93.71)	116 (97.48)	250 (95.42)
Type of work (n=319)	p=0.037					
Makes you hotter	109 (93.97)	88 (91.67)	89 (83.96)	165 (90.16)	121 (89.94)	286 (89.94)
Does not make you hotter	7 (6.03)	8 (8.33)	17 (16.04)	18 (9.84)	14 (10.37)	32 (10.06)
Reason of feeling hot (n=319)						
Carrying heavy loads	41 (37.61)	7 (7.87)	5 (5.62)***	43 (25.90)	10 (8.26)	53 (18.47)
Fast-paced work	10 (9.17)	9 (10.11)	6 (6.74)	14 (8.43)	11 (9.09)	25 (8.71)
Clothing	53 (45.69)	44 (45.36)	25 (23.58)***	76 (41.30)	46 (34.07)	122 (32.24)
Other: impact of sunlight	60 (55.05)	73 (82.02)	77 (86.02)***	111 (66.87)	100 (81.22)	210 (73.30)
Working hours per day (n=319)	p=0.000		p=0.000			
3 to 5 hours	3 (1.63)	3 (2.22)	2 (1.89)	3 (1.63)	3 (2.22)	6 (1.88)
5 to 8 hours	131 (71.30)	43 (31.85)	13 (12.36)	131 (71.20)	43 (31.85)	174 (54.55)
More than 8 hours	50 (27.17)	89 (65.93)	91 (85.85)	50 (27.17)	89 (65.93)	139 (43.57)
Provided with heat protective measures by employer (n=156)	p=0.058		p=0.07			
Yes	37 (61.67)	62 (66.67)	0 (0.00)	86 (66.67)	13 (48.15)	99 (63.46)
No	23 (38.33)	31 (33.33)	0 (0.00)	43 (33.33)	14 (51.85)	57 (36.54)

Chisquare/Fisher exact test; *: $p<0.05$; **: $p<0.01$; ***: $p<0.001$

Annex 8. Risk of heat stress at home

Variable	Gender n (%)		Occupation groups n (%)			Total n (%)
	Male	Female	Other jobs	Construction	Service provider	
House	p=0.000*					
Private house	75 (65.22)	7 (7.22)	42 (39.62)	69 (37.50)	55 (41.04)	124 (38.99)
Rented house	30 (26.09)	70 (72.16)	60 (56.60)	90 (48.91)	70 (52.24)	160 (50.31)
Subsidised house	10 (8.70)	19 (19.59)	3 (2.83)	24 (13.04)	8 (5.97)	32 (10.06)
Others: living in the work place	0 (0.00)	1 (1.03)	1 (0.94)	1 (0.54)	1 (0.75)	2 (0.63)
Type of house (n=315)	p=0.000*					
Tiled-roof house	30 (26.32)	6 (6.19)	7 (6.73)	21 (11.48)	22 (16.67)	43 (13.65)
Corrugated iron-roof house	70 (61.40)	81 (83.51)	89 (85.58)	142 (77.60)	98 (74.24)	240 (76.19)
Flat-roof house	12 (10.53)	6 (6.19)	8 (7.69)	14 (7.65)	12 (9.09)	26 (8.25)
Tenement house	2 (1.75)	1 (1.03)	0 (0.00)	3 (1.64)	0 (0.0)	3 (0.95)
Other	0 (0.00)	3 (3.09)	0	3 (1.64)	0 (0.0)	3 (0.95)
Assessment of heat conditions at home (n=319)	p=0.000*		p=0.07*			
Very hot	18 (15.52)	12 (12.37)	32 (30.19)	25 (13.59)	37 (27.41)	62 (19.44)
Hot	48 (41.38)	57 (58.76)	38 (35.85)	87 (47.28)	56 (41.48)	143 (44.83)
Normal	44 (37.93)	24 (24.74)	25 (23.58)	62 (33.70)	31 (22.96)	93 (29.15)
Cool	6 (5.17)	4 (4.12)	11 (10.38)	10 (5.43)	11 (8.15)	21 (6.58)

*Chi-square/Fisher exact test

Annex 9. Adaptive behaviours to heat waves in the workplace

	Crude OR (95% CI)	Adjusted OR (95%CI)
Female versus male	1.2 (0.7-2.3)	0.8 (0.4-1.9)
Aged over 50 versus below 50	1.1 (0.5-2.1)	1.3 (0.6-3.0)
Income less than US$100 versus over US$100	1.3 (0.7-2.5)	1.04 (0.4-2.6)
Migrant versus local resident	1.0 (0.5-1.9)	1.4 (0.7-3.1)
Self-employed versus hired employee	2.2 (1.1-4.3)*	2.5 (0.96-6.4)*a
Good health versus poor health	1.6 (0.7-3.3)	1.0 (0.4-2.5)
Hot workplace versus normal workplace	3.0 (0.7-13.1)	2.05 (0.4-9.5)
Hot home versus normal home	0.9 (0.5-1.7)	0.9 (0.4-1.8)
Have heard of heat stroke versus have not heard	09 (0.5-1.9)	0.7 (0.3-1.5)
Have heard of heat exhaustion versus have not heard	3.1 (1.6-6.0)***	3.3 (1.7-6.95)**
Secondary school education and lower versus high school education and higher	0.7 (0.3-1.3)	0.5 (0.2-1.1)

*: $p<0.05$; **: $p<0.01$

A: marginal significant at $p=0.069$

Annex 10. Perceptions and knowledge of heat stress

Variable	Occupation group n (%)			Gender n (%)		Total n (%)
	Other jobs	Construction	Service provider	Male	Female	
Normal temperature in area has increased in the last five years	p=0.004*					
Yes	85 (73.28)	54 (55.67)	65 (61.32)	118 (64.13)	86 (63.70)	204 (63.95)
No	16 (13.79)	29 (29.90)	16 (15.09)	38 (20.65)	23 (17.04)	61 (19.12)
Don't know	15 (12.93)	14 (14.43)	25 (23.58)	28 (15.22)	26 (19.26)	54 (16.93)
Heat events in area are:	**p=0.057***					
More common	58 (50.00)	29 (29.90)	51 (48.11)	79 (42.93)	59 (43.70)	138 (43.3)
Less common	14 (12.07)	15 (15.46)	9 (8.49)	26 (14.13)	12 (8.89)	38 (11.9)
No change	18 (15.52)	22 (22.68)	15 (14.15)	34 (18.48)	21 (15.56)	55 (17.2)
Don't know	26 (22.41)	31 (31.96)	31 (29.25)	45 (24.46)	43 (31.85)	88 (27.6)

*: Chi-square test

Annex 11. Awareness of the impact of extreme heat on health

Variable	Gender n (%)		Occupation groups n (%)			Total n (%)
	Male	Female	Other jobs	Construction	Service provider	
Heat waves cause serious health problem	p=0.009*		p=0.000*			
Yes	88 (75.86)	71 (73.20)	89 (83.96)	130 (70.65)	118 (87.41)	248 (77.74)
No	22 (18.97)	26 (26.80)	11 (10.38)	49 (26.63)	10 (7.41)	59 (18.5)
Don't know	6 (5.17)	0 (0.00)	6 (5.66)	5 (2.72)	7 (5.19)	12 (3.76)
Extreme heat waves can contribute to high mortality rates						
Yes	50 (43.10)	40 (41.20)	44 (41.51)	83 (45.11)	51 (37.78)	134 (42.00)
No	22 (18.97)	29 (29.90)	25 (23.58)	45 (24.46)	31 (22.96)	76 (23.80)
Don't know	44 (37.93)	28 (28.87)	37 (34.91)	56 (30.43)	53 (39.26)	109 (34.20)

*: Chi-square/Fisher exact test

Annex 12. Knowledge of heat stress

	Gender n (%)		Occupation groups n (%)			
Variable	**Male**	**Female**	**Other jobs**	**Construction**	**Service provider**	**Total n (%)**
Have heard about heat strokes (n=319)						
Yes	53 (28.96)	45 (33.58)	37 (32.17)	25 (25.77)	36 (34.29)	98 (30.91)
No	130 (71.04)	89 (66.42)	78 (67.83)	72 (74.23)	69 (65.71)	219 (69.09)
Knowledge about symptoms of heat strokes (n=98)						
Good and very good	42 (79.25)	37 (82.22)	29 (78.38)	21 (84.00)	29 (80.56)	79 (80.61)
Moderate	11 (20.75)	8 (17.78)	8 (21.62)	4 (16.00)	7 (19.44)	19 (19.39)
Poor to very poor	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
Knowledge about first aid for heat strokes (n=98)						
Good to very good	14 (26.42)	6 (13.33)	9 (24.32)	6 (24.00)	5 (13.89)	23 (23.47)
Moderate	28 (52.83)	27 (60.00)	19 (51.35)	16 (64.00)	20 (55.56)	55 (56.12)
Poor to very poor	11 (20.75)	12 (26.67)	9 (24.32)	3 (12.00)	11 (30.56)	20 (20.41)
Have heard about heat exhaustion (n=319)						
Yes	80 (43.48)	58 (42.96)	50 (43.10)	41 (42.27)	47 (44.34)	138 (43.26)
No	104 (56.52)	77 (57.04)	66 (56.90)	56 (57.73)	59 (55.66)	181 (56.74)

	Gender n (%)		Occupation groups n (%)			
Variable	**Male**	**Female**	**Other jobs**	**Construction**	**Service provider**	**Total n (%)**
Knowledge about symptoms of heat exhaustion (n=138)						
Sufficient	55 (68.75)	41 (69.49)	35 (70.0)	24 (58.54)	37 (77.08)	96 (69.06)
Insufficient	14 (17.50)	10 (16.95)	7 (14.0)	11 (26.83)	6 (12.50)	24 (17.27)
Poor to very poor	11 (13.75)	8 (13.56)	8 (16.0)	6 (14.63)	5 (10.42)	19 (13.67)
Knowledge about adaptive measures for hot conditions (n=319)						
Good to very good	1 (1.63)	0 (0.00)	1 (0.86)	1 (1.03)	1 (0.94)	3 (0.94)
Moderate	22 (11.96)	20 (14.81)	15 (12.93)	9 (9.28)	18 (16.98)	42 (13.17)
Poor to very poor	159 (86.41)	115 (85.19)	100 (86.21)	87 (89.69)	87 (82.08)	274 (85.89)

Annex 13. Associated factors related to knowledge of heat strokes

	Crude OR (95% CI)	Adjusted OR (95%CI)
Female versus male	1.2 (0.8-2.0)	1.8 (0.95-3.4)
Aged over 50 versus below 50	0.7 (0.4-1.2)	0.7 (0.4-1.3)
Income less than US$100 versus over US$100	1.03 (0.6-1.7)	0.96 (0.5-1.9)
Migrant versus local resident	0.5 (0.3-0.8)**	0.5 (0.3-0.8)**
Self-employed versus hired employee	0.9 (0.6-1.5)	0.9 (0.5-1.9)
Good health versus poor health	0.8 (0.4-1.5)	0.7 (0.3-1.4)
Hot workplace versus normal workplace	1.6 (0.7-3.8)	1.3 (0.6-3.2)
Hot home versus normal home	1.1 (0.7-1.8)	1.3 (0.8-2.3)
Secondary school education and lower versus high school education and higher	0.5 (0.3-0.8)**	0.5 (0.3-0.8)*

*: $p<0.05$; **: $p<0.01$

Annex 14. Associated factors related to knowledge of heat exhaustion

	Crude OR (95% CI)	Adjusted OR (95%CI)
Female versus male	0.97 (0.6-1.5)	1.6 (0.9-2.9)5
Aged over 50 versus below 50	0.4 (0.2-0.7)**	0.4 (0.2-0.7)**
Income less than US$100 versus over US$100	0.5 (0.3-0.8)**	0.3 (0.1-0.6)***
Migrant versus local resident	0.5 (0.3-0.9)*	0.5 (0.3-0.9)*
Self-employed versus hired employed	1.1 (0.7-1.7)	2.3 (1.2-4.7)*
Good health versus poor health	0.9 (0.5-1.6)	0.9 (0.4-1.8)
Hot workplace versus normal workplace	2.1 (0.99-1.6)	1.8 (0.8-4.1)
Hot home versus normal home	0.9 (0.5-1.4)	0.99 (0.6-1.7)
Secondary school education and lower versus high school education and higher	0.5 (0.3-0.9)*	0.6 (0.3-1.05)

*: $p<0.05$; **: $p<0.01$; ***: $p<0.001$

Heat stress and adaptive capacity of low-income outdoor workers and their families in the city of Da Nang, Vietnam

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