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**Experiencing and Adapting to Heatwaves: A Study of Bangladesh-Born
Migrants in Victoria**

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Abstract

Climate change is a critical concern in Australia and globally. Anthropogenic climate change will contribute to increasing intensity and frequency of heatwaves. People view and respond to heatwaves in many ways, depending on their awareness, expertise, access to resources and geographic location. Previous experience of climate extremes is a critical factor in shaping how people perceive risks and adapt to reduce the impacts on their lives and livelihoods. In the past decades, many studies have focused on heatwaves, heat-health impacts including mortality and morbidity, and heatwave adaptation and mitigation. However, limited research reflects on culturally and linguistically diverse (CALD) populations and migrants in relation to heatwave experiences and adaptation. Advancing understanding of the impacts of heatwaves on migrants' lives, and the significance of their cultural beliefs and past experience of heatwaves, can provide insight into heatwave adaptation. In particular, migrant communities with heatwave experience may have potential to respond effectively to heatwave events at the resettlement site.

This study aims to understand the experience of heatwaves among members of a migrant community in a site of settlement, namely Bangladesh-born migrants in Victoria. It investigates risk perception around heatwaves, the impact of heatwaves on daily lives, and coping techniques used by this cultural community. Considering the diverse cultural background and experiences of the participants, this study also examines whether and how their environmental knowledge, cultural beliefs and previous adaptation experience influence their ability to adapt to heatwaves in Victoria. In addition, this study discusses some of the major challenges confronting this population in applying heatwave adaptation strategies.

A mixed-methods approach comprising both qualitative and quantitative research was used to conduct this study. The data collection instruments consisted of a semi-structured

interview protocol and a survey questionnaire. One-on-one, semi-structured interviews were conducted with 20 participants, who were purposively chosen from five Local Government Areas (LGAs). The survey data (n=393) were collected from five LGAs in Victoria using a three-stage cluster sampling technique.

A four-part survey questionnaire involving *Heatwave Risk Perception*, *Heatwave Adaptation Strategies*, *Cultural Beliefs towards Heatwave Adaptation* and *Barriers towards Heatwave Adaptation* was developed to assess the experience of participants. The 33 item *Heatwave Adaptation Strategies* measure was used to identify heatwave adaptation techniques used by participants; participants were asked to respond to these 33 items both in relation to adaptation measures used previously in Bangladesh, and currently in Victoria. The questionnaire used a six-point Likert type scale for recording participants' self-reported responses. Quantitative data were processed and analyzed using Statistical Package for Social Science (SPSS) version 26. A descriptive analysis (mean and standard deviation) was undertaken to report the overall results, while advanced inferential statistics (i.e. t-tests & multiple regressions) was used to identify several predictor variables and their association with each other.

The findings of the study are presented in chapters four and five. In chapter four, the analysis of the interviews yields the Bangladesh-born Victorian migrants' own explanation on their understanding of heatwaves, their risks to everyday life, and a range of challenges and adaptation measures to cope with this climate extreme based on their current and previous heatwave experience. The semi-structured interview protocol was developed to gain an in-depth understanding of participants' pre- and post-migration heatwave experiences and challenges. A hybrid method of thematic analysis, comprising both inductive and deductive approaches, was used to analyse interview data.

The quantitative results are presented in chapter five. The results show the extent to which the participants perceived heatwave risks, their use of adaptation strategies, cultural beliefs, and barriers towards heatwave adaptation. For instance, this migrant community perceived a high frequency of heatwave risk ($M=4.60$, $SD=1.22$). The stepwise multiple linear regression results also demonstrate the significant predictors of heatwave adaptation strategies (HAS) in Victoria.

Both qualitative and quantitative findings suggest that lack of access to information about heatwaves and their consequences is one of the major challenges for participants in adapting to heatwaves in Victoria. In addition, both qualitative and quantitative findings add nuance to understanding migrants and their adaptive capacities in coping with climate extremes in the host country. The study may provide useful insights for relevant planning organisations and government officials engaging in climate change adaptation planning and striving to reduce the negative impacts of heatwaves across all members of the community.

Declaration

This is to certify that

- i) The thesis comprises only my original work towards the degree of MPhil.
- ii) Due acknowledgement has been made in the text to all other material used.
- iii) The thesis is less than 50,000 words in length, exclusive of tables, maps, bibliographies, and appendices.

Signed _____



Dilruba Khanam

Acknowledgements of Country

I acknowledge the Traditional Owners of the land on which I live and work, and pay my respects to their Elders past, present and future.

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Firstly, I would like to show my heartfelt gratitude to my principal supervisor Prof. Lesley Head, for her immense emotional, academic, and professional support throughout my MPhil research journey. The opportunity to work with her has broadened my research knowledge, indeed. Her encouragement, guidance and continuous feedback helped me enrich the quality of this piece of work. Without her support, it would not have been possible to complete the study. It has been a great honour to work under her supervision.

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Next, my sincere thanks go to all the Bangladesh-born Victorian community representatives (CRs) across metropolitan Melbourne for helping me during my fieldwork. Without their support and guidance, it would not have been possible to get this research done. I am also grateful to the people who supported me for organizing the field visit to collect data. I would like to express my sincere appreciation to the individuals who participated in FGDs (Focus Group Discussions), interviews and surveys for their contribution in this study.

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Chapter 1

Introduction

Scientists report that anthropogenic climate change will contribute to increasing intensity and frequency of heatwaves (Herold et al., 2018; Loughran et al., 2017; Nairn & Fawcett, 2014; Perkins et al., 2012; Purich et al., 2014). Australia has experienced many climatic extremes recently, some with detectable anthropogenic influences, including extreme heatwaves (in 2009, 2012, 2013, 2014, 2019 & 2020), marine heatwaves (in 2011 & 2016), severe droughts (in 2005, 2006, 2008 & 2018), and catastrophic bushfires in 2003, 2009, 2013, 2019 and 2020 (Bureau of Meteorology [BOM], 2020; Clarke et al., 2019; King et al., 2017).

Heatwaves are projected to increase in intensity, frequency, and duration throughout the 21st century across Australia (BOM, 2018; Cowan et al., 2014; Loughran et al., 2017; Perkins et al., 2012; Purich et al., 2014). Heatwaves have been directly responsible for more than 4555 fatalities caused by Australian natural hazards during 1900 to 2010 (Coates et al., 2014; p. 33). The reduction of Australian labour productivity caused by extended periods of hot weather has also resulted in an annual economic loss of around AUD\$9 billion in 2014 (Zander et al., 2015).

In Australia, strategies for reducing heat-related morbidity and mortality and other impacts on people's lives and livelihoods include heatwave prediction and warning, heat-health alerts via the Department of Health, community awareness programs through GP clinics and community centres, and practising various adaptation techniques at household and individual levels. The impacts of extreme heat are also influenced by individuals' acclimatisation process (de Dear & Brager, 1998; Tong et al., 2010). Thus, many socio-cultural factors, individual experience, adaptive attitudes, and access to information influence perceived risks of climate

hazards and adaptation strategies in everyday life (Anderson & Bell, 2009; Kjellstrom et al., 2020; Rahman & Zafarullah, 2020; Valois et al., 2020; Zografos et al., 2016).

Migrants coming from different regions of the world may have diverse experience in adapting to extreme climates, including migrants who come from countries vulnerable to climate change with low socio-economic conditions. International migrants have often been framed by policy-makers, media and wider community members as a 'burden' for receiving countries (International Organization for Migration [IOM], 2020; Organisation for Economic Co-operation and Development [OECD], 2017; Tacoli, 2009; United Nations General Assembly [UNGA], 2016). Yet it is necessary also to recognise migrants' capacities, including their capacities for climate change adaptation.

There is limited understanding of migrants' adaptive responses and experiences to heatwaves in sites of resettlement. And yet some cultural and social geographers have suggested that migrants might have capacities and resources that strengthen their adaptive options (Head et al., 2018; Klocker et al., 2018; Strengers & Maller, 2017). According to Hansen et al. (2013), it is essential that policymakers are aware of the disparities in the adaptive capacity of migrants due to socio-cultural and language obstacles while they are formulating and disseminating heat-health strategies. However, little attention has been paid globally to understanding the impacts of climate change on migrants in terms of their life, housing, socioeconomic status, and everyday activities in the host country (Hansen et al., 2013; Lundgren-Kownacki et al., 2018). This study aims to explore Bangladeshi-born migrants' experience, adaptation techniques, enablers, and barriers towards heatwave adaptation in Victoria, their site of relocation.

1.1 Background and rationale of the Study

As a multicultural country, Australia has a remarkable and largely successful history of migration due to the wide range of state-specific and regional migration programs by the Australian Government (Massey & Parr, 2012). It is reported by the Australian Bureau of Statistics (ABS) (2016) that 49 per cent of the Australian population is either a first- or second-generation migrant. The Department of Immigration and Border Protection (DIBP) (2017) stated that 30 per cent of the total migrant population in the period 2016-2017 in Australia are from Southern Asia including India, Sri Lanka, Pakistan, Bangladesh, Nepal, Bhutan, and the Maldives. The people of Bangladesh started their migration journey to Australia in 1940. Until 1971 they were known as East Bengali and/or East Pakistani. After independence in 1971, the Bangladeshi nationals started their migration journey as "Bangladeshi" (Department of Premier and Cabinet [DPC], 2018). The 2001 Australian Census recorded 9,050 Bangladesh-born people living in Australia (Department of Home Affairs [DHA], 2006ⁱ). After 2001, there was a dramatic change in the migration flow of Bangladesh-born people in Australia with an increase to 41,237 persons in 2016 from 27,809 persons in 2011 (ABS, 2016; DHA, 2014ⁱⁱ & 2018). The largest number of Bangladesh-born migrants live in New South Wales (58.7%; 24217) followed by Victoria (19%; 7829), Queensland (6.7%; 2763), Western Australia (6.3%; 2578), South Australia (4.8%; 1969), Northern Territory (1%; 402), ACT (3.3%; 1368) and Tasmania (0.3%; 109) (DHA, 2018).

In Victoria, the total number of Bangladeshi immigrants increased from 1251 residents (1971-2000) to 7829 persons during 2000-2016 (DPC, 2018). The majority (73% or 5672

ⁱ DHA was known as Department of Immigration and Multicultural Affairs until January 2007.

ⁱⁱ DHA was also known as Department of Immigration and Border Protection (DIBP) until December 2017

persons) of Bangladesh-born Victorian migrants live in Wyndham, Monash, Maribyrnong, Greater Dandenong, Moreland, Brimbank, Casey and Darebin (ABS, 2016). The majority of Bangladeshi migrants arrive as skilled migrants, while others come for higher education purposes.

The Bangladeshi migrants have a long history of dealing with climate extremes, and Bangladesh is considered 'a country of exceptional vulnerability to natural hazards' (United Nations Development Programme [UNDP], 2011, p.54). In Bangladesh, even though there are some strategic disaster management plans by the Ministry of Disaster Management and Relief (MoDMR) in response to the flood, cyclones, earthquakes, landslides and lightning, there is no such strategy for heatwave adaptationⁱⁱⁱ. However, heatwaves are one of the major extreme climate events in Bangladesh (Burkart et al., 2013; Lubna et al., 2020; Nissan et al., 2017). For instance, during April-June of each year, the temperature increases to 41°C in many parts of Bangladesh, and heatwaves last for up to 30 days, depending on wind circulation, soil-moisture and precipitation (Rahman et al., 2015; Nissan et al., 2017). People from different parts of Bangladesh report using their traditional knowledge and community practices to reduce the impacts of heatwaves and climate changes in their lives and livelihoods (Alam & Miller, 2019; Ashraf & Faruk, 2018; Khanam & Azad, 2014). It is important to recognise culturally and linguistically diverse (CALD) populations and address them in climate change discussions and policy planning programs for climate change adaptation. According to Gissing and Coates (2018), in Australia, many vulnerable people do not have plans to cope with heatwaves as 40 per cent of those at risk in heatwaves did not think it is necessary to have a plan or did not know

ⁱⁱⁱ *Disaster Management Plans and Strategies in Bangladesh* <https://modmr.gov.bd/site/page/30addfaf-20f9-4865-93dc-1eea08b9790e/Disaster-Management-Policies-and-Strategies>

what to do. However, research also suggest that individuals' experience of weather-related hazards, and engagement in the adaptation and mitigation process, help them adapt successfully with a changing environment (Adger, 2016; Lee et al., 2015; Moser & Boykoff, 2013; O'Neil & Graham, 2016; Sherson & Alam, 2020). Exposure to heatwaves has a detrimental impact on human health (Campbell et al., 2018; Smith et al., 2016; Sun et al., 2014) including increased mortality (death) and morbidity (illness) (Anderson & Bell, 2011; Bi et al., 2011; Campbell et al., 2018; Green et al. 2019; Haines et al., 2006; Martiello & Giacchi, 2010; Urban et al., 2017; Watts et al., 2015). However, very few studies focus on culturally and linguistically diverse communities' and/or migrants' adaptation strategies, barriers to adaptation and their experiences of heatwaves (Hansen et al., 2013; Lundgren-Kownacki et al., 2018).

This study focuses on Bangladesh-born migrants living in Victoria, Australia, and their experience and perception of heatwave risks, processes of adaptation to extreme heat, and barriers and opportunities to heatwave adaptation. Members of this community have a history of coping with environmental hazards in their country of origin, including extreme heat, however, it is likely that heatwaves in Victoria differ (e.g. less humidity, less precipitation, different socio-cultural context). Considering the diverse cultural background and experiences of the participants, this study investigates whether and how their environmental values, knowledge and behaviour (EVKB) (Head et al., 2018) affect their capacity to adapt to heatwaves, including by identifying their previous experiences, cultural beliefs and adaptation strategies to heatwaves in Bangladesh.

1.2 Research questions

With reference to the Bangladesh-born migrant community in Victoria, the key research questions are:

1. What are the everyday experiences of the Bangladesh-born community of heatwaves in Victoria?
2. What strategies do they apply to cope with heatwaves in Victoria?
3. What challenges do they experience in implementing adaptation strategies to cope with heatwaves in Victoria?
4. How did they manage heatwaves in Bangladesh?
5. What factors predict participants' heatwave adaptation practices in Victoria?

This thesis comprises six individual chapters before reference lists and appendices. While chapter 1 provides the significance of the study, the background of the research, rationale of the study and research questions; chapter 2 deals with the analysis of the contemporary, relevant literature through determining the research gap and framing the conceptual framework for the study. The methodology chapter (chapter 3) depicts the steps in details for conducting this study using a mixed-method research approach. Chapter four and five describe the results and analysis of both the quantitative and qualitative data, respectively. Furthermore, chapter six discusses the findings considering the relevant literature. This chapter also concludes with research limitations, implications and future research suggestions.

Chapter 2

Literature review

Understanding people's perceptions of climatic risks to health, life and livelihoods is important; these perceptions affect adaptive behaviours (Akompad et al., 2013). This chapter starts with a brief definition of the term 'heatwave' in the context of Australia. Next, it reviews scientific literature that focuses on the impacts of heatwaves, heatwave risk perception, opportunities and barriers to adaptation, and the importance of considering cultural diversity in relation to heatwave adaptation. It also presents the conceptual framework of this study which is based on the 'Human Thermal Adaptation' framework (de Dear & Brager, 1998) and further informed by relevant research on heatwaves, cultural diversity and heatwave adaptation (e.g. Hansen et al., 2013; Humphreys & Nicol, 1998; Hanson-Easey et al., 2013; Saman et al., 2013).

2.1 Understanding Heatwaves

A heatwave is typically defined as three or more consecutive days when both daytime and night-time temperatures are excessively high (Bureau of Meteorology [BOM], 2018). The definition of heatwaves provided by BOM (2018, p. 1) is "heatwaves are defined as an extended period of hot weather at or above 35°C for three or more consecutive days". However, the definition of heatwaves varies (Table 1) in accordance with the climatology of different locations (Zuo et al., 2015, BOM, 2018).

Table 1 Definitions of heatwaves in Australia

Locations	Definitions of Heatwave
South Australia (Adelaide)	Five consecutive days with a maximum air temperature over 35°C or three consecutive days over 40°C
Western Australia (Perth)	Three days in a row over 35°C
Queensland (Brisbane)	36°C for two days or more
Victoria (Melbourne)	Three or more consecutive days over 35°C

Source: Zuo et al., 2015, BOM, 2018

Although there are thresholds for heatwaves, researchers define the word "heatwave" in different ways based on the context of their study (Kuchcik, 2006). For example, in a study evaluating the impact of Brisbane heatwaves on human health, Tong et al. (2010) used ten definitions of heatwaves, seven of which were developed for that particular study based on heatwave intensity and duration. For calculating heatwave intensity, Nairn and Fawcett (2013) developed a formula^{iv} termed "Excess Heat Factor [EHF]"^v. 'Excess Heat Factor' calculates the intensity of heatwaves through factoring in their numbers, duration and spatial distribution. In general, heatwave intensity or EHF is a combination of long-term temperature (Excess Heat^{vi}) and short-term temperature anomaly (Heat Stress^{vii}) indices (Nairn & Fawcett, 2013). Heatwave conditions exist when the EHF is positive. In general, using EHF is beneficial to quantify the impact of heatwaves, especially on the economy (Natural Capital Economics, 2018). Based on the intensity, heatwaves are classified into three categories by the BOM (2018) to determine the

^{iv} **EHF** = Excess Heat × (1, Heat Stress)

^v **Heatwave Intensity (Excess Heat Factor):** The combined effect of Excess Heat and Heat Stress calculated as an index provides a comparative measure of intensity, load (accumulated excess heat), duration and spatial distribution of a heatwave event. Heatwave conditions exist when the EHF is positive.

^{vi} **Excess Heat:** This is unusually high heat arising from a high daytime temperature that is not sufficiently discharged overnight due to unusually high overnight temperature. Maximum and subsequent minimum temperatures averaged over a three-day period are compared against a climate reference value to characterize this unusually high heat in an excess heat index. This is expressed as a long-term (climate-scale) temperature anomaly.

^{vii} **Heat Stress:** This arises from a period where temperature is warmer, on average, than the recent past. Maximum and subsequent minimum temperatures averaged over a three-day period and the previous 30 days are compared to characterize this heat stress in a second index. This is expressed as a short-term (acclimatisation) temperature anomaly. Nairn and Fawcett (2013), p: 10-13.

magnitude of temperature change, strategies for adaptation and to identify the possible challenges for people and infrastructure:

1. **Low-intensity heatwaves** are the most common, and most people can cope with this level of heat. During low intensity heatwaves maximum temperatures reach above the threshold for 3 or more consecutive days with a tendency to ease down to a low degree overnight.
2. **Severe heatwaves** are less frequent and are challenging for vulnerable people such as the elderly, particularly those with pre-existing medical conditions. It is an event where EHF values exceed a threshold for severity that is specific to the climatology of each location.
3. **Extreme heatwaves** are the rarest kind. They affect the reliability of infrastructure, like power and transport, and are dangerous for anyone who does not take precautions to keep cool—even those who are healthy. People who work or exercise outdoors are particularly at risk. An event where EHF values are well in excess of the severity threshold result in widespread adverse outcomes.

BOM (2018)

Even though there is no specific temperature threshold recommended for each category by BOM, the Department of Health (DoH) (2011) states that the highest and lowest thresholds are 34°C and 30°C respectively for different areas of Victoria in terms of heatwave intensity calculation. DoH refers to the temperature threshold of heatwaves as 'heat health temperature threshold'. The primary purpose of determining the temperature threshold is to issue heat health alerts. It is also noteworthy that while severe and low-intense heatwaves are experienced by people in spring and early autumn in Victoria, extreme heatwaves typically occur during mid-summer. This study used BOM's definition (mentioned above) to conceptualise heatwaves.

2.2 Heatwaves and their impacts

2.2.1 Heatwaves in Australia

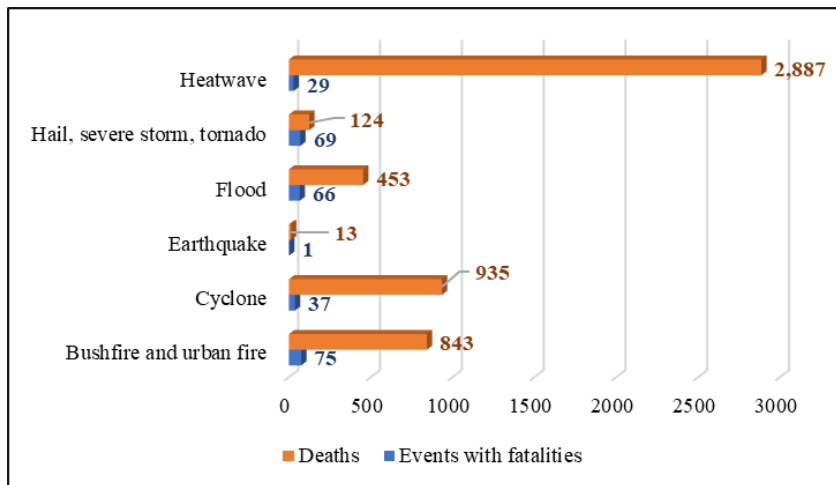
Extremes including summer heatwaves and winter dry spells have a significant effect on Australia's atmosphere, with several areas seeing elevated severity and length of such

phenomena during the mid-twentieth century (Cowan et al., 2014; Perkins-Kirkpatrick et al., 2016). Since 1910, Australia's mean temperature has risen by over 1°C, leading to increased frequency of extreme heat events (Bettio et al., 2019; BOM & CSIRO, 2018). As climate change is changing the ambient mean temperature, communities across Australia will experience hotter, longer and more frequent extreme heatwave events (Steffen et al. 2014). As with the rest of Australia, potential climate predictions for Victoria under plausible greenhouse gas emission scenarios are consistent with a temperature increase of 0.5-1.3 ° C between the 1990s to 2030s (Clarke et al., 2019). Further, Wang and McAllister (2011) projected that by 2070 the residents of Melbourne, Sydney and Adelaide are expected to experience at least twice as many very hot days in a year. Thus, the residents of Victoria, businesses, government and the environment have been impacted by climate change in many ways, with heatwaves a key threat.

2.2.2 Impacts of Heatwaves

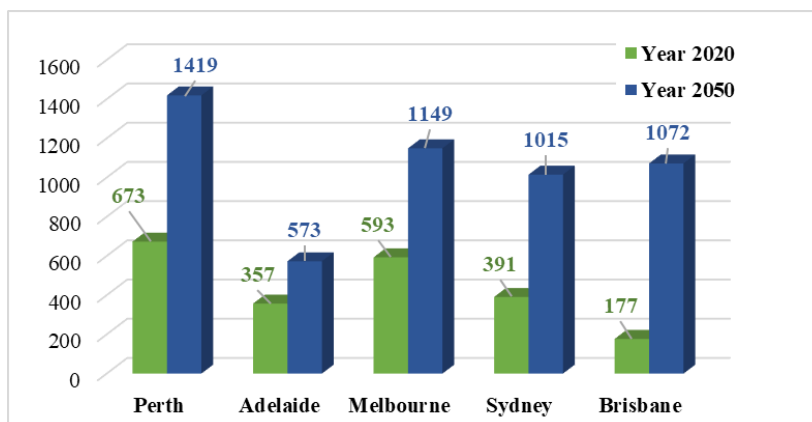
Heatwaves have a considerable impact not only on community health but also on the economy. A number of studies have reported that major heatwaves have caused more deaths in Australia (Figure 1) than any other natural disasters (Department of Infrastructure and Transport Major Cities Unit [DITMCU], 2013; Coleman, 2016; Zhang et al., 2018a). Elderly people are reported to be the group most vulnerable to the consequences of heatwaves. For example, due to extreme heatwaves 1100 people aged over 65 died in Australia and New Zealand during 1997 to 1999 (McMichael et al., 2003, p.3).

Figure 1 Estimated numbers of deaths from natural disasters in Australia, 1890–2013^{viii}



In 2009, heatwaves (which contributed to the "Black Saturday" fires) led to the death of at least 432 people across Australia, and of those 374 deaths were counted in Victoria by the Victorian Coroner's Office (Department of Human Services [DHS], 2009; Alexander & Tebaldi, 2012). Based on the current trends of heat-related death, Coleman (2016) predicts that by 2050 Melbourne will be the second most heat-affected city while Perth will be the most heat-affected city in Australia (Figure 2).

Figure 2 Predicted number of heat-related deaths across cities^{ix}



^{viii}Source: DITMCU (Australian Government Department of Infrastructure and Transport Major Cities Unit) (2013). *State of Australian cities 2013*, DITMCU, Canberra.

https://www.infrastructure.gov.au/infrastructure/pab/soac/files/2013_00_INFRA1782_MCU_SOAC_FULL_WEB_FA.pdf

^{ix} Source: Coleman S (2016). *Built environment: Increased extreme weather events*. In: *Australia state of the environment 2016*, Australian Government Department of the Environment and Energy, Canberra. <https://soe.environment.gov.au/theme/built-environment/topic/2016/increased-extreme-weather-events#table-BLT6>

In addition to increased heat-related deaths, disruption of people's day-to-day activities has become a regular phenomenon for communities across Australia. For instance, in January 2009, residents of Melbourne experienced failure of train and tram networks due to outage of power (Reeves et al., 2010), and in January 2014 again people suffered from disrupted public transport services in Melbourne as a result of heatwaves (Steffen et al., 2014). It is also reported that extreme heat affects people's mental health. For example, Beggs et al. (2018) reported in 'the Conversation' that:

Extreme heat affects the mental health of Australians to the same degree as unemployment, yet Australia's policy action on climate change lags behind other high-income countries such as Germany and the United Kingdom (29 November).

Economic loss is considered one of the major consequences of heatwaves in high-income countries. For instance, heatwave events cost Victoria 0.025 percent of gross state product each year totalling \$87 million (Department of Environment, Land, Water and Planning [DELWP], 2019, p.1). It was predicted that by 2030 heatwaves will impact on the Victorian economy, and that will worsen over time, with estimated costs approximately \$179 million per year if necessary actions are not taken (DELWP, 2019, p.1). However, a comprehensive and inclusive adaptation plan is required to respond to Australia's deadliest hazard.

Experience and adaptation to heatwaves vary according to people's knowledge and understanding of heatwaves and their possible impacts (Tong et al., 2014). Several studies have identified that populations from ethnic minority groups or CALD communities are at higher risk of extreme heat because of their vulnerable socioeconomic status, language barriers, living conditions and pre-existing health conditions (Hansen et al. 2013; O'Neill et al., 2003; Yardley et al., 2011). Thus, analysing and addressing people's perception of heatwaves risks at the individual and community level, are perhaps important for adaptation.

2.3 Heatwave risk perception (HRP)

At the outset, the concept of heatwave risk perception utilized in this study needs to be clarified. According to United Nations International Strategy for Disaster Reduction [UNISDR], (2009) the term ‘risk’ is referred to as ‘the combination of the probability of an event and its negative consequences’ (p.25). The notion of this definition and many others is to anticipate potential losses and future uncertain outcomes due to hazards and disasters (UNISDR, 2009; Joffe, 2003). Likewise, the perception of risk is considered as a psychological process concerning internal processes and the ways in which the processes are shaped by mental limitations (Kahneman et al., 1982). Heatwave risk perception is described by Hanson-Easey et al. (2019) as follows:

...risk perception is mediated by a fairly rational set of judgments that, based on previous experience, involve a consideration of what resources are presently available to reduce a known threat, and whether these adaptations will be sufficient in doing so. (p.31)

Grothmann and Patt (2005) also describe risk perception of climate extremes as the perceived probability of exposure to climate change impacts and the perceived severity of imminent and existing harmful impacts. This study conceptualizes heatwave risk perception as the individual’s perception of potential heatwave risks, considering their current and previous experience of heatwaves, ability to understand the potential impacts on their everyday life and livelihoods, information accessibility, knowledge and barriers towards adaptation.

Since vulnerability to heatwaves has been linked with diverse aspects of risk perception and perceived adaptive capacity (Adger, 2006; Eady et al., 2020; Parkins & MacKendrick, 2007), recognising the threats posed by heatwaves is important for taking appropriate adjustment measures to reduce the adverse impacts. For example, a mixed-method study in Waterloo Region

(Ontario, Canada) examined risk perceptions and coping practices among senior citizens (Eady et al., 2020). They found that vulnerability to heat is often associated with inaccurate perceptions of risk. According to Weberand and Stern (2011), understanding the difference between public perceptions of climate change risk and risk conceptualisation by scientists is important to minimise the negative impact on human beings and the environment. Wolf et al. (2010) further explained that:

In the context of heatwaves, it may well be the perceptions of those who are at risk from heat stress, and the perceptions of those who provide support and advice to those at risk, that play a key role in influencing response behaviour, and therefore affect public health outcomes (p.45)

Studies also suggest that risk perception varies across countries, individuals and communities considering the weather pattern, cultural background, previous experience, socio-economic factors, and degree of public communication (Ban et al., 2019; Botzen et al., 2016; Howe et al., 2019). Further, understanding of those factors that determine the level of risk perception and adaptive behaviour during heatwaves could help individuals reduce the severity of the impacts (Abrahamson et al. 2009; Akompab et al., 2013b; Eady et al., 2020, Esplin et al., 2019; Taylor et al., 2014; Qin et al., 2015).

2.3.1 Factors affecting individuals' perception of heatwave risk

A number of factors have been identified (Table 2) by previous researchers (e.g., Akompab et al., 2013a; Beckmann & Hiete, 2020; Eady et al., 2020) as having an influence on individuals' perception of heatwave risks. People understand heatwave risks and their personal vulnerability depending on a set of contextual and individual factors including age, income, family composition, health status, heat sensitivity, heat-health problems, level of community

engagement to heatwave-risk communication, heatwave experiences, the severity of heatwave impacts and knowledge about climate change and spatial contexts (Abrahamson et al. 2009; Akompab et al., 2013a; Beckmann & Hiete, 2020; Chowdhury et al., 2012; Hanson-Easey et al., 2019)

Conducting a cross-sectional survey (n=267) during summer 2012 among a sample of population aged between 30 to 69 years in Adelaide (Australia), Akompab et al. (2013a) found that age is a significant factor that shapes risk perception towards heatwaves (OR = 1.04; 95% CI, 1.00–1.07). Even though this result is similar to other studies (Lindell & Hwang, 2008; Stafoggia et al., 2008), slightly different interpretations were described by Abrahamson et al. (2008), and Beckmann and Hiete (2020). For example, using a semi-structured interview approach (n=73) among men and women aged between 72–94 years and living in their own homes (London & Norwich, UK), Abrahamson et al. (2009) found that a few senior citizens considered themselves either old or at risk from the effects of heat. However, the majority of those elderly participants reported that older people could perceive heatwave risks very well as they had taken appropriate steps to reduce the effects of heat. In addition, analysing the data from 468 online surveys among the urban citizens in Augsburg, Germany; Beckmann and Hiete (2020) concluded that people of Augsburg aged between 18–29 years, had a higher level of heat related health risk perception than the people aged between 65-74 years, followed by the participants older than 74 years. Collectively, these studies highlight the significance of age as a factor shaping heat-health heatwave risk perception.

This is further exemplified in work by Shepherd et al. (2012) in Australia that investigated the Australian public's risk perceptions of environmental hazards using a social survey method (n=1261); they found that even through aged people are highly vulnerable to

heatwaves, they had a high-risk perception ability. Unlike Shepherd et al., Kalkstein and Sheridan (2007) investigated social impacts of the heat-health warning system to measure risk perception among Hispanics (Phoenix, Arizona, USA), and revealed that younger people had the highest heat risk perception ability, which prompt them towards heatwave adaptation actions as well. Further, these studies (Abrahamson et al., 2009; Akompab et al., 2013a; Beckmann & Hiete, 2020; Eady et al., 2020) also confirm that underlying health problems, chronic illness, marital status, family composition, gross annual household income, and education were significant factors that influenced risk perception of heatwaves. Other studies focus on the role of social connectedness and peer-relationships. Eady et al. (2020) and Sampson et al. (2013) found that social, interpersonal, and intergenerational relationships are protective of perceiving heat-health risks and of facilitating adaptation behaviour (Table 2). Other cohorts of studies broadly reinforce these findings (e.g. Madrigano et al., 2018; Ricc et al., 2020; Wolf et al. 2010) and link peer relationships with heat-health risk perception. While most of these studies use a community survey or mixed-method approach to investigate people's perception of heatwaves, Sampson et al. (2013) used semi-structured in-depth interviews (n=173) to assess the perceptions of heat-related threats and vulnerability and the role of social support across communities, government and non-profit organizations. It has been suggested by Sampson et al. (2013) that peer-relationships and social support are important factors to enhance the ability of vulnerable populations to perceive heat-health risk and deliver health messages to their peers to protect from heat. It is also argued that social connectedness and peer-relationships, or in other words 'social capital', enable residents to coordinate and achieve community actions towards climate change adaptation (Agnitsch et al. 2006; Chavis & Wandersman, 2002; Ebi & Semenza, 2008; McNeill et al., 2006; Mngumi, 2020).

While much research has focused on identifying and evaluating heat-health risk perceptions of communities across the world, a few studies have compared heat-stress perception among the local and immigrant workers. It is exemplified by Messeri et al. (2019) that while native workers received information on heat-health issues through training courses, migrant workers were mainly informed through written or oral communications within their migrant peer groups (p.1). Further, Messeri et al. found that native workers were more informed about heatwave adaptation through safety courses (65% of natives) compared to migrant workers ($\chi^2 = 21.15; p = <0.001$). Others have also highlighted the significance of socio-cultural factors (e.g. language barriers, access to information, job risks and adaptation barriers) and heatwave and climate change risk perception (Frondel et al., 2017; Goldberg et al., 2020; Hansen et al., 2013; Wolf et al., 2010; Yardley et al., 2011). The studies presented thus far provide evidence that individuals' ability to perceive heatwave risks lies in their experiences in dealing with the impacts of heatwaves in various aspects of everyday life, especially impacts on their health, economy and family. Further, Wolf et al. (2010) stated that:

Heat risk is complex, dependent upon a multi-factorial combination of, among others, co-morbidity, medication, exposure, structural environment and appropriate responses, the latter being influenced heavily by perceptions of risk (p.49)

It is also argued that risk perception is specific to culture and place (Taylor et al., 2014; Weber & Hsee, 1999). According to Akompab et al. (2013a), the impact of heatwaves on people's health can be minimised if people know the risks and adopt healthy behaviours during a heatwave. Studies on climate psychology also point out that emotions, in addition to cognition, in public perceptions of risks have a significant association in adaptation decision making (Akompab et al., 2013a; Ban et al., 2019; Liu et al. 2013, Slovic et al., 2005; Wolf et al. 2010).

This distinction is further exemplified in a study in 50 US states of warm climates using a national survey dataset of 9,217 respondents (Howe et al., 2019). The study reported that:

...populations located in warmer climates have the highest risk perceptions...such populations do not necessarily experience the greatest health effects from extreme heat. In addition, while at the state and county level, risk perceptions are consistent with differences in average temperatures, at local (city and neighbourhood) scales, variation in risk perceptions is also strongly related to sociodemographic factors. Place-based social vulnerability factors are associated with heat-risk perceptions. Areas with high-minority and low-income populations, for example, perceive greater risks; likewise, white men tend to judge the risks of heat to be lower than do others, as with other risks (p.6746)

A number of studies on flood preparedness in Europe also suggest that there is a relationship between previous experience of a flood with flood awareness, perception of flood severity, flood preparedness and the likelihood of taking protective measures (e.g. Burningham et al., 2008; Bradford et al., 2012; Harries, 2012; Lamond et al., 2009; Soane et al., 2010). Conversely, Whitmarsh (2008) argued that perception of climate change risks and adaptation differ little from people who have direct experience of the hazard from that of non-victims. In a meta-analysis study based on 44 extensive literature reviews entitled 'Experience with natural hazards and adaptation,' van Valkengoed and Steg (2019) stated that experiencing a natural hazard is positively associated with adaptation.

Table 2 Predictors of heat-health risk perception

Source	Core concept	Method used	Data date	Country	Specific factor (s) to HRP
Akompab et al., 2013a	Predictors of heatwave risk perception (heat-health)	Cross-sectional survey (n=267)	Summer 2012	Australia	-Age, income & family composition
Beckmann & Hiete (2020)	Health-related heat risk perception	Online survey (n=468)	July 2019	Germany	-Age, sick people or people with a poor subjective health status, heat sensitivity
Eady et al. (2020)	Relationships between the risk perceptions and coping practices towards heatwave resilience	Interviews: n = 15 & survey: n = 244	Interviews (August 2014 -September 2015) and surveys (April 2016- September 2016)	Canada	-Social connection - Access to resources -Ability to perceive heatwave risks
Chowdhury, Haque & Driedger (2011)	Heatwave risk perception	Open-ended interviews (n=12) & Survey (n=114)	Not specified	Canada	-Level of public & expert engagement in heatwave risk communication & mitigation -Misconception about climate change & temperature rises -Lack of risk communication
Abrahamson et al. 2009	Perceptions of heatwave risks to health	Semi-structured interviews (n=73)	July & September 2007	United Kingdom (UK)	-Age -Dissemination of information - Chronic illness
Sampson et al. (2013)	Perceptions of heat-related threats and vulnerability & the role of social support	Semi-structured in-depth interviews (n=173)	during 2009–2010	USA	-Experience -Peer- relationships -inaccessibility to social resources/services
Messeri et al. (2019)	Heat-stress perception & management among native and immigrant workers (Construction & Agricultural Sectors)	Survey (n= 104)	Summer 2017	Italy	-Workplace arrangement - Socio-cultural factors (e.g. linguistic, job risks, adaptation barriers)
Frondel, Simora & Sommer, (2017)	Analysing the determinants of individual risk perception towards heat waves, storms & floods	Survey (n=6000)	2012 & 2014	Germany	-personal experience with adverse events and personal damage are strong drivers of individual risk perception towards heatwaves, storms & flood

2.3.2 Risk perception and adaptation behaviour to heatwaves

Table 3 presents some examples of literature where scholars demonstrate scientific evidence of the relationships between risk perception and heatwave adaptation behaviour using both modelling (analyzing survey data using a multilevel regression model) and narrative approaches (focus group discussions and interviews) among participants in various countries. The vast majority of those studies have found an association between people's heatwave risk perception, experience and willingness to engage in adaptation responses, while others showed risk perception as a partial mediator toward people's adaptation practices (Xie et al., 2019). There are numerous cross-sectional studies (e.g. Elrick-Barr et al. 2017, Xie et al., 2019) in Australia, which suggest that people's ability to perceive heatwaves or other climate hazard risks is associated with adaptive capacities. Therefore, knowledge about the hazard, risk communication, previous hazard experience and socio-cultural dimensions influence hazard perception and preparation. For example, a study by Elrick-Barr et al. (2017), using a survey (n=400) among two coastal communities in Western Australia and Queensland found that households with prior experience of environmental hazard in their current location rated existing knowledge ($\chi^2 = 10.16$, $p < 0.001$), policies informing household action ($\chi^2 = 5.517$, $p < 0.05$) and previous experience ($\chi^2 = 9.97$, $p < 0.01$) as significant predictors of risk perception and are more likely to respond to those risks than households without hazard experience ($p = 0.1145$). These findings are also consistent with other similar studies (Bickerstaff et al., 2008; Hanson-Easey et al. 2013; Ngo et al., 2020)

In addition, analysis of perceived heatwave risk involves social narrative approaches. Hansen et al. (2011) and Wolf et al. (2010) attempted to evaluate the influence of heatwave risk

perception on people's adaptation behaviour, where they confirmed that knowledge about heat and life experience played a substantial role in adaptation behaviour promoting heatwave resilience. Analyses of the narratives of residents (n=105) in Norwich and London, UK, among the older people aged between 72 and 94 years, established this association further:

Knowledge and perception of heat effects by both elderly and their social contacts, the transmission of narratives about coping strategies between them, and perceptions of personal independence and resilience, all play important roles in contributing to vulnerability through strong bonding networks. (p.51)

Thus, these findings demonstrate a complex positive relationship between heatwave risk perception and adaptation considering the influence of social capital such as social contacts of the elderly population in the UK. In addition, the analysis from the interviews (n=35) and focus groups (n=4) in Adelaide, Australia by Hansen et al. (2011) revealed that:

...some older people have fixed opinions and are defiant or reluctant to change behaviours during extreme heat, and it was thought many lacked insights into the potential dangers of excessive heat exposure. It was recognised that life experience may have played a role in shaping some of these attitudes whilst also contributing to resilience (p.4721)

However, participants of this study were key persons engaged in emergency services, aged care, government sectors, policymaking and community services, not older people themselves. In addition, a number of studies (Ban et al., 2019; Esplin et al., 2019; Liu et al., 2013) in America and China also suggest a strong significant relationship between heat-health risk perception and health-related behavioural responses influenced by various factors, such as concerns about health ($\beta = 0.45, p < 0.01$), concerns about the weather forecast ($\beta = 0.36, p < 0.01$), checking on others ($\beta = 2.11, p < 0.001$) and air-conditioner use at home ($\beta = 1.21, p < 0.05$).

Table 3 Association between heatwave risk perception and adaptation

Source	Core concept	Method used	Data date	Country	Key findings
Hansen et al. (2011)	Perceptions of heat susceptibility and barriers to adaptation to heatwaves	Interviews (n=35) & FGDs (n=4)	May & October 2010	Australia	Lack of knowledge and understanding of the potential dangers of excessive heat exposure discourage older people from changing behaviours during extreme heat. Life experience plays a significant role in increasing adaptation behaviour and contributing to resilience.
Esplin et al. (2019)	The subjective experience of heatwaves, risk perception & heat-health related behavioural responses	Online survey (n=267)	30 September to 19 October 2015	America	The subjective experience of extreme heat is a significant predictor of heat-health risk perception, which influences health-related behavioural responses.
Ban et al. (2019)	Heat-health risk perception and its mediating effect	Survey (n=3065)	18th July to 6th August 2016	China	Perceiving the risk factors of temperature exposure was significantly associated with intention to adapt to heatwaves.
Liu et al. (2013)	Relationships between the risk perceptions and adaptation practices towards heatwave & heatstroke	Survey (n = 2,183)	September to November 2010	China	There is a significant positive relationship between risk perception and the number of adaptation behaviours.
Wolf et al. (2010)	Role of social networks in individuals' responses to heatwave risks	Structured interviews (n=105)	July to September 2007	United Kingdom	Knowledge and perception of heat effects are essential for elderly people in transmission of stories about coping strategies; however, neither elderly people nor their social contacts perceive the severity of heatwave risks to the elderly and hence do not communicate nor act upon risks.
Elrick-Barr et al. (2017)	Perception of climate hazard (e.g., storms & heatwaves) & adaptive capabilities and capacities	Interviews (n=17) & Survey (n=400)	Not specified	Australia	Existing knowledge, policies informing household action and previous hazard experience are key determinants of adaptive capabilities for risk perception and capacities towards hazard preparation
Xie et al. (2019)	Association between climate change risk perception and willingness to act	Online survey (n=921)	April to May, 2016	Australia	Risk perception partially mediates behavioural willingness, and socio-cultural aspects (prescriptive norms, biosphere values, and free-market ideology) have a strong influence.

2.4 Adaptation to heatwaves

According to the Inter-governmental Panel on Climate Change [IPCC] (2018), adaptation is essential alongside mitigation to reduce the adverse impacts of climate extremes. According to Smit and Pilifosova (2001), the primary aim of adaptation to climate change is to reduce vulnerabilities and increase resilience to adverse impacts. While various public health studies report the increased number of heat-related death across the world (Adams & Jardine, 2020; Arriagada et al., 2020; Gun, 2019; Honda & Onozuka, 2020; Macintyre & Heaviside, 2019; Murage et al. 2020), many studies emphasise behavioural adaptation strategies in helping people adapt to increasingly hot weather in their daily life activities (Ban et al., 2019; Das & Smith, 2012; Hendel et al., 2017; Viguie et al., 2020; White-Newsome et al., 2014; Xu et al., 2019). In addition, Rahman and Zafarullah (2020) state that adaptation can help reduce climate-related risks to health:

Adaptation is a valuable tool for minimizing the effects of climate change on human health, but the mechanisms involve various societal, cultural, economic, political, environmental, information and technological challenges that need to be addressed rigorously and cautiously. There is an increased need for information about climatic impacts on human health and a need to increase institutional capacity, social and human capital, leadership, communication and partnerships as well as promoting stakeholders' engagement in the adaptation processes in order to ensure success (p. 59)

Adaptation to heatwaves is essential to reduce adverse impacts on life and livelihoods (Budhathoki & Zander, 2019; Saman et al., 2013; Smit & Pilifosova, 2001; Wolf et al., 2010; Wang & McAllister, 2011; Wang et al. 2018;). Although the approaches to heatwave adaptation vary from one nation to another - based on the patterns of weather, geophysical location and demography - there are various coping practices towards thermal adaptation (i.e. de Dear &

Brager, 1998; Hansen et al., 2013; Humphreys & Nicol, 1998; Williams, et al. ,2017; Saman et al., 2013). The modes of adjustments to a thermal environment (heatwaves and cold waves) include but are not limited to changes in everyday activities such as changing drinking habits, changing clothing, adjusting room temperature and reducing travel time as part of behavioural adaptation practices. In addition, other adaptation strategies documented in various studies include staying under a shaded place [especially in remote and regional areas] during the mid-day, cooling down in open ponds or showers, drinking saline water and lemon water, eating watermelons, using the handheld fan (made up of leaves and bamboo sticks) and helping each other (e.g. Ashraf & Faruk, 2018; Esplin et al., 2019). Individuals' past and current thermal experiences and reaction to a temperature are considered the 'psychological process' of adaptation practices. Individuals' acquired knowledge, past experience and skills to adjust to climate hazards enables them to cope with extreme temperatures; this is beyond the 'simplistic approaches to adaptation' (Esplin et al., 2019; Greening & Dollinger, 1992; Weinstein et al., 2000).

2.4.1 Challenges related to heatwave adaptation

Many countries are facing challenges related to heatwave adaptation, including both global south and global north countries. For example, socio-economic features, psychosocial factors, human physiology, and public health intervention and policies are considered dimensions that influence community and individual capacity to adapt to heatwaves (Bakhsh et al., 2018; Hansen et al., 2011). Even though heatwave plans are made at the national and local level in the various countries, gaps remains in the social and institutional arrangements (Bakhsh et al., 2018; Beckmann & Hiete, 2020; Hansen et al., 2011; PricewaterhouseCoopers Australia

[PwC], 2011; Wamsler & Johannessen, 2020). Studies which emphasise the socio-economic aspects report that people's inability to buy electronic equipment (fans, air-conditioner or cooler) is one of the major barriers to heatwave adaptation, and the cost of the maintenance of those devices and energy bills also vital to consider as barriers to heatwave adaptation. For example, in a study by Gissing and Coates (2018) more than 20 per cent of people in Western Sydney were found to be concerned about the impacts of energy prices on their ability to use air-conditioning.

While multiple actors are working to educate people about heatwave adaptation, research indicates that digitalisation and visualisation to support adaptation to heat is important for educating the vulnerable (Ballantyne et al., 2018; Opach et al., 2020). However, the language barrier is reported as one of the barriers to the migrant communities in term of accessing and understanding the heatwave adaptation support resources (Hansen et al., 2011 & 2013; Hurlimann et al., 2018; Schmid & Keijzer, 2009; Sheikh-Mohammed et al., 2006). A study in the UK found that while the various sources of information from both electronic and print media might provide useful risk communication links and resources on climate change impacts and adaptation approaches, they are unlikely to encourage people to engage with adaptation decision making (Harcourt et al., 2020). Heatwave communication in regards to heat-health communication, adaptation communication and emergency response is paramount to reduce the adverse impacts of heatwaves across communities and sectors.

Considering the unavoidable impacts of heatwaves and climate change, Australian government agencies have developed and planned numerous actions to increase heatwave preparedness across communities. The Victorian Government has had a heatwave plan and a heat alert system to reduce the impacts of heatwaves across different sectors since 2009 (DITMCU, 2013). The Victorian Government, including the Department of Environment, Land, Water and

Planning [DELWP], also provide reports and information on how warmer and drier climate will affect Victoria and how Victorians can be climate ready. In a recent report (funded by Victorian State Government: DELWP) on best practice and key target audiences for communicating climate science and impacts, Holmes and Hall (2019) reviewed academic texts, reports, and 'best practice' guides for climate communications. They stated that until 2019 'there is no Victorian-focussed academic literature describing approaches to Climate Change Communication (CCC) that can be evaluated as 'best practice' (p.22). They also reported that The Monash Climate Change Communication Research Hub (MCCCRH) did three audience reports on climate change communication in 2017 and 2018 focusing on climate literacy and behaviours. However, the challenge identified was the lack of effective climate change communication services to the targeted audiences who are vulnerable to the increased temperature due to their socio-economic conditions, language barriers, age and lack of access to information. According to Ajzen et al. (2011), the simple transmission of information related to the subject matter such as environment, energy use and other conserving behaviour is associated with changing people's lifestyles and behavioural pattern. In addition, vulnerability to climate changes and heatwaves depends on the exposure, sensitivity and adaptive capacity of the community (Cardona, 2005; Filho et al., 2018; Turner et al., 2003). The lack of knowledge about climate change, climate hazards and adaptation measures are also recognised as key barriers to practising adaptation behaviour (Paton, 2003; van Valkengoed & Steg, 2019). Communication regarding heatwaves, heatwave adaptation and impacts for vulnerable communities is essential to reduce adverse impacts.

2.4.2 Addressing the target audience for heatwave adaptation

Climate change communication is important for climate change mitigation and adaptation, especially for health communication, risk communication and science communication (Khadka et al., 2020; Nerlich et al., 2010). Studies suggest that climate change communication is a significant matter for individuals and communities to participate in adaptation responses for future climate extremes. For example, a study by Vulturius et al. (2020) compared two groups of forest owners: (i) n=1493, who participated in two climate communication projects and (ii) n=909, who were randomly sampled. The results show that the forest owners' participating in CCC projects have abilities to perceive subjective risks and have beliefs in their knowledge and ability to take more adaptive actions towards climate change impacts. Therefore, this study is one of the examples providing the key message that people with experience and knowledge in the context of climate extremes adaptation and mitigation planning show more positive behavioural response. In addition, individuals' and communities' proactive adaptation measures towards climate extremes depend on their knowledge, previous experience, awareness, cultural beliefs and attitudes towards behavioural adjustments (Elrick-Barr et al., 2017; Ngo et al., 2020; O'Neill et al., 2012; Stern, 2012; Stevenson & Peterson, 2015; Witte & Allen, 2000).

Further, the impacts of increased temperature can be devastating. Identifying and recognising the cultural, traditional, and Indigenous knowledge and capacities for heatwave adaptation are some of the ways to foster inclusive heatwave adaptation. In addition, understanding people's cultural beliefs, current experience, potential understanding on climate risks and climate change impacts are also significant in order to communicate climate change

and climate change adaptation effectively across communities (de Bruin & Bostrom, 2013; Hamilton-Webb et al., 2017; Lee et al., 2015).

Therefore, identifying and addressing the opportunities and challenges towards heatwave adaptations, considering every community or target audience, is important for a multidimensional and multi-stakeholder approach to heatwave adaptation and mitigation planning. It is also essential to address target audiences across society and to identify their cultural practices and knowledge on heatwaves and heatwave adaptation that shape their adjustment behaviours. This study can potentially provide some initial and essential insights into the context of migrants' previous and current heatwave experience, knowledge, and ability to adapt to heatwaves.

2.4.3 Addressing cultural diversity in the context of climate change adaptation

Responses to global climate change are mediated by cultural dimensions of lives and livelihoods (Adger et al., 2013). The cultural dimensions of lives and livelihoods include both the objective and subjective aspects of peoples' adaptive capacity for climate change impacts and the adaptation process. Objective aspects – a common focus of climate change adaptation research - include risk assessment, policy analysis, the costs of the decarbonising economy and the carbon economy (National Research Council [NRC], 2010; Adger & Kelly, 2012). This focus is less developed in the disciplines of science relative to anthropology, human geography and other social sciences (Adger & Kelly, 2012; Kuruppu, 2009; Lorenzoni et al., 2000; Wester-Herber, 2004;). It is also argued by Golledge (2001) that:

Human transformed environments were the result of deliberated decision-making activities, that the resulting structure of the environment reflected human values, beliefs,

wants, and needs and that human actions in those environments were preserved by immediate perceptions and stored in and recalled from long-term memory. (p. 1106)

Experts indicate that further effort is required to research non-material aspects of climate change adaptation, in order to understand better and to enable culturally diverse people to deal with the impacts of climate change (Fresque-Baxter & Armitage, 2012; Kuruppu, 2009). For example, in a study on water resource adaptation to climate change in Kiribati, Kuruppu (2009) argues that water adaptation planning is an integrated part of peoples' cultural values attached to the available assets they use for water crisis management due to climate change. Reviewing the literature on social capital, and climate change adaptation Wolf et al. (2010) argued that:

Social capital indicates that the presence of bridging social capital (links between distinct groups), bonding social capital (relationships between individuals who share social identity) or linking social capital (networks of trust across authority gradients) may, albeit not necessarily, lead to an increase in resilience in societies and that both are associated with survival and recovery from natural disasters (p. 44-45).

Thus, this research highlights the need to consider the participation of each social group in climate change adaptation for a sustainable practice. Therefore, understanding CALD communities' experiences and responses to the impacts of climate change in sites of resettlement would be beneficial in planning and implementing adaptation and mitigation plans. It is also argued that temperature in Bangladesh is strongly seasonal and varies widely from northern/north-western locale to southern/ south-western locale of the country (Nissan et al., 2017; Nissan et al., 2020). Consequently, migrants coming from various areas of Bangladesh have distinct previous experience dealing with and adapting to intense temperatures. Considering the diverse pre-migration perception concerning the participants' origin could add further rigour in adapting to heatwaves in Victoria. Hence, this research aims to expand an emerging focus on how

Bangladesh-born migrants in Victoria experience and respond to the impacts of heatwaves in their site of relocation.

2.5 Finding the research gap

A sizable body of research on heatwaves and heatwave adaptation across the world in this decade (2011-2020) focuses on the issues of heat-health adaptation, actions, and strategies (e.g. Akompab et al., 2013; Becker & Stewart, 2011; Demuth et al., 2016; Esplin et al., 2019; Flatharta et al., 2019; Sharifi et al. 2020; Zander et al., 2019). However, few studies explore culturally diverse communities and their risk perceptions, and actions and responses to heatwaves (e.g. Hansen et al., 2013; Messeri et al. 2019; Ogie et al. 2018; Zografos et al., 2016). Furthermore, a better understanding of cultural perceptions of climate risks and adaptation strategies are required to reduce maladaptive outcomes (Douglas & Wildavsky, 1983; Loring & Gerlach, 2009; Raymond et al., 2010). Even though many strategies have taken place to reduce the adverse impacts of heat on life and livelihood across Australia, multi-stakeholder processes towards the development and implementation of adaptation policies (Akompab et al., 2013b), and regular review of the adopted approaches (Cane et al., 2013; Coates et al. 2014; Loughnan et al., 2014; Zander et al. 2015) are essential for responding effectively to the consequences of heatwaves. According to Steffen et al. (2014), Australians are better able to deal with heatwaves than people in many countries of the northern hemisphere; however, it is appropriate to understand heatwave impacts on culturally and linguistically diverse (CALD) communities and their adaptation strategies towards building a resilient community in responding to the impacts of heatwaves.

2.6 Conceptual framework of the study

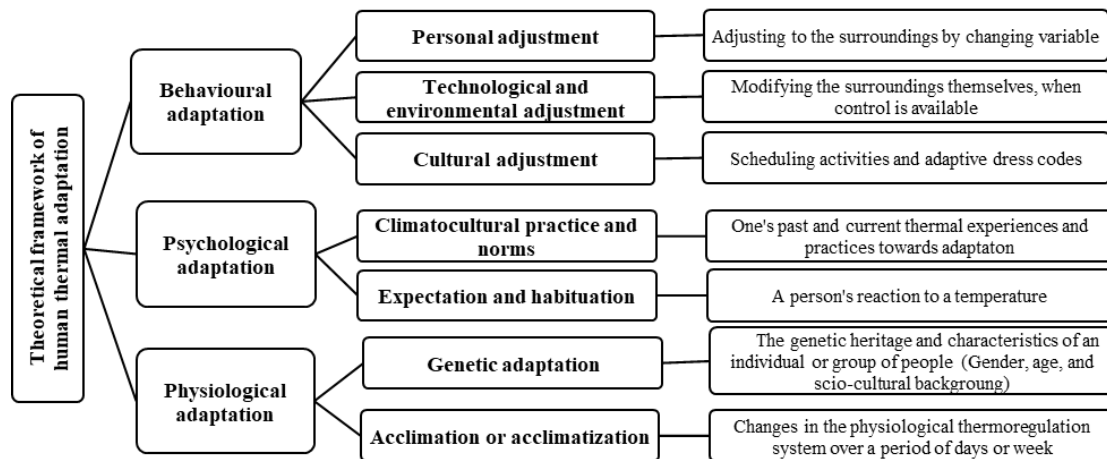
The conceptual framework of the study was adopted based on the concept of 'thermal adaptation', developed by de Dear and Brager (1998). The concept of thermal adaptation refers to the adaptation processes based on the individual responses of people to exposure to thermal environments such as heat or cold.

2.6.1 Concept of 'Thermal Adaptation'

An early study carried out by Haldane (1905) in England on the influence of high temperature on building occupants pointed out a range of engineering aspects of building construction for maintaining thermal comfort. From 1905 to 1980, research (e.g. Bedford, 1936; Houghten & Yagloglou, 1923; Olgyay, 1963; Vernon & Warner, 1932) focused on thermal adaptation factors and conceptual models. In 1981, the 'psychophysiological model of thermal perception' was introduced in which thermal adaptation was considered as both a physiological and psychological response based on climato-cultural determinants (Auliciems, 1981).

More recently, de Dear et al. (1997) developed the concept of 'human thermal adaptation'. Based on the thermal adaptation hypotheses of several studies (i.e. Auliciems, 1981; Canter, 1983; Prosser, 1958; Folk, 1974; Goldsmith, 1974; Helson 1964; Kaplan & Kaplan, 1982; Nicol, 1993; Oseland; 1994; Veitch & Arkkelin,1995), de Dear and Brager (1998) suggest that thermal adaptation has three major components: (i) behavioural adaptation, (ii) psychological adaptation, and (iii) physiological adaptation (Figure 3).

Figure 3 Human thermal adaptation framework (de Dear & Brager; 1998 p 85-87)



While contemporary thermal comfort research focuses on the laboratory-derived experiment for predicting individual responses towards the thermal conditions within a static environment (Auliciems, 1989; Nicol, 1993), the 'human thermal adaptation' model is conceptualised to predict the subjective responses to a real thermal condition (de Dear & Brager, 1998). Studies highlight the importance of human thermal adaptation in adapting to climate extremes (Auliciems & Szokolay, 1997; Saman et al., 2013; Singh et al., 2010; Yao et al., 2009). The adaptive approaches of thermal comfort and preferences emphasise thermal environmental factors which are beyond the fundamental physics and physiology (de Dear et al., 1997; de Dear & Brager, 1998). These factors can include demographics (gender, age, economic status), context (building design, building function, season, climate, semantics, social conditioning), and cognition (attitude, experience, preference, and expectations) (Baker, 1993; Baker & Standeven, 1994; de Dear et al., 1997; Griffiths et al., 1988; McIntyre, 1982; Oseland, 1995).

Behavioural adjustment focuses on adjustments to the surroundings, which include personal, technological, and cultural adjustment. Personal adjustment includes adjusting clothing, activity, posture, eating and drinking habits, or moving to a different location. Technological adjustment and environmental modification include opening/closing windows or

shades, turning on fan /cooling, using air diffuser, operating other ventilation, and air-conditioning systems. The cultural adjustment represents adaptive behaviours (dress codes, drinking /eating habits), which help people cope with heatwaves. Chatzidiakou et al. (2012) state that behaviour, attitudes, awareness, willingness, and knowledge of people about heatwaves and countermeasures (adaptation) are significant factors in terms of behavioural or cultural adjustment towards climate change adaptation.

Psychological adaptation is another significant mode of thermal adaptation. It encompasses one's past and current heatwave experiences and practices towards a thermal condition and its adaptation. According to de Dear and Brager (1998), the psychological dimension of thermal adaptation comprises the effects of cognition and cultural variables that are described as sensory information (subjective responses) of persons about their perception of (experience) and reaction to (expectation) an environmental stressor. This type of adaptation encompasses the comfort conditions of an individual in an indoor or outdoor environment. For example, relaxation within an indoor climatic opportunity can be associated with the notion of habituation in psychophysics; however, repeated or chronic exposure to a high temperature can lead people to rethink their current state of comfort or discomfort (de Dear and Brager, 1998; Glaser, 1966; Frisancho, 1993). Thus, the psychological adaptation towards heatwaves refers to an individual's altered perception of, and reaction to, a thermal environment due to their current and past experiences, expectations and habituation (de Dear & Brager, 1998).

Physiological adaptation is one of the ways to respond to heatwaves. One primary physiological response to heatwaves is increased sweating (Brager & de Dear, 1998). However, acclimatisation to heat enables physiological adaptation to environmental stressors. Brager and de Dear (1998) argue that individuals can acclimatise to high temperatures through physiological

strain and regulations: e.g. age, body hydration, environmental conditions, workloads, and clothing pattern (Borg et al., 2015; Brager & de Dear, 1998; Moran et al., 2002; Merry et al., 2010). A heat-acclimatised person can better adapt to heatwaves compared to an unacclimatised person under the same heat load (Brager & de Dear, 1998; Hardy, 1961; Périard et al., 2015; Wyndham, 1970).

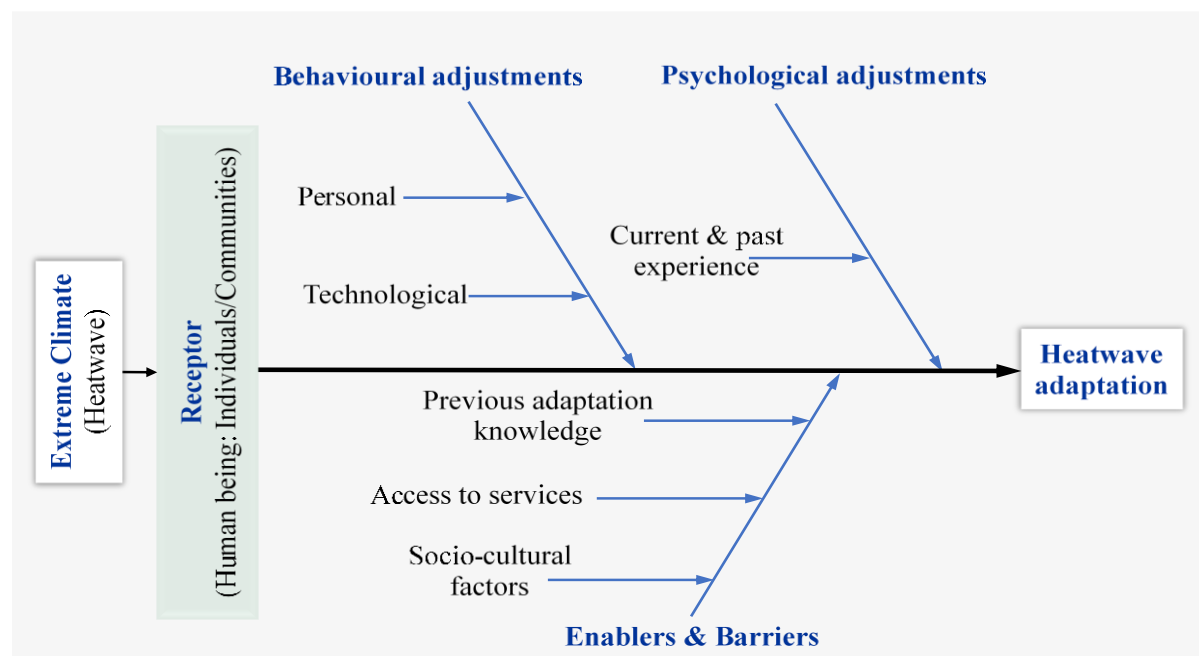
In addition, Brager and de Dear (1998) stated that if a person is uncomfortable, or expects to become so, they take corrective action according to their age, gender, socio-cultural background, economic status, environmental conditions, workload and expectations towards a thermal environment.

2.6.2 Conceptual framework of this study

The conceptual framework (Figure 4) of the study has been developed based on the 'Human Thermal Adaptation' framework (Brager & de Dear, 1998) and other contemporary literature reviewed on heatwave, cultural diversity and heatwave adaptation (e.g. Hansen et al., 2013; Humphreys & Nicol, 1998; Hanson-Easey et al., 2013; Saman et al., 2013). Previous studies also suggest that humans can adapt to the impacts of extreme climate by considering the approaches of human thermal adaptation. (Auliciems & Szokolay, 1997; Saman et al., 2013; Singh et al., 2010; Yao et al., 2009). In terms of behavioural modes of thermal adaptation, this study identifies the adaptation strategies of Bangladesh-born migrants in Victoria towards heatwaves adaptation by applying various personal and technological adjustments. By exploring their current and past experiences regarding heatwaves and the adaptation process, this study also addresses the psychological aspects of thermal adaptation. As mentioned earlier, physiological strains and regulations have an influence on the process of adjustments towards heatwave

adaptation. Further, it quantifies factors that influence migrant’s heatwave adaptation responses based on their perception of heatwave risks, current risks, and previous experience of heatwave adaptation. Research indicates that experience with one climate-related event influences adaptation responses to subsequent climate risks (Gasbarro et al., 2019; 169). Accordingly, this study considers both current (Victoria-based) and past (Bangladesh-based) experiences of heatwave adaptation.

Figure 4 The conceptual framework



The components chosen from the 'Human Thermal Adaptation' framework include behavioural adjustment and psychological adjustments. However, among the three components (Personal, technological and cultural) of behavioural adjustments of the framework, two components (personal and technological) were considered in this study. As the purpose of this research does not require identification of the fine line between personal and cultural adaptation strategies, the ‘cultural adjustment’ components were merged mostly in personal categories.

Figure 4 shows the essential components of the study.

Chapter 3

Methodology

This chapter presents the methods of the study. It provides a rationale for mixed methods as an appropriate design for investigating the research questions. The detailed procedures, including the selection of participants, collection of data and techniques of data analysis, are elaborated. A detailed process of questionnaire development is also included later in this chapter. Relevant figures and tables are included which summarise the methods. This chapter concludes with outlining the ethical considerations maintained, followed by a preliminary analysis for assessing the normality of quantitative data for inferential statistics.

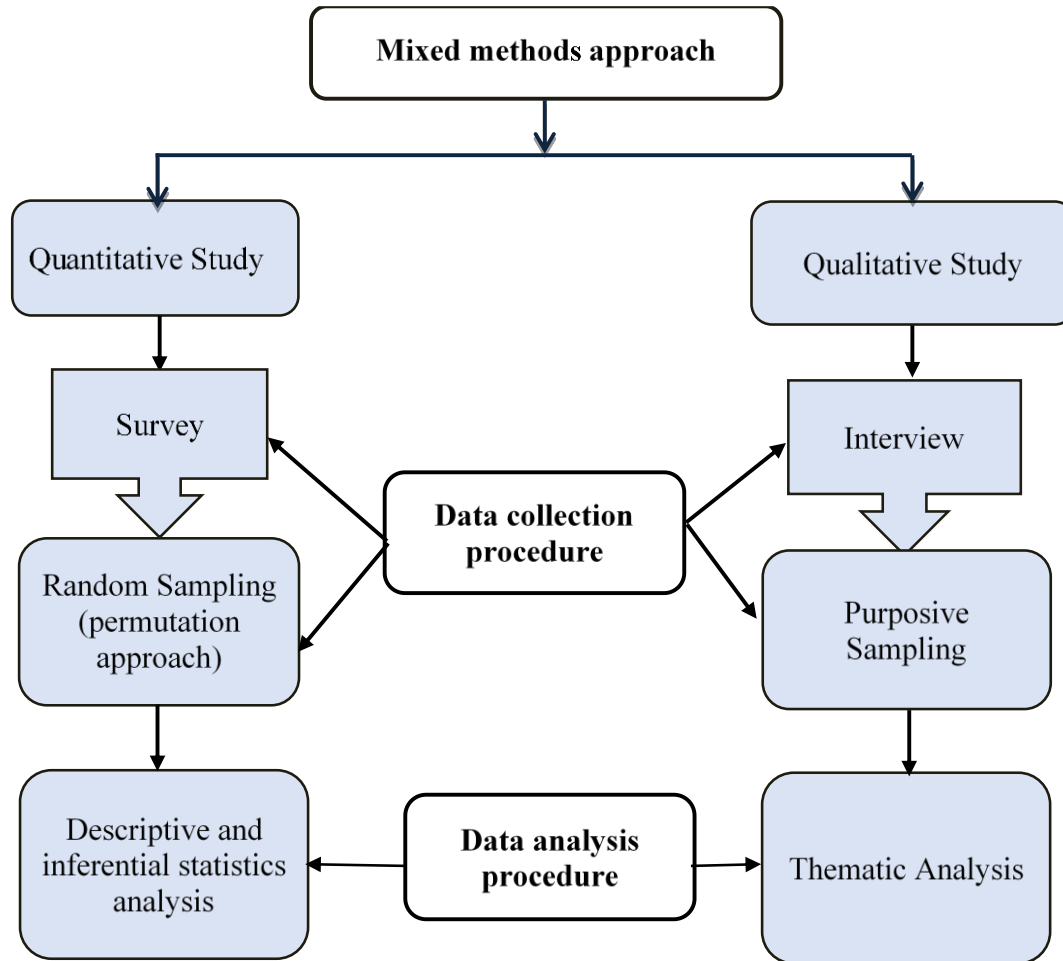
3.1 Research Design

A mixed-methods design (Figure 5), comprising both quantitative and qualitative research approaches was used to conduct this study. A combined method is a 'legitimate inquiry approach' which provides sound knowledge in terms of research design and findings (Creswell, 2008 as cited in Brewer & Hunter, 1989, p. 28). A mixed-method study enables researchers to obtain a clear and in-depth understanding of a phenomenon (Creswell, 2008; Neuman, 2012; Sarantakos, 2005; Sufian, 2009). Jick (1979) argues that a mixed methods research approach, with the combination of interviews and surveys, provides rich and comprehensive findings. Bergman (2010) provides a strong rationale for choosing a mixed methods design:

Mixed methods research is eminently suited for exploring variations in the construction of the meaning of concepts in relation to how respondents, for instance, make sense of their experiences or report on attitudes in interviews and questionnaires, respectively. A systematic inquiry into the variations of social constructions of meaning among interview and survey respondents may not only help in validating research instruments and scales but may go further in that they

could produce complementary subsets of results, which would enrich overall findings. (p. 172)

Figure 5 Research design



As part of the combined method (Table 4), this study followed the methods and principles of quantitative research for measuring self-reported risk perception of heatwaves and adaptation strategies during heatwaves. By applying the survey tools, this study intended to identify the key factors and challenges to the vulnerability to heatwaves of the participants. One-to-one, semi-structured interviews were also conducted to explore participants' current and previous experiences and barriers regarding heatwaves in both the Victoria and Bangladesh context.

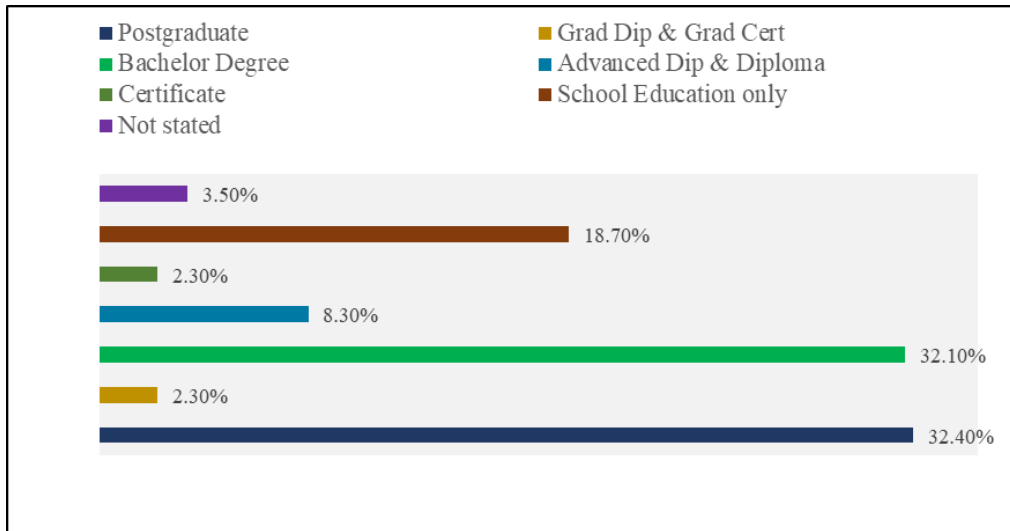
Table 4 Summary of research method by the research question

Research Questions	Method of study	Data collection techniques	Data analysis procedures
1. What are the everyday experiences of the Bangladesh-born community of heatwaves in Victoria?			• Thematic analysis
2. What strategies do they apply to cope with heatwaves in Victoria?	Qualitative	• One-to-one interview	• Descriptive & inferential statistics
3. What challenges do they experience in implementing adaptation strategies to cope with heatwaves in Victoria?	& Quantitative	• Survey	
4. How did they manage heatwaves in Bangladesh?			
5. What factors predict participants' heatwave adaptation practices in Victoria?	Quantitative	Survey	Inferential statistics

3.2 Demographic profile of the population

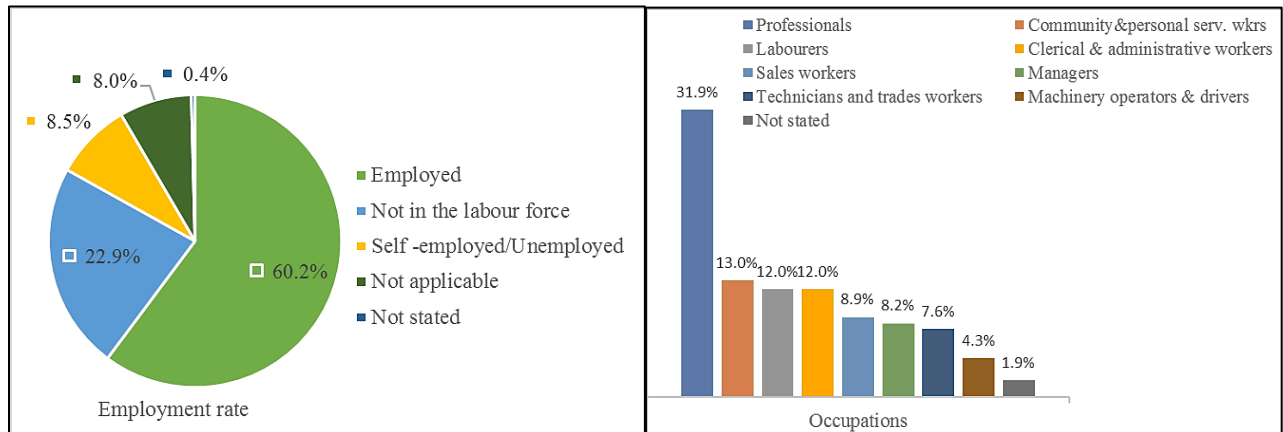
The population of this study is Bangladesh-born migrants living in Victoria. According to the 2016 Census, the total number of Bangladesh-born migrants in Victoria is 7829 people (ABS, 2016). Ninety per cent (DPC, 2018) of the total population (7829) of Bangladesh-born migrants in Victoria are aged 18 to 94 years. The target population for this study was people aged 18 years and older. While the majority arrived through the skilled and humanitarian migration programs, others came to Victoria for higher education purposes. Approximately 67 per cent (ABS, 2016) of the Bangladeshi migrants in Victoria have attained tertiary education (Figure 6).

Figure 6 Educational attainment



In terms of their participation in the labour force, approximately 60 per cent (DPC, 2018) of the total Bangladeshi migrant community in Victorian are employed and contribute to the national economy (Figure 7). Participants with diverse employment characteristics were included in this research project.

Figure 7 Employment and occupation

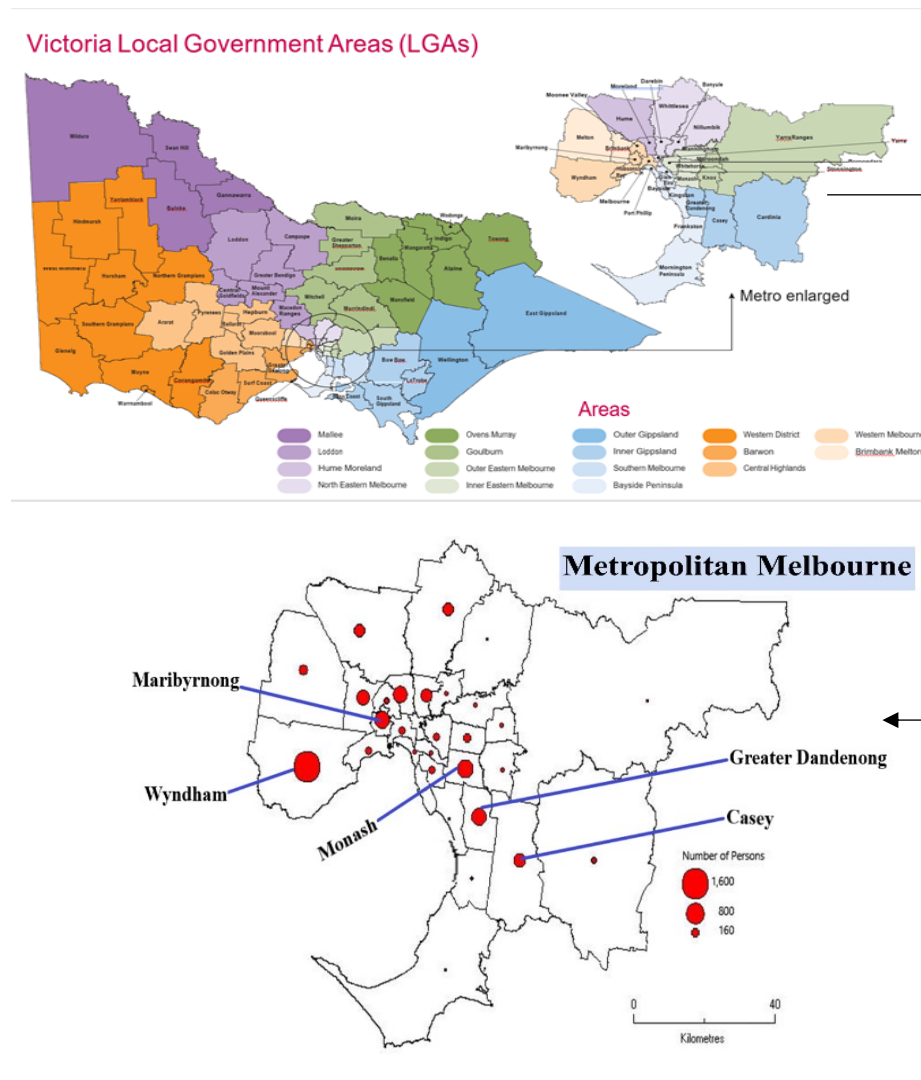


3.4 Sampling

3.4.1 Study area

The Bangladeshi community is widespread across metropolitan and regional Victoria, especially in Melbourne, Geelong, and surrounding areas. The majority (80% or 6254 persons) of Bangladesh-born Victorian migrants live in Wyndham, Monash, Maribyrnong, Greater Dandenong, Moreland, Brimbank, Casey, Darebin, Whittlesea and Hume (ABS, 2016).

Map 1 Study area^x



^x Source: https://dhhs.vic.gov.au/sites/default/files/documents/201610/DHHS_Victoria_Map_Areas-LGAs.pdf & DPC (2018)

The study was conducted in five (5) randomly selected metropolitan local government areas (LGAs) out of 10 major Melbourne metropolitan LGAs (Map 1). The LGAs [Wyndham, Monash, Maribyrnong, Greater Dandenong & Casey] were selected by using a random sampling technique (lottery method). A total of 25 suburbs were selected from the 5 LGAs (Table 5) as study areas. For selecting the suburbs from each of the LGAs, firstly, a list of suburbs with a good number of Bangladesh-born people was sought from each of five Bangladeshi community representatives (CRs) from the five selected LGAs. Secondly, five suburbs from each LAG were randomly chosen (lottery method) from the list of suburbs provided by the CRs. Finally, the selected suburbs were checked with the ‘Community profile report’ by DPC (2018) based on the data from the ABS 2016 Census of Population and Housing. Table 5 represents the geographical distribution of population for the Bangladeshi migrants in those suburbs. Community members belonging to these suburbs of these five metropolitan areas were regarded as the target population of this study.

Table 5 Geographical distribution of target population ^{xi}

Local Government Areas [LGAs] (City Council)	Suburbs with most Bangladesh-born	Number of People (%) of Total Bangladesh-born Victorian community
Wyndham	Truganina, Tarneit, Hoppers Crossing, Werribee, Wyndham Vale	1582 (20.2)
Monash	Clayton, Glen Waverley, Mount Waverley, Mulgrave, Oakleigh East	613 (7.8)
Maribyrnong	Footscray, West Footscray, Braybrook, Kingsville, Maidstone	573 (7.3)
Greater Dandenong	Noble Park, Dandenong, Springvale, Dandenong North, Keysborough	554 (7.1)
Casey	Berwick, Hampton Park, Cranbourne North, Narre Warren, Endeavour Hills	395 (5.0)
Total: 5 City Councils	25 Suburbs	3717 (±47)

^{xi} Source: Department of Premier and Cabinet [DPC], (2018), *Bangladesh-born Victorian Community Profiles: 2016 Census. The State of Victoria*. Available at www.multicultural.vic.gov.au.

Furthermore, it is essential to note that there were three additional reasons for choosing LGAs from metropolitan Melbourne as the study area for this research: (1) the primary location of the student researcher, including her University, where she is enrolled (The University of Melbourne), is in Melbourne; (2) considering the data presented in figure 2, Melbourne will be experiencing more heatwaves related deaths forecasting for 2050 (p.11); (3) student researcher herself belongs to the Bangladesh-born Victorian migrant community as well. Concisely, the residential area of the researcher and the projected data of Melbourne's heatwaves vulnerability drives metropolitan Melbourne as a compelling geographic location for researching migrant experience and its significance to understand adaptation to urban climate in multicultural Australia.

3.4.2 Sample size

There are various strategies to determine the representative sample size from the target population including computing the number of the participants, using a sample size table or calculator, use of census data, use of a sample size from similar studies and using a statistics formula (Rea & Parker, 2014). Using a statistical formula is one effective way to determine adequate sample size by estimating the population prevalence with excellent precision (Naing et al., 2006). For this study, Daniel's (1999) formula (Equation 1) has been followed for determining the primary sample size ($n = 383$) from the total target population ($N = 3717$) (Table 5). This technique also ensures that each unit of the target population has an equal chance of inclusion in the sample if the population is large and homogeneous.

Equation 1 Sample Size Calculation

Formula 1: Determination of sample size	
$n = \frac{z^2 pq}{d^2}$	
$\text{In which } n = \frac{z^2 p(1-p)}{d^2} = \frac{(1.960)^2(0.47)(0.53)}{(0.05)^2} = \frac{0.95694256}{0.0025} = 382.777024 = \pm 383$	
<p>N = Total target population=3717</p> <p>n = sample size</p> <p>p = (47% or 0.47) anticipated proportion of population aged between 19years – 94years or true proportion of factor in the total population</p> <p>q = $1 - p = 1 - 0.47 = 0.53$</p> <p>d = level of errors 5% (0.05)</p> <p>z² = Confidence Level (95% / 1.960)</p>	<p>Daniel (1999), p-157, Formula: 5.8.1</p>

The distribution of the survey packages was proportionately done based on the number of populations of each LGA (Table 6). According to the formula the sample population (n=383) estimates 11 of the target population (N=3717). However, a total of 1250^{xiii} survey packages were distributed to the target population at the different community events (described below in data collection procedure) with the support of community CRs. A total of 407 surveys were collected from the selected 5 LGAs following the procedure (Table 6). With a return rate of 33%, the total number of valid surveys is 393. Due to excessive missing data, 14 surveys were discarded. While the distribution of surveys was done proportionately, the return rate varied slightly across LGAs (Table 6).

^{xiii} The distribution of survey packages represents more than three times (33%) the expected sample size (11%)

Table 6 Number of surveys

LGAs	Total number of Bangladesh-born people	Distributed surveys	Surveys returned	Average Return rate
Wyndham	1582	530	179	
Monash	613	210	73	
Maribyrnong	573	200	61	33%
Greater Dandenong	554	180	49	
Casey	395	130	45	
Total: 5 City Councils	3717	1250	407	32.56%

In addition, as part of the qualitative study, twenty (20) one-to-one interviews were conducted using a purposive sampling technique. Two (2) participants from each local government area were selected purposively to ensure equal participation of respondents from selected areas of the study. Since purposive sampling allows researchers to choose the participants who can help the researcher understand the central aspects of the research problem (Creswell, 2008), this method is beneficial for qualitative study (Babbie, 1998). The participants of the study were aged 18 and above.

3.5 Data collection tools

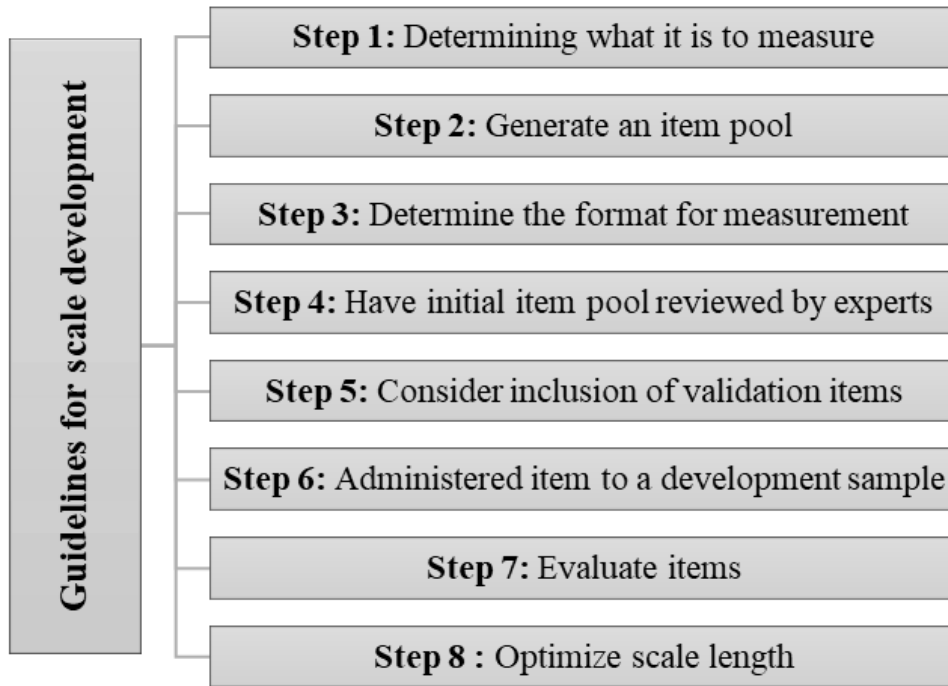
Data collection instruments included a survey questionnaire and a semi-structured interview protocol. Since there is no published relevant standardized survey instrument found in literature, a survey questionnaire was developed for this study.

3.5.1 Survey questionnaire

As outlined in Figure 8, the survey questionnaire comprised several components under three different sections. The development of the survey questionnaire consisted of several steps (Figure 8), as suggested by DeVellis (2017). The detailed procedure of questionnaire development can be found in Appendix-8, in which the headings including *generation of the item*

pool, content validation and response format describe the procedures of developing the items for other questionnaires used in this study.

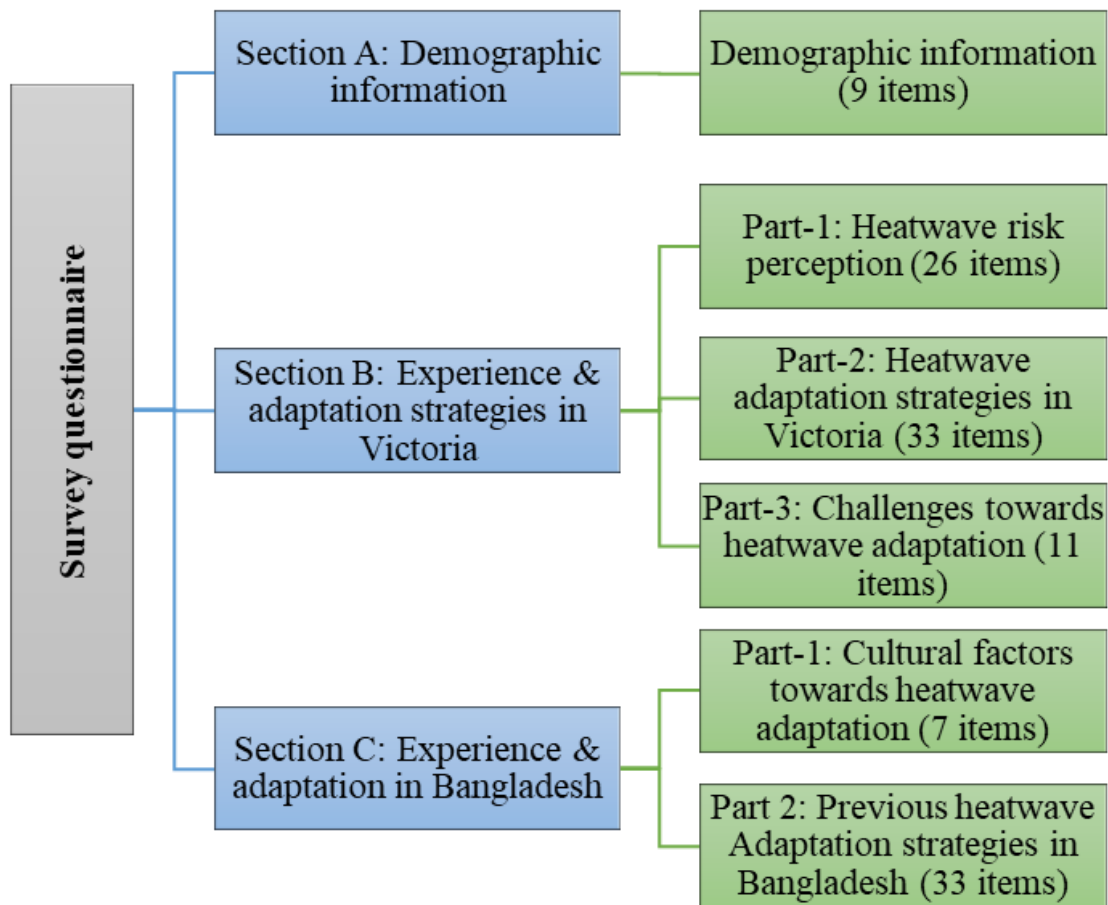
Figure 8 Guidelines for scale development



The initial items for the survey were generated following a comprehensive literature review (i.e. Hansen et al., 2013; Humphreys & Nicol, 1998; Hanson-Easey et al., 2013; Saman et al., 2013). The detailed survey can be found in Appendix 6. The survey questionnaire comprises the following parts under three different sections (see

Figure 9):

Figure 9 Survey questionnaire



3.5.1.1 Section A: Demographic Information

This section of the questionnaire includes nine items about demographic information of the participants such as gender, age, level of education, employment status, years of living in Victoria, and household composition.

3.5.1.2 Section B: Experience and adaptation in Victoria

This section of the questionnaire contains three different parts, including various aspects related to heatwaves in Victoria, measuring participants' heatwave understanding and adaptability based on their post-migration heatwave experience.

3.5.1.2.1 Part 1: Heatwave risk perception (HRP)

This part of the survey includes a 26-item questionnaire describing participants' understanding and knowledge about the impacts of heatwaves on the different aspects of their life in Victoria to assess their perception of heatwaves risks. The items were designed following a six-point Likert type scale: never=1, very rarely=2, rarely=3, occasionally=4, frequently=5, and always=6. As discussed in Appendix-8, this questionnaire was designed by the researcher following the step by step process of scale development offered by DeVellis (2017). The questionnaire has three factors: (i) concern about heatwaves, (ii) feelings about heatwaves, and (iii) information accessibility during heatwaves. An example of concern related items can be found as *"I am concerned about my sleeping routine during heatwaves"*. Items related to feelings about heatwaves were framed as *"I feel disoriented due to heatwaves"*. Similarly, items related to information accessibility is designed as *"I am informed about the consequences of heatwaves."* The reliability of this questionnaire was calculated using Cronbach's alpha (α), showing

a highly accepted value of 0.89. A questionnaire comprising more than ten items with a Cronbach's alpha (α) score above 0.7 is considered as a useful index for a psychological measure (Pallant, 2020; DeVellis, 2017). In general, it indicates that participants generally understood the items clearly and responded accordingly. The questionnaire yields a total score, the value of which can range from 26 to 156. The lower value of the questionnaire indicates that the participants perceive the heatwave risks in their lives at a lower frequency: i.e. never to rarely. The average mean score of the items (26) of the HRP (Heatwave Risk Perception) questionnaire was 4.55 ($SD = 0.84$), indicating a higher level of perception of heatwave risk among this migrant community.

3.5.1.2.2 Part 2: Heatwave adaptation strategies (HAS) in Victoria

The second part of the survey was designed to address the behavioural aspects of the thermal adaptation by exploring the various types of adjustments (personal and technological) of the participants ($n=393$) from the Bangladesh-born Victorian community. This part of the questionnaire was designed to examine participants' frequency of use of various adaptation strategies to cope with heatwaves in Victoria. The Heatwave Adaptation Strategies (HAS) measure comprised 33 items covering two major aspects: personal adjustment (25 items), and technological adjustment (8 items). A six-point Likert type scale was used: never=1, very rarely=2, rarely=3, occasionally=4, frequently=5, and always=6. An example of the item is "*I change my drinking habits by avoiding hot drink*". The questionnaire also followed the procedure of scale development by DeVellis (2017). The reliability coefficient alpha (α) of the HAS measure was showing a highly accepted value of 0.87, indicating that the items that make up the scale 'hang together' (Pallant, 2016, p.101). The questionnaire yields a total score, the value of which can range from 33 to 198. The lower value of the questionnaire indicates that the participants hardly used the adaptation strategies (rating as never to rarely) or at a lower frequency during

heatwaves. The average mean score of the items (33) of the HAS measure was 4.03 ($SD = 0.67$), demonstrating that participants use various strategies occasionally to adapt to the heatwaves in Victoria.

3.5.1.2.3 Part 3: Challenges towards heatwave adaptation

This part of the survey includes a questionnaire consisting of 11 items designed to measure challenges in implementing adaptation strategies for coping with heatwaves in Victoria. The items were designed on a six-point Likert type scale: strongly disagree=1, disagree=2, disagree somewhat=3, agree somewhat =4, agree=5, and strongly agree=6. For example, Item-1 of the questionnaire states, “*The costs of energy consumption prevent me from using cooling technologies during heatwaves*”. All the procedures of scale development were followed to develop this measure. The Cronbach’s alpha coefficient (α) for the items of this measure was computed with 393 community members, showing an accepted value of 0.77. The questionnaire yields a total score, the value of which can range from 11 to 66. The lower value of the questionnaire indicates that a participant has come across the lower level of challenges to adapt to heatwaves compared to a participant who obtains a high score. The average mean score of the items (11) of the measure was 4.72 ($SD = 0.70$), showing participants’ agreement on the challenges towards heatwave adaptation.

3.5.1.3 Section C: Pre-migration experience (Bangladesh context)

This section includes two questionnaires to examine participants’ (a) cultural factors towards heatwave adaptation and (b) adaptation strategies when they were living in Bangladesh.

3.5.1.3.1 Part 1: Cultural factors towards heatwave adaptation

This questionnaire includes seven items describing participants' cultural beliefs on their heatwave adaptation ability based on their pre-migration (*Bangladesh*) heatwave knowledge and experiences. Each item had a six-point Likert type scale ranging from: strongly disagree (1) to strongly agree (6). For example, Item 1 states “*My cultural values help me adapt with extreme weather*”. The reliability of the total scale was calculated using Cronbach's alpha, showing a highly accepted value of 0.83. The questionnaire yields a total score, the value of which can range from 7 to 42. A lower value indicates that a participant has a lower level of positive attitude that their previous experience of heatwaves in Bangladesh help them adapt to heatwaves in Victoria. The average mean score of the items (7) of the measure was 4.79 ($SD = 0.48$), indicating a positive agreement of the participants that their previous heatwave experience in Bangladesh has an influence on how they are perceiving the heatwave risks and taking adaptation measures to cope with the negative impacts of heatwaves in Victoria.

3.5.1.3.2 Part 2: Previous heatwave adaptation strategies (PHAS) in Bangladesh

This part of the survey includes the same questionnaire (Heatwave adaptation strategies in Victoria) included in part 2 of Section-B. The purpose of applying the 33-item questionnaire, having a six-point Likert type scale was to assess the extent to which the participants had used the adaptation strategies while living in Bangladesh. For example, Item 33 states “*I used to check on others (family/relatives/friends/neighbours) to offer help*” The main reason behind exploring those strategies is to understand their level of knowledge for adapting to heatwaves in the site of resettlement. This measure also helps the researcher to compare the frequency of the usage of various adaptation strategies as a part of their pre- and post-migration practices. The

Cronbach's coefficient alpha (α) score was 0.92 of the thirty-three (33) items for the PHAS measure, showing a high level of internal consistency across the items. The questionnaire yields a total score, the value of which can range from 33 to 198. The overall mean score was 3.36 ($SD = 0.48$), demonstrating that the participants knew about some of the adaptation strategies as they experienced heatwaves in Bangladesh.

3.5.2 Interview protocol

A semi-structured interview protocol was developed to understand the knowledge, experience, adaptation techniques, and challenges in relation to heatwaves. The items of the interview protocol were developed following a comprehensive literature review. The detailed protocol can be found in Appendix 7.

3.6 Data collection procedure

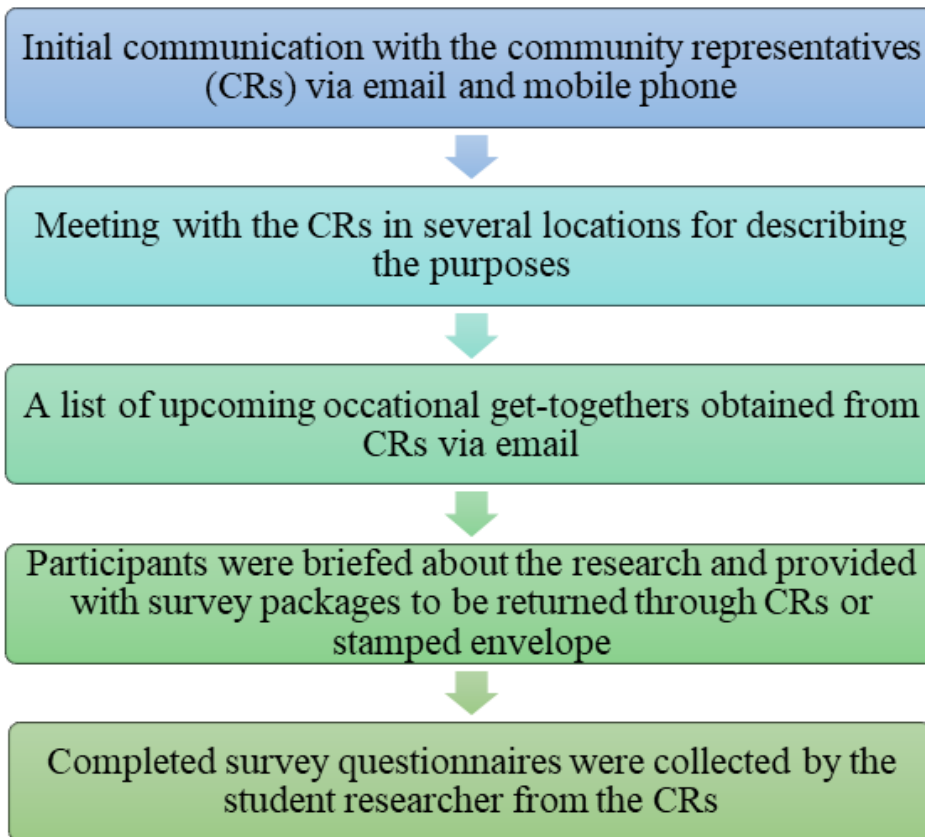
Upon permission from the Science Human Research Ethics (HRE) Advisory Group of the University of Melbourne, data collection took place from December 2018-April 2019. Data collection procedures included the application of the survey questionnaire and the conduct of one-to-one, semi-structured interviews.

3.6.1 Survey

The procedure consisted of several steps (Figure 10). Firstly, to reach the participants of the study, community representatives (CRs) of the Bangladeshi migrants in Victoria were contacted. There were several community representatives within the Bangladeshi migrant community in Victoria, depending on the location. The student researcher is also a member of this community and had an established relationship with other members of the community. The

Bangladeshi Community Association in Victoria is an informal platform that organizes various occasional/cultural events to increase the connections among people. Individual meetings were organised by the student researcher with the community representatives to explain the purpose of the study. The Bangladeshi community organizes numerous get-togethers throughout the year. With the support of the CRs, the student researcher briefed potential participants in a casual get-together. After the briefing, participants agreeing to participate in the survey were provided with a questionnaire package consisting of an explanatory statement of the research, a consent form, a guideline for completing and submission of the survey, and a questionnaire. They were given one week to return the completed survey questionnaires to the CRs of their areas or via stamped envelopes. While 356 surveys were collected from the community leaders by the student researcher, another 51 were received via pre-paid stamped envelope supplied by the student researcher as well. Participants' anonymity was ensured while designing the survey questionnaire. Participants willing to participate in the qualitative part of the study were then contacted for an interview.

Figure 10 Steps of the quantitative data collection procedure



3.6.2. Interview

Upon prior consent, the potential participants for the interviews were communicated with via telephone to discuss their availability. The location and time for an interview were set in accordance with the individual participant's convenience. Individual participants signed a consent form (Appendix 4) before taking part in the interview. Interviews were audiotaped with the permission of the participants.

3.7 Data analysis procedure

Both quantitative and qualitative data analysis techniques were used. Quantitative data were processed and analysed using Statistical Package for Social Science (SPSS) version 26. A

descriptive analysis was undertaken to report the overall results, such as demographic information about the participants, and a summary of participants' scores on the scales used in different sections of the survey questionnaire. Mean scores (*M*), Standard Deviation (*SD*), frequency and percentage were calculated depending on the research questions of the study. An advanced inferential statistics method was also required to identify several predictor variables and their association with each other. Inferential statistics included several *t*-tests and several multiple regressions.

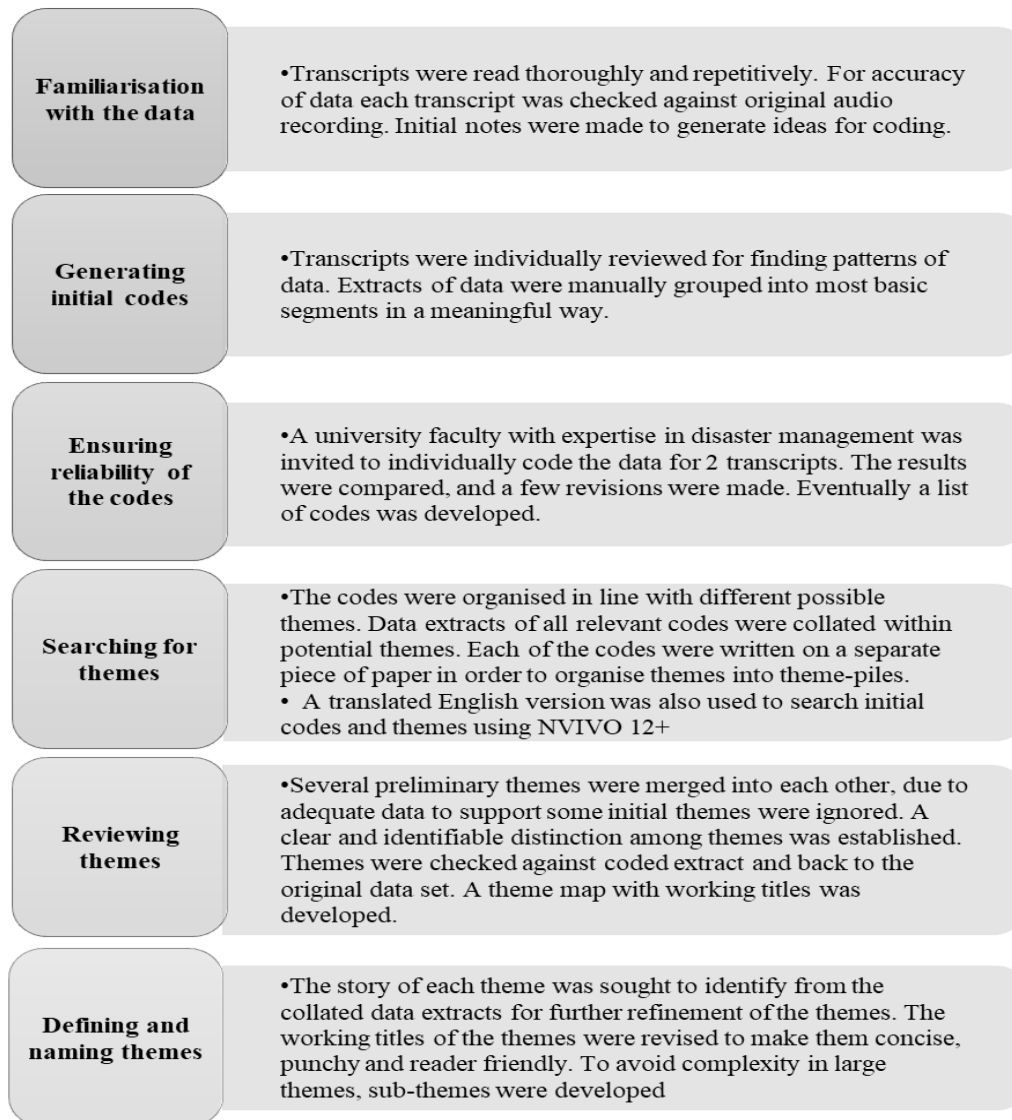
Thematic analysis procedures were used to analyse the interview data (Braun & Clarke, 2006). The thematic approach is considered an essential way to analyse qualitative data (Brixey et al., 2007; Fereday & Muir-Cochrane, 2006). A hybrid method, comprising both inductive and deductive approaches (Creswell, 2008), was used to develop themes for several reasons. Firstly, previous research investigating heatwaves or extreme weather commonly explored individuals' understanding of the nature of heatwaves: the intensity of the temperature and level of tolerance. Next, various adaptation techniques in case of extreme temperature were identified. Then, individual challenges to cope with extreme temperature were prioritised. These three core aspects: nature of heatwaves, adaptation strategies and barriers towards adaptation, were emphasised to develop the semi-structured interview protocol in this study. Accordingly, it was also anticipated that these themes might be supported by the data collected from interviews. Thirdly, a number of themes emerged from the qualitative data inductively, which were not necessarily anticipated themes. The hybrid method was identified as one of the important ways of analysing qualitative data within a thematic analysis (Brixey et al., 2007; Fereday & Muir-Cochrane, 2006). Based on the research questions, a deductive *a priori classification*

framework^{xiii} (Crabtree & Miller, 1999) was developed. New categories developed inductively were added to the existing framework.

The thematic analysis process involved six stages (Figure 11). Firstly, repetitive reading of the interview transcripts occurred to generate the direction of the data and get ideas about coding. After reviewing the transcripts, data were clustered for thematic coding. Next, several thematic categories were identified from the open coding process. To determine the applicability of codes to the raw data, as an essential step (Boyatzis, 1998) for this study, a PhD researcher in a similar field was invited to code the data independently for two transcripts. The outcomes were compared, and a few amendments were made. For example, there were disagreements found in selecting codes regarding participants' understanding of the nature of heatwaves. Issues regarding the discrepancy were discussed and adjusted. To minimise the variations, the same process was repeated with several transcripts. In addition, it is noteworthy to acknowledge that despite using Bangla transcripts for manually identifying themes, a translated English version was used to search initial codes and themes using NVIVO 12+. The intention behind using both hand-search and NVIVO was to reduce the possibilities of missing and overlapping of important facts or themes. The next step was to merge the codes into similar categories that helped reduce the codes more systematically (Creswell, 2008; Leech & Onwuegbuzie, 2008). A number of similar categories were then used for developing themes, which were then named and added to the initial framework.

Figure 11 Thematic analysis procedure (Braun & Clarke, 2006)

^{xiii} *Deductive a priori in qualitative research prioritizes researchers' presumptions in investigating the phenomena. The framework allows researchers to directly find the answers to their queries that were embedded in the research objectives. For more details, please see Oswald, D. J. (1990). JS Mill's a priori deductive methodology: a case study in post-modern philosophy of science. Review of Social Economy, 48(2), 172-197.*

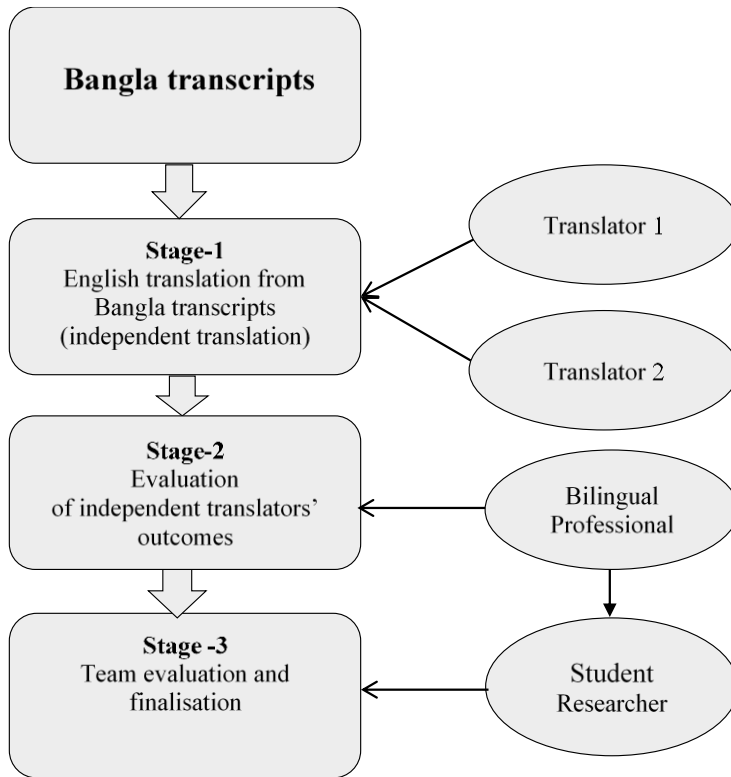


3.8 Transcription and translation

Interview data were transcribed in Bangla verbatim. Bangla transcripts were mainly used in the analysis for identifying themes. Once themes had been identified, participants' quotes used in the analysis were translated into English based on the conceptual translation process (Figure 12), which involved two independent translators who translated the themes from Bangla to English. Further, a bilingual professional (PhD researcher) experienced in disaster and environment-related studies within the context of Bangladesh was engaged to find if any

discrepancies were there in the independent translators' English version compared to the Bangla version. Finally, the researcher revised the English version in line with the bilingual professional's comments and used in this study.

Figure 12 Translation process (adapted from Brislin, 1970 & 1980)



There are several reasons for prioritising Bangla transcripts for analysis. Qualitative researchers (Regmi et al., 2010; Al-Amer et al., 2015) emphasized the use of interviewees source language to analyse data. A significant variation was found when comparing the first two Bangla transcripts with the translated ones (English version). The original integrity of the responses of the participants was likely to be missed due to the translation process. There are not only cultural challenges in identifying commonalities and differences in Bangladesh compared to the Australian context but also there are challenges with the Bangla language itself. For example, a number of Bangla words (e.g. *Samassa*-challenge or problem; *Borkha* – a long cover-up dress for

Muslim women; *Tibro garam*-severity of the temperature; and *Boiri abohaowa*-extreme weather) lack an easily identifiable equivalent in English. Hence, it is important to note that many participants' quotes used in Chapter 4 can be found in nonstandard English. This is due to the translation process in which the original integrity of responses was carefully maintained.

3.9 Ethical considerations

The code of ethics endorsed by the University of Melbourne Human Research Ethics Committee was maintained during all stages of this research, including data collection and data reporting. For example, as per ethics guidelines, an explanatory statement was distributed to the participants covering the purpose of the research, various procedures involved in data collection, data recording and data reporting, and their roles as participants in this research. All participants interviewed signed a consent form, and their identities remained anonymous. Pseudonyms are used in reporting the findings of the study. Participants were also advised that they were at liberty to withdraw from the research without providing a reason by simply not completing the survey or returning a blank survey. Relevant documents regarding ethical issues including the approval letter from the Science Human Research Ethics (HRE) Advisory Group (Appendix 1), the explanatory statement for participants in plain language (Appendix 2 & 3), and a sample of the consent form for the participants (Appendix 4 & 5) can be found in the appendices.

3.10 Positionality statement

Being a part of this community, surviving five major cyclones (1997, 2007, 2009 & 2013) since my childhood and experiencing several mild to severe level heatwaves, I personally can feel that adapting to climate extremes is very hard. It becomes more challenging when migrants

experience resettlement and extreme climates simultaneously. Even though the Bangladesh-born migrants have diverse experiences of heatwaves, it was not easy for me to conduct the data collection phase due to several challenges. For example, identifying migrant (the target population) and non-migrant Bangladeshis, approaching both parties with respect and honour, making the back-and-forth communication effective, dealing with participants' disregarding behaviour were sometimes challenging. However, the community leaders were very supportive and encouraging, as were many of my community members. Thus, this entire thesis also portrays the confidence of doing human research with tremendous challenges.

3.11 Preliminary analysis for inferential statistical analysis

A preliminary analysis was conducted to test the normality of the distribution of the scores. In general, a non-significant result of Kolmogorov-Smirnov statistics (Sig value more than 0.05) indicates normality. However, with large samples, the significant level of skewness is not as important as the actual size and the visual appearance of the distribution (Tabachnick & Fidell, 2013, p.80). Pallant (2020) also stated that a non-significant result is quite common in large samples, and the actual shape of the distribution can be seen in the normal probability plots (p.63). A reasonably straight line suggests a normal distribution. In the scales (HRP^{xiv}, HAS^{xv}, CHA^{xvi}, CFHA^{xvii} & PHAS^{xviii}) of this study, scores appear to be reasonably normally distributed by an inspection of the normal probability plots (labelled as Normal Q-Q Plot) in Figure 13.

^{xiv} **HRP:** Heatwave risk perception,

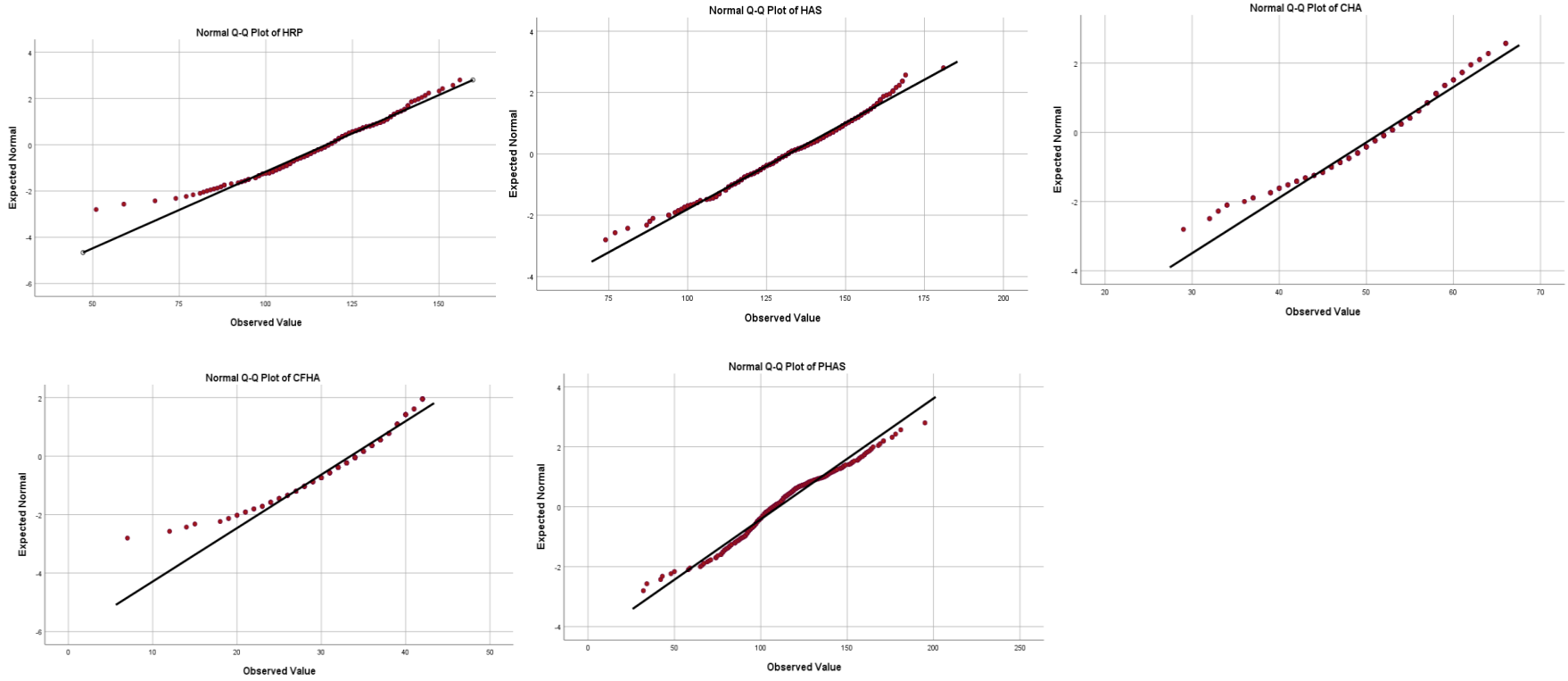
^{xv} **HAS:** Heatwave adaptation strategies in Victoria

^{xvi} **CHA:** Challenges towards heatwave adaptation

^{xvii} **CFHA:** Cultural factors towards heatwaves adaptation

^{xviii} **PHAS:** Previous Heatwave adaptation strategies in Bangladesh

Figure 13 Normal Q-Q plots of the scale

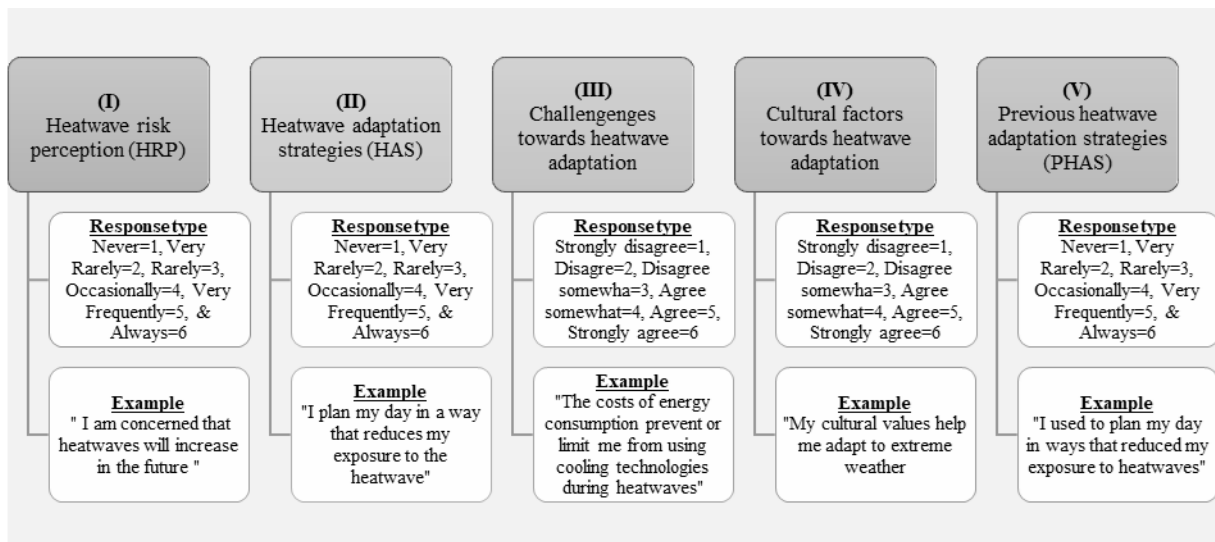


Chapter 4

Measuring risk perception of and adaption to heatwaves

This chapter presents the result and analysis of the survey data. To begin, the demographic profile of the survey respondents (n=393) is presented. Next, the chapter presents five major areas of analysis: (i) heatwave risk perception (HRP), (ii) heatwave adaptation strategies (HAS) in Victoria, (iii) challenges to heatwave adaptation; (iv) cultural factors around heatwave adaptation and comparison of the usages of adaptation strategies between Bangladesh and Victoria, and (v) predictors of heatwave adaptation. The following figure (Figure 14) illustrates the structure of these five areas of analysis, as used in the survey questionnaire.

Figure 14 Survey questionnaire



As mentioned in Chapter 3, the survey questionnaire consists of four independent and one repeated measure (Previous Heatwave Adaptation Strategies [PHAS]) of Heatwave Adaptation Strategies (HAS) measure. Six-point Likert type scales were used to measure participants' self-reported frequency and agreement expressions on heatwave experience,

barriers, and adaptation. Tables and figures are presented to summarise quantitative data, which were analysed using both descriptive and inferential statistics.

4.1 Demographic profile of the sample population

The total number of survey respondents was 393, of which 52 per cent were male, and 48 per cent were female. The age of the survey respondents ranged from 18 years to 68 years and older, where most of the respondents (83%) were 28 to 57 years old. A majority of participants were highly educated and employed. Most participants had a tertiary education with a postgraduate degree (60%), graduate diploma or graduate certificate (25%), or bachelor's degree (10%). Based on self-reported employment status, the majority of participants were employed or self-employed; only 9% ('Not applicable', 'other') did not specify their employment status. In addition, more than 50% of respondents have been living in Victoria for 6 to 15 years, followed by 16 to 20 years (17%) and 1 to 5 years (11%). Only 7% of the total sample population has been living here for more than 25 years.

The family composition was classified into six different types. A majority of respondents lived as a couple with children (70%), followed by a couple with no children (15%). Finally, the respondents were asked if they have experienced heatwaves in Victoria. Almost all the respondents (97%) reported having heatwave experience in Victoria. Table 7 shows the demographic profile of the respondents.

Table 7 Demographic profile of respondents

Variables	Groups	Frequency	Percent (%)
Gender	Male	204	52
	Female	189	48
Age range	18-27 yrs	16	4
	28-37 yrs	108	28
	38-47 yrs	138	35
	48-57 yrs	78	20
	58-67 yrs	25	6
	68+ yrs	26	7
Level of education	Postgraduate degree	234	60
	Graduate diploma and Graduate certificate	98	25
	Bachelor's degree	41	10
	Advanced diploma	12	3
	School and college education only	4	1
Employment status	Employed	177	45
	Unemployed	12	3
	Self-employed	30	8
	Retired/Pensioner	41	10
	Student	58	15
	Business	40	10
	Not applicable	28	7
	Other	6	2
Years of living in Victoria	>1 year	7	2
	1-5 yrs	44	11
	6-10 yrs	107	27
	11-15 yrs	121	31
	16-20 yrs	66	17
	21-25 years	18	5
	25+ yrs	29	7
Family composition	Single	29	7
	Couple with no children	59	15
	Couple with children	273	70
	Single-parent household	6	2
	Extended family household with children	19	5
	Extended family household with no children	4	1
	Other	2	1
Heatwave experience in Victoria	Yes	379	96
	No	13	4

4.2. Heatwave risk perception (HRP)

This section explores the experiences of the Bangladesh-born Victorian migrant community based on their perception of heatwave risks considering three aspects: (i) concern

about heatwave risks in everyday life (ii); feelings during heatwaves; and (iii) access to information about heatwaves. As outlined in Figure 14, the response pattern of the items of HRP measure was a six-point Likert type scale ranging from always (6) to never (1).

4.2.1 Concern about heatwave risks in everyday life

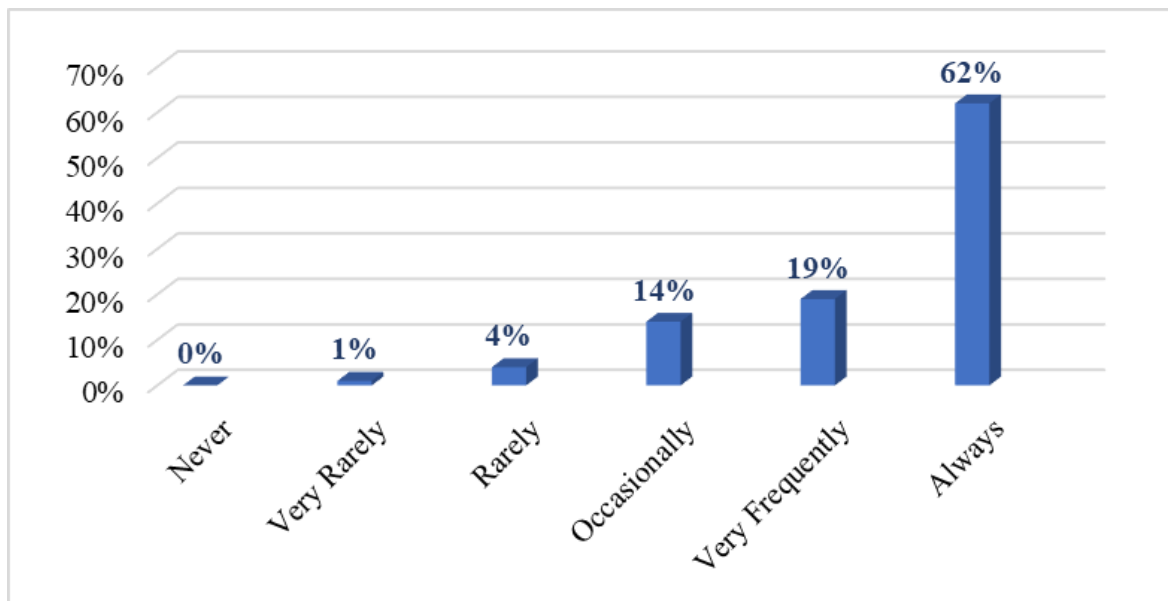
This survey measured the heatwave risk perception (HRP) based on current experience in Victoria. The first three items of the HRP scale were used to measure their overall concern about heatwaves in terms of (i) impacts on personal lives and livelihoods, (ii) increasing trends, (iii) impacts on the wider community. Table 8 shows the average score (M) and standard deviation (SD) of the three items; it indicates respondents' average level of concern is between 'very frequently' to 'always'.

Table 8 General perception of heatwave risks

No	Items	M	SD
1	I am concerned that heatwaves cause negative impacts on my life	5.36	0.95
2	I am concerned that heatwaves will increase in the future	5.11	0.71
3	I am concerned that heatwaves cause negative impacts on other communities	5.12	1.04

A frequency analysis of item 1 was conducted to see participants' response pattern ($M=5.36$, $SD=0.95$). As depicted in Figure 15, the majority (62%) of respondents indicated they were 'always concerned' about the negative impact of heatwaves on their lives followed by 'very frequently concerned' (19%) and 'occasionally concerned' (14%). This implies that respondents have a high level of concerns about the negative impacts of heatwaves on their everyday life in Victoria.

Figure 15 Heatwaves cause negative impacts on my life



Further, thirteen items (Item 4-17) explored heatwave impacts on participants' everyday activities. This part of the questionnaire was designed to measure how frequently Bangladeshi migrants in Victoria are experiencing impacts of heatwaves in their lives and livelihood. As the following table indicates (Table 9), participants experience adverse impacts of heatwaves across different aspects of daily life.

Table 9 summarizes the mean scores of items that examine participants' level of concern about heatwaves in their everyday life. There are five items obtaining a mean score of 5 and above, which indicates a high frequency of concern. The participants' highest concern about the impact of heatwaves was on their personal health ($M=5.21$, $SD=1.08$). The other aspects of participants' everyday life scoring above 5 include garden ($M=5.07$, $SD=1.03$), high energy bills ($M=5.07$, $SD=0.93$), sleeping routine ($M=5.05$, $SD=0.94$), and taking care of family members ($M=5.05$, $SD=0.95$).

Table 9 also shows that 8 items scored between 4.50 and 5, indicating occasional to very frequent levels of concern: travel time ($M=4.97$, $SD=1.07$), outdoor activities ($M=4.97$, $SD=1.10$), eating habits / avoiding hot meal ($M=4.93$, $SD=1.02$), personal comfort through maintaining body temperature ($M=4.89$, $SD=1.02$), drinking habit / staying hydrated

($M=4.87$, $SD=0.97$), mode of travel to work or other places ($M=4.85$, $SD=1.02$), changes in daily routine ($M=4.80$, $SD=1.02$), and drinking habit / avoiding hot drink ($M=4.62$, $SD=1.12$).

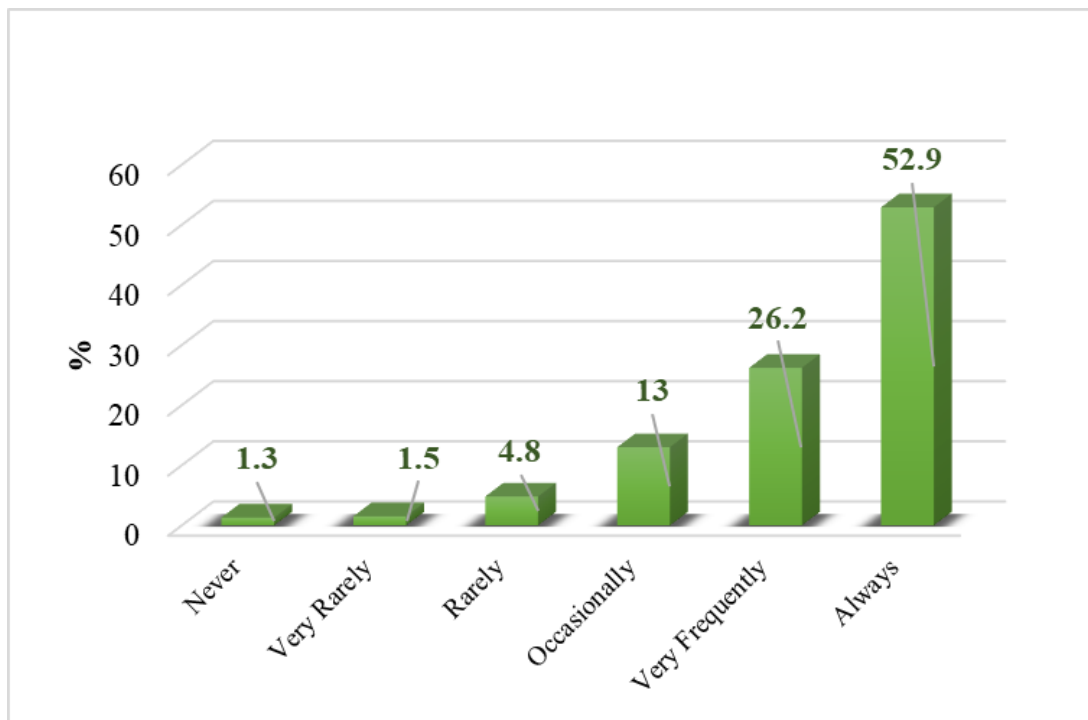
Table 9 shows only one item securing a mean score below 4, indicating participants' lower concern about this aspect of everyday life. The item is avoiding alcohol consumption ($M=3.33$, $SD=2.08$) as a part of changing drinking habit. This implies that the Bangladesh-born migrants in Victoria are not very concerned about their drinking habits relating to alcohol consumption during heatwaves.

Table 9 Level of concern on the aspects of everyday life

No.	Items	<i>M</i>	<i>SD</i>
4	Health impacts	5.21	1.08
13	Garden, due to the hot weather	5.07	1.03
15	High energy bills due to increased use of cooling systems	5.07	0.93
5	Sleeping routine	5.05	0.94
12	Family members	5.05	0.95
11	Outdoor activities (e.g. exercise, other outdoor tasks)	4.97	1.1
17	Travel time	4.97	1.07
14	Avoiding hot meal	4.93	1.02
6	Personal comfort (i.e. body temperature)	4.89	1.02
7	Staying hydrated	4.87	0.97
16	Mode of travel (to work or other)	4.85	1.02
10	Daily routine	4.8	1.02
8	Avoiding hot drink	4.62	1.12
9	Avoiding alcohol consumption	3.33	2.08

As shown in Table 9, health impacts during heatwaves represent the most significant concern. Frequency analysis shows that a majority (79%) of participants had a high level of concern (i.e. 'always' 53%; 'very frequently' 26%) about the impacts of heatwaves on their health (Figure 16).

Figure 16 Health impacts



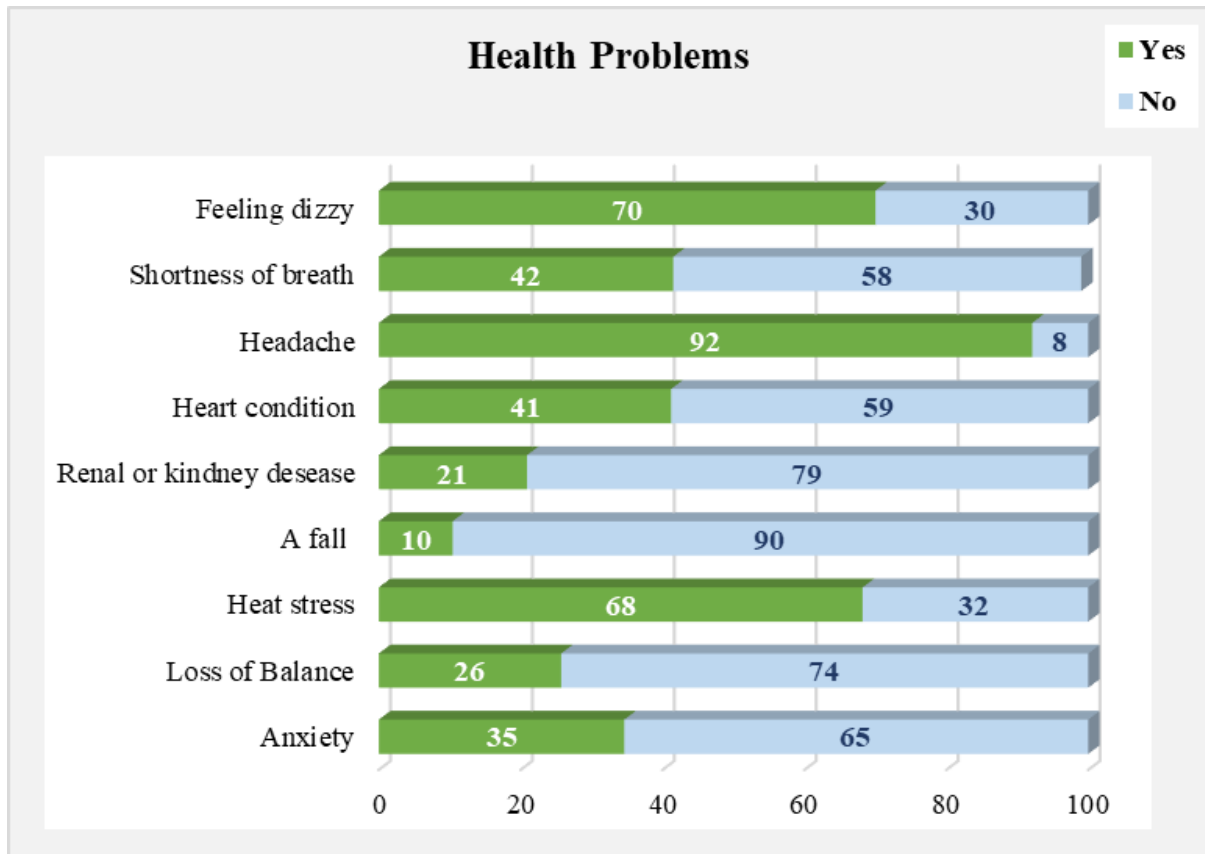
To further explore health impacts, a structured question about personal health problems during heatwaves provided a list of nine (9) health problems (to which respondents answered ‘yes’ or ‘no’) and an open option. The listed health problems included anxiety, loss of balance, heat stress, a fall, renal or kidney disease, heart condition, headache, shortness of breath and feeling dizzy (More than 90% experienced headaches due to heatwaves. Other major health problems were ‘feeling dizzy’ (70%), heat stress (68%), ‘shortness of breath’ (42%) and ‘heart condition’ (41%). However, these health problems are particularly problematic for people with underlying health conditions (see more details in “Barriers to adaptation”).

Figure 17). Five participants added four different health problems including excessive thirstiness; feet burn, dehydration, skin rash and skin burn. Participants reported personal experience of several health problems during heatwaves (see Figure 17).

More than 90% experienced headaches due to heatwaves. Other major health problems were ‘feeling dizzy’ (70%), heat stress (68%), ‘shortness of breath’ (42%) and

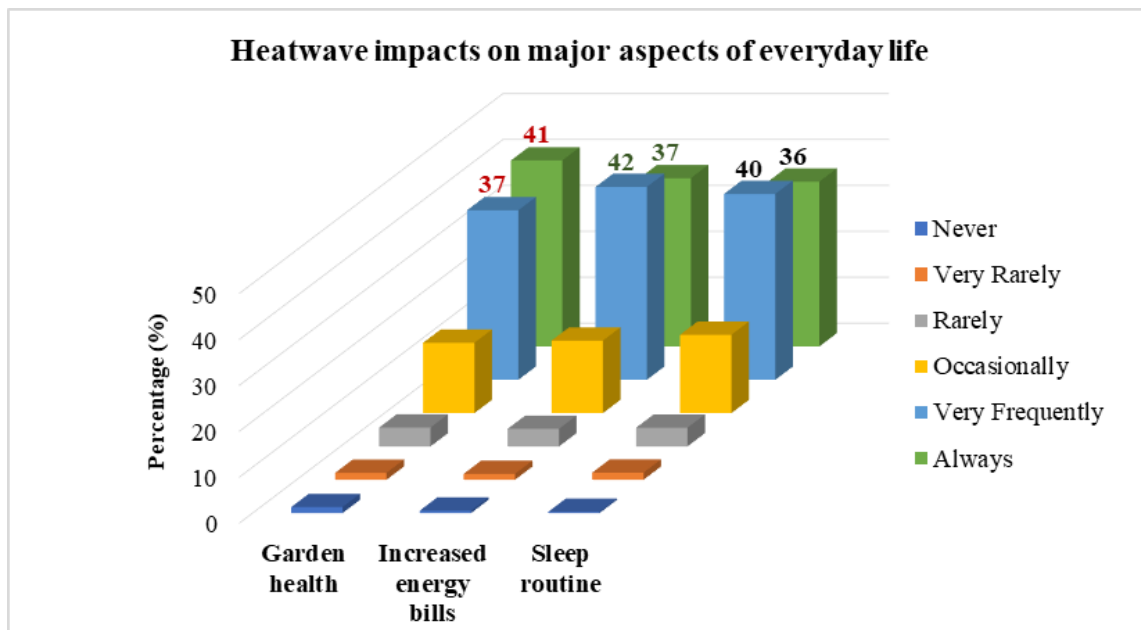
‘heart condition’ (41%). However, these health problems are particularly problematic for people with underlying health conditions (see more details in “Barriers to adaptation”).

Figure 17 Health problems



As shown in Table 9, *garden health* and *high energy bills due to increased use of cooling systems* were the most concerning impacts of heatwaves, after health. Bangladeshis are eager to grow their vegetable garden in their backyard. The respondents showed a high degree (78%) of concern about the impact of heatwaves on their vegetable patch, as shown in Figure 18 (‘Always’ 41%; ‘Very frequently’ 37%).

Figure 18 Heatwave impacts on major aspects of everyday life



Increased energy bills due to the high use of cooling systems was another concerning aspect of daily life during heatwaves. A majority (79%) of the participants rated their level of concern on increased energy bills as ‘Always’ to ‘Very Frequently’ (Figure 18). Further, changes in sleeping routine during heatwaves was identified as a significant impact of heatwaves, with 76% of participants indicating that they experienced sleep disruption ‘Always’ to ‘Very frequently’ (Figure 18).

4.2.2 Level of feeling during heatwaves

This section explores how the Bangladeshi migrant community feel during heatwaves. The survey comprised 5 items (items 18 -22) about their feelings during heatwaves on the Heatwave risk perception (HRP) scale. The community indicated that they felt uncomfortable during heatwaves very frequently ($M=5.15$, $SD=1.01$) (Table 10). People also reported that they felt disoriented ($M=4.68$, $SD=0.99$), unwell ($M=4.51$, $SD=1.11$), and distressed ($M=4.64$, $SD=1.21$). Responding to the item “I enjoy heatwaves”, participants’ scoring ($M=1.78$, $SD=1.21$) indicates very low enjoyment of heatwaves on average.

Table 10 Feeling during heatwaves

No	Items	<i>M</i>	<i>SD</i>
18	I feel uncomfortable during heatwaves	5.15	1.01
19	I feel disoriented during heatwaves	4.68	0.99
20	I feel unwell during heatwaves	4.51	1.11
21	I enjoy heatwaves	1.78	1.15
22	I feel distressed during heatwaves	4.64	1.21

4.2.3 Access to information about heatwaves

Items 23-26 in the HRP measure explored how frequently people get information about heatwaves and their consequences. Participants' responses are presented in Table 11. On average, participants were rarely informed about heatwaves ($M=3.26$, $SD=1.25$) and their consequences ($M=3.35$, $SD=1.28$). Participants reported that they had limited access to information regarding heatwaves and how to adapt.

Table 11 Information accessibility

No	Items	<i>M</i>	<i>SD</i>
23	Informed about heatwaves	3.26	1.25
24	Informed about the consequences of heatwaves	3.35	1.28
25	Awareness about heatwaves	3.73	1.03
26	Followed news regarding heatwaves	3.78	1.06

In addition, participants on average rarely received information from print and electronic media during heatwaves ($M=3.73$ $SD=1.03$), and they only rarely to occasionally followed the news regarding heatwaves ($M=3.8$, $SD=1.06$). This indicates that the Bangladeshi migrant community needs improved awareness regarding heatwaves, their consequences and adaptation strategies.

4.3 Adaptation to heatwaves

The response pattern of item (33) of the "Heatwave Adaptation Strategies (HAS)" questionnaire was a six-point Likert-type scale ranging from 'Never' (1) to 'Always' (6).

Table 12 highlights that out of 33 strategies, 18 techniques were (on average) ‘occasionally’ ($M=4$) to ‘very frequently’ ($M=5$) used to adapt to extreme heat by this community. Ten items scored a mean of 4.5 or higher, suggesting these strategies are very frequently used. The strategies are described within two predetermined clusters (personal adjustment and technological adjustment) and the associations between demographic variables and adaptation practices are analysed below.

4.3.1 Personal adjustment

The personal adjustment component consists of 25 adaptation strategies (Table 12). Eight items had a mean score of 4.5 or higher, implying that these strategies were used very frequently by the respondents. *Avoiding alcohol consumption during heatwaves* ($M=4.88$, $SD=1.14$), obtained the highest mean score, indicating this was the most common adjustment strategy used by respondents. Other strategies with high mean scores include *drinking more water to keep hydrated* ($M=4.81$, $SD=1.05$), *wearing protective clothing (e.g. hat, sunglasses) when going out* ($M=4.62$, $SD=1.06$), *cold water splash* ($M=4.61$, $SD=1.05$), *moving to a cooler room* ($M=4.58$, $SD=0.94$), *avoiding hot drinks* ($M=4.51$, $SD=1.00$), *spending less time in the car* ($M=4.52$, $SD=0.97$) and *avoiding physical activities* ($M=4.50$, $SD=1.02$).

Six strategies were used occasionally (a mean score between 4.00 and 4.50) by respondents (Table 12). These include *changing eating habits by avoiding hot meals* ($M=4.46$, $SD=1.00$), *wearing lighter coloured and more relaxed clothes* ($M=4.41$, $SD=1.04$), *planning day in a way that reduces exposure to the heatwave* ($M=4.40$, $SD=1.08$), *taking a frequent shower to keep your body cool* ($M=4.36$, $SD=1.00$), *staying at home* ($M=4.24$, $SD=1.06$), and *placing a wet cloth on face or neck to cool down* ($M=4.00$, $SD=1.29$).

In contrast, strategies that were used rarely (mean score below 4.00) include *checking on others (family/relatives/friends/neighbours) to offer help* ($M=3.92$, $SD=1.10$), *changing*

appointment ($M=3.84$, $SD=1.16$), *avoiding cooking* ($M=3.84$, $SD=1.19$), *going to a cooler place* (e.g. a shopping mall, community centre or local library) ($M=3.77$, $SD=1.37$), *reducing meal preparation time* ($M=3.76$, $SD=1.14$), *spending more time in the workplace because it is cooler/air-conditioned* ($M=3.74$, $SD=1.3$), *spending more time working from home* ($M=3.74$, $SD=1.19$), *going to a swimming pool* ($M=3.67$, $SD=1.33$), *changing sleep time* ($M=3.61$, $SD=1.17$), and *going to friends' or relatives' house* ($M=3.53$, $SD=1.33$). The least used strategy by the respondents was leaving children, adult(s) and pet(s) in the car with air-conditioning running ($M=1.24$, $SD=0.74$).

4.3.2 Technological adjustment

A list of eight strategies was included in the Technological Adjustment component (see Table 12). Out of these eight strategies, two exceeded a mean score of 4.5, which implies that these strategies were most frequently used by respondents. The strategy with the highest mean score was *using ceiling or pedestal fan at home* ($M=4.79$, $SD=1.28$) followed by *closing indoor blinds and curtains to keep the sun out* ($M=4.71$, $SD=1.19$). Further, two strategies had a mean score of 4: these strategies were used occasionally. The strategies were *sitting in the car with the air-conditioning on* ($M=4.04$, $SD=1.31$) and *using an air-conditioner at home* ($M=4.00$, $SD=1.55$).

Table 12 also illustrates that there are a number of strategies within the Technological adjustment component which were rarely used; for example, *using shade cloths, awnings or external blinds* ($M=3.73$, $SD=1.62$), *increasing air circulation by leaving a window or door open* ($M=3.44$, $SD=1.94$), and *using a portable cooler at home* ($M=3.38$, $SD=1.78$). *Using an air diffuser to keep calm or relieve stress* ($M=3.19$, $SD=1.66$) was the least frequently used strategy for coping with heatwaves.

Table 12 Summary table of adaptation measures

No.	Statements	Adaptation Victoria	
		<i>M</i>	<i>SD</i>
Personal adjustment			
1	Planning day in a way that reduces exposure to the heatwave	4.4	1.08
2	Staying at home during heatwaves	4.24	1.06
3	Avoiding physical activities (e.g. workout, exercise, strenuous activity)	4.5	1.02
4	Moving to a cooler room in the house	4.58	0.94
5	Wearing protective clothing (e.g. hat, sunglasses) when going out	4.62	1.06
6	Avoiding alcohol consumption during heatwaves	4.88	1.14
7	Changing drinking habits by avoiding hot drinks	4.51	1
8	Drinking more water to keep hydrated	4.81	1.05
9	Changing eating habits by avoiding hot meals	4.46	1
10	Spending less time in the car during heatwaves	4.52	0.97
11	Taking a frequent shower to keep your body cool	4.36	1
12	Using cold water splash to keep body cool	4.61	1.05
13	Placing a wet cloth on face or neck to cool down	4	1.29
14	Wearing more relaxed clothes	4.41	1.04
21	Going to a cooler place (e.g. a shopping mall, community centre or local library)	3.77	1.37
22	Going to friends' or relatives' house	3.53	1.33
23	Going to a swimming pool	3.67	1.33
24	Spending more time in the workplace because it is cooler/air-conditioned	3.74	1.3
25	Spending more time working from home	3.74	1.19
26	Changing appointments	3.84	1.16
29	Avoiding cooking	3.84	1.19
30	Reducing meal preparation time	3.76	1.14
31	Changing sleep time	3.61	1.17
32	Leaving kid (s), adult (s) and/or pet (s) in the car with air-conditioning running	1.24	0.74
33	Checking on others (family/relatives / friends/ neighbours) to offer help	3.92	1.1
Technological adjustment			
15	Using an air conditioner at home	4	1.55
16	Using a portable cooler at home	3.38	1.78
17	Using ceiling or pedestal fan at home	4.79	1.28
18	Increasing air circulation by leaving a window or door open	3.44	1.94
19	Using shade cloths, awnings, or external blinds	3.73	1.62
20	Closing indoor blinds and curtains to keep the sun out	4.71	1.19
27	Sitting in the car with the air-conditioning on	4.04	1.31
28	Using an air diffuser to keep calm or relieve stress	3.19	1.66

4.3.3 Demographic variables influencing participants' usage of adaptation strategies

In order to examine the influence of demographic variables on strategies to cope with heatwaves, t-test and several one-way between-groups ANOVA with post-hoc comparisons using Tukey HDS were utilised. The results indicate significant difference on the usage of

heatwave adaptation strategies based on participants' age ($F(5, 385) = 2.46, P = .03$), employment status ($F(7, 384) = 2.78, P = .00$) and family size ($F(6, 385) = 2.90, P = .00$). A more comprehensive interpretation of these results can be found in Appendix 9b.

4.4 Challenges to heatwave adaptation

To examine the major barriers towards the implementation of heatwave adaptation strategies, an 11 item six-point Likert-type scale (Challenges towards heatwave adaptation) was used (Figure 14). Responses between 'Agree somewhat (4)' to 'Strongly agree (6)' indicate participants' agreement with stated heatwave adaptation challenges.

The mean scores (Table 13) show that there are three key challenges towards heatwave adaptation, including energy bills (item 1), participants' age (item 3 & 4) and underlying health problems (item 5). While survey data showed that 'the costs of energy consumption' ($M=5.31, SD=1.06$) is the a primary barrier to heatwave adaptation, 'Cultural or religious norms do not allow people to wear light and cool clothes ($M= 4.89, SD=0.97$)' and 'Houses without built-in cooling technology ($M=4.84, SD=0.97$)' were also referred to as significant barriers to heatwave adaptation. The survey respondents also agreed 'language ($M=4.50, SD=1.23$)' and 'the different nature of heatwaves ($M=4.79, SD=1.03$)' were major barriers to heatwave adaptations (Table 13).

Table 13 Mean table of challenges to adaptation

No.	Statement	<i>M</i>	<i>SD</i>
1.	The costs of energy consumption	5.31	1.06
2.	Cultural or religious norms do not allow people to wear light and cool clothes	4.89	0.97
3.	Older people are the most vulnerable group	5.15	0.86
4.	Children are the most vulnerable group	5.22	0.81
5.	Underlying health problems	5.05	0.91
6.	The different nature of heatwaves	4.79	1.03
7.	Language	4.50	1.23
8.	Houses without built-in cooling technology	4.84	0.97
9.	Pensioners or people with low income are vulnerable	4.75	0.89
10.	People with mobility issues have trouble reaching a cooler	4.70	0.95
11.	My work requires me to spend time in direct sunlight or outdoors	2.76	1.50

4.5 Cultural factors that shape adaptation

The study sought to explore whether migrants' cultural factors and prior knowledge of heatwave adaptation in the country of origin help them cope with heatwaves in Australia. It also sought to explore whether culturally informed methods of heatwave adaptation would enable them to deal with heatwaves. The questionnaire aimed to explore cultural factors around heatwave adaptation using a Cultural Beliefs towards heatwave adaptation (CBHA) measure. A six-point Likert scale ranging from strongly agree (6) to strongly disagree (1) was used to determine self-reported beliefs towards heatwave adaptation (Figure 14).

The 7-item questionnaire covered a variety of statements related to cultural factors. For example, to measure cultural values to heatwave adaptation, participants were asked to rate their agreement /disagreement with an item "My cultural values help me adapt to extreme weather". Similarly, their beliefs towards context-specific previous heatwave experience were assessed by the statement, "My previous experience of heat in Bangladesh helps me cope with hot weather in Victoria".

Table 14 shows the distribution of their responses to these questions. The results demonstrate that the majority of participants (54.5%) strongly agree that their cultural values help them adapt to heatwaves in Australia. Most participants (92.1%) responded that they are accustomed to environmental risks (item 2) and have learnt adaptation strategies to cope with heatwaves (item 3) (90.1%) in Bangladesh. They also indicated that their previous experience of heat in Bangladesh helped them cope with heatwaves in Victoria (agree=41.7% & strongly agree=22.6%). More than 92% of respondents further classified the 'Victorian heatwaves', as "worse heatwaves" than the heatwaves they experienced in Bangladesh.

Table 14 Cultural beliefs towards heatwave adaptation

No	Statements	Strongly disagree	Disagree	Disagree somewhat	Agree Somewhat	Agree	Strongly agree
		Percentage (%)					
1	My cultural values help me adapt to extreme weather	1.3	6.1	6.1	15.0	17.0	54.5
2	As a Bangladeshi, I am accustomed to environmental risk; this enables me to adapt to heatwaves	1.0	3.3	3.6	27.0	51.9	13.2
3	I learnt adaptation strategies to cope with heatwaves in Bangladesh	1.3	1.3	7.1	31.8	33.8	24.4
4	My previous experience of heat in Bangladesh helps me cope with hot weather in Victoria	1.5	1.8	6.6	25.7	41.7	22.6
5	I believe it is harder for migrants to cope with heatwaves in Australia than it is for non-migrants	2.5	2.0	8.1	22.4	33.8	30.5
6	I believe heatwaves in Australia are worse than they are in Bangladesh	1.0	2.3	4.6	21.9	33.3	36.9
7	In Bangladesh, we helped each other by sharing our knowledge and experience of heatwave adaptation	2.0	3.6	6.4	26.2	35.6	26.2

4.6 Comparison of the usage of adaptation strategies

To investigate the frequency of the usage of adaptation strategies the respondents used in Bangladesh and Victoria, the ‘Previous Heatwave Adaptation Strategies [HAS]’ scale was used. This is a six-point Likert-type scale, where all the items are reiterated from the Heatwave Adaptation Strategies [HAS] scale. The purpose was to compare adaptation practices between Bangladesh and Victoria.

The results show that participants used various strategies of heatwave adaptation before migrating to Victoria (See Appendix 9c Adaptation comparison). However, the frequency of use of those strategies varied between the two contexts. Therefore, based on higher *Mean differences (1 or above)*, a further analysis using Chi-square (χ^2) tests was conducted showing a statistically significant difference between six adaptation strategies (Table 15).

Table 15 comparison of adaptation strategies between Bangladesh and Victoria

No	Statements	Bangladesh	Victoria	Mean difference	χ^2	P
		M	M			
20	Closing indoor blinds and curtains to keep the sun out	3.12	4.7	1.58	52.03	.001
27	Sitting in the car with the air-conditioning on	2.67	4.04	1.37	46.47	.001
15	Using air conditioner at home	2.64	4.01	1.37	107.09	.001
18	Increasing air circulation by leaving a window or door open	4.7	3.45	1.25	112.70	.001
21	Going to a cooler place (e.g. a shopping mall, community centre or local library)	2.57	3.76	1.19	124.76	.001
23	Going to a swimming pool	2.51	3.66	1.15	137.53	.001

The scores of *Closing indoor blinds and curtains to keep the sun out* ($\chi^2= 52.03$, $P < .001$), *Sitting in the car with the air-conditioning on* ($\chi^2= 46.47$, $P < .001$), *Using air conditioner at home* ($\chi^2= 107.09$, $P < .001$), *Going to a cooler place* ($\chi^2= 124.78$, $P < .001$) and *Going to a swimming pool* ($\chi^2= 137.53$, $P < .001$) show that these strategies were used more in Victoria than in Bangladesh. In contrast, *increasing air circulation by leaving a window or door open* ($\chi^2= 112.70$, $P < .001$) was found to be used more in Bangladesh than in Victoria.

There are six adaptation strategies (items 6, 8, 11, 12, 17 and 18), which participants used occasionally to very frequently to adapt to heatwaves both in Bangladesh and Australia. For example, ‘*Using ceiling or pedestal fan at home*’ (M=5.12, SD=1.35), ‘*Increasing air circulation by leaving a window or door open*’ (M=4.70, SD=1.70), ‘*avoiding alcohol consumption during heatwaves*’ (M=4.36, SD=1.56), ‘*Drinking more water to keep hydrated*’

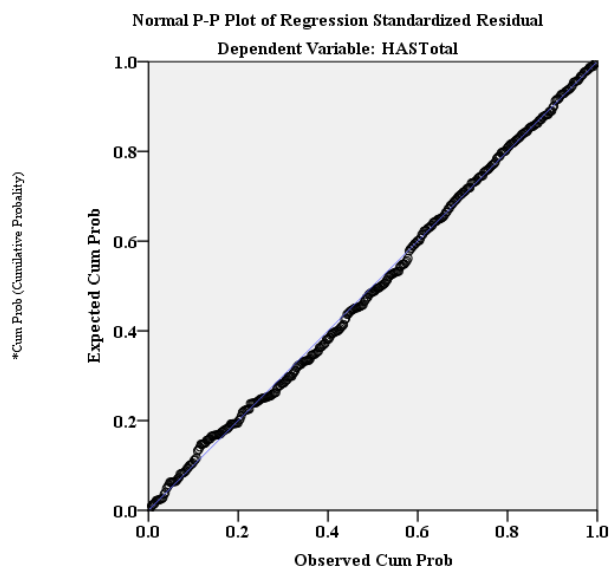
(M=4.21, SD=1.43), *Using cold water splash to keep your body cool* (M=4.10, SD=1.31) and *Taking a frequent shower to keep your body cool* (M=4.03, SD=1.33).

4.7 Predictors of adaptation to heatwaves

The final objective of the study was to identify the factors influencing respondents' adaptation practices to heatwaves in Victoria. The composite score of 'Heatwave adaptation strategies (HAS)' in Victoria was the outcome variable, while composite scores of heatwave risk perception (HRP) and previous (used in Bangladesh) heatwave adaptation strategies (PHAS) were considered as predictor variables.

The Pearson product-moment correlation coefficient test was used to describe the strength and relationship between the variables (HRP and PHAS) and HAS in Victoria as a prerequisite to perform hierarchical multiple linear regression. The results revealed that there were positive correlations between respondents' perceived heatwave risks and adaptation strategies in Victoria ($r=.230$, $n=392$, $p < 0.005$), and PHAS in Bangladesh and HAS in Victoria ($r=.355$, $n=390$, $p < 0.005$). Preliminary analyses were conducted to ensure no violation of assumptions of normality and linearity for HAS (Figure 19).

Figure 19 Normal P-P Plot of Regression Standardized Residual



The stepwise hierarchical multiple linear regression analysis was utilized to predict the influencing factors of HAS using the enter method (Table 16). The analysis was carried out in two steps. In Step 1, the predictability of HRP and PHAS variables were measured for HAS in Victoria. In step 2, demographic variables were added to the equation.

Results of the Step 1 analysis revealed that both HRP ($\beta= 0.197, SE=0.059, p < 0.001$) and PHAS ($\beta= 0.317, SE=0.036, p < 0.001$) variables were found to be significant predictors of HAS in Victoria. Together they accounted for 15.3% of the variance in participants' adaptation practices (HAS) in Victoria ($R^2= 0.153, F(1, 384) = 34.59, p < 0.001$). After adding demographic variables in Step 2, the result showed a slight increase (2%) in the explained variance (17.1%, $R^2= 0.171, F(3, 378) = 9.74, p < 0.001$). The results signify that migrant communities' heatwave risk perceptions and their previous practices of heatwave adaptation have a statistically significant influence on their adaptations practices in Victoria, more so than their current experiences during heatwaves and hot weather in Australia.

Table 16 Predictors of participants' adaptability

Model	B	SE	β	P***
Step 1				.000
(Constant)	76.807	7.618		
HRP total	.245	.059	.197	.000
PHAS total	.239	.036	.317	.000
Step 2				.000
(Constant)	77.557	9.682		.000
PHAS total	.250	.038	.331	.000
HRP total	.234	.059	.189	.000
Gender	-.483	1.797	-.013	.788
Age	-.284	1.073	-.018	.792
Education	-1.253	1.062	-.058	.238
Employment	-.273	.424	-.032	.521
Years of living in Vic.	1.850	.958	.136	.045
Family composition	-1.227	1.031	.331	.235

Note:

- *Dependent Variable: HAS Total (Constant)*
- *Standard Error (SE)*
- **** $p < .001$*
- *Heatwave Risk perception (HRP)*
- *Previous Heatwave Adaptation Strategies (PHAS) in Bangladesh*
- *Heatwave adaptation strategies (HAS) in Victoria*

Among the demographic variables measured, only *years of living in Victoria* ($\beta=0.136$, $SE=0.958$, $p < 0.05$) was found to be a statistically significant predictor of adaptation practices in Victoria. This result implies that respondents who have been living in Victoria for a longer period are likely to practise more adaptation strategies during heatwaves compared to those who have been living in Victoria for a shorter period.

Chapter 5

Understanding pre- and post-migration heatwave experience

This chapter presents and analyses the qualitative findings of the study, beginning with the demographic profile of the participants. The hybrid thematic analysis method is used to identify the themes depending on the nature of data and research questions. Six major themes emerged: (i) understanding of the intensity of temperature, (ii) burden of heatwaves on migrants, (iii) coping measures, (iv) information accessibility and awareness, (v) cultural beliefs and (vi) house occupancy patterns and thermal adaptation. The subthemes that emerged from the data are also presented where necessary. Participants' quotes, along with their observations, are used to reflect on the themes.

5.1 Demographic profile of the interviewees

The age of the participants (n=20) ranges from 30 years to 55 years. Eight participants have been living in Victoria for 6 to 10 years (n=8), followed by 1 to 4 years (n=7) and 11 to 15 years (n=5). Most of the participants migrated to Victoria for higher education, job, and living with family. Out of twenty (20) participants, nineteen (19) were in a couple living with children. In terms of gender, 11 were females, and 9 were males. The majority of the interviewees (n=13) were living in a rented house, while others (n=8) owned a house. The following table (Table 17) summarises the demographic information of the interviewees. Pseudonyms are used to quote and denote the statements of the interviewees (Table 17).

Table 17 Demographic details of the interviewees

Pseudonyms	Gender	Age	Years of living in Victoria	Reason to migrate	Family Composition	Housing Tenure Type
Haque	Male	39	3	Spouse	Couple with children	Rented
Hasan	Male	45	6	Job	Couple with children	Owned
Jane	Female	47	12	Study (PhD)	Couple with children	Owned
Jani	Female	42	11	Spouse	Couple with children	Owned
Jasmine	Female	38	10	Study	Couple with children	Owned
Jewel	Male	46	10	Educational opportunities	Couple with children	Rented
Joya	Female	46	7	Family	Couple with children	Owned
Lily	Female	30	7	For her job & her child's education	Couple with children	Rented
Lina	Female	40	7	Spouse	Couple with children	Rented
Mark	Male	43	4	For family	Couple with children	Rented
Mira	Female	45	11	Family	Couple with children	Owned
Nora	Female	36	3	Study	Couple with children	Rented
Pam	Female	41	4	For a better life & better living	Couple with children	Rented
Rajib	Male	42	7	Study	Couple with children	Rented
Ratish	Male	37	1	Job	Couple with children	Rented
Riad	Male	47	15	Job	Couple with children	Owned
Roza	Female	44	7	Spouse	Couple with children	Rented
Saha	Female	31	1	Job & family	Couple with children	Rented
Sakib	Male	53	12	Family	Extended family	Rented
Shabib	Male	32	2	Study & job	Couple	Rented

5.2 Understanding the intensity of temperature

Having a preliminary perception and understating of heatwaves based on their pre- and post-migration experience, this migrant community shared a wider range of knowledge on heatwaves and adaptation responses. As a tropical country, the nature of heatwaves in Bangladesh is different from that in Victoria, Australia, especially considering the level of humidity. The participants pointed out that it is very common in Bangladesh that the temperature goes down in the afternoon and does not affect their health or daily activities much, even when the temperature reaches more than 35 degree Celsius. Some participants argued that heatwaves are predictable in Bangladesh. Sharing re-called memories, a participant described that:

In my childhood (laughing), I saw those workers who used to work in the summer. After 12 pm, when the weather became extremely hot, they came home or spent two to three hours in the shade of a tree. When the temperature decreases, they started to work again in the afternoon. But the problem here [Victoria] is that the temperature changes very quickly, it is very fluctuating, while in Bangladesh, the temperature is quite predictable. After 2 pm, the temperature gradually decreases. But here in Australia, sometimes in afternoon temperature suddenly rises high... (Rajib)

Referring to the nature of heatwaves in Bangladesh, some participants shared that they did not feel a headache, vomit, or experience heat-stroke (Rajib, Jane & Joya). One woman shared her experience as:

Even though I stayed in a hot country [Bangladesh], I did not understand the concept of the heatwave before. When I came here realised that the extreme temperatures are harmful. (Jasmine)

When participants were asked to talk about their experience of current heatwaves in Australia, they expressed concern: *'It [heatwave] is a matter of concern!'*. Since they have migrated to Australia, they have observed gradual changes in the local weather (Victoria's weather) patterns as stated by the participants. Several participants expressed fears about

increasing trends of extended periods of hot weather by comparing the intense nature of heatwaves in each year in Australia. One participant said:

...it is not too difficult for me to feel the difference in the nature of heatwaves as I have experienced a number of heatwave events in my childhood in Bangladesh. And I have been experiencing it here in since 2012. (Rajib)

Participants seemed concerned about the trend of increasing heatwaves while they were talking about the severity of heatwave impacts on their life and livelihood. Sharing their understandings on the 'trends increasing of temperature' in Australia, the participants used various terms which were likely to be based on their experience and observation on heatwaves in Victoria, such as 'day-to-day temperature increase', 'difference between real and predicted weather', 'intensity or severity of the temperature (*TIBRO GARAM*¹⁹)' and 'extreme (*BOIRI*²⁰) weather'. A person who has been residing in Victoria for seven years observed shifts in temperature fluctuations through studying weather prediction variations, which she defined as follows:

In my seven years' experience, the weather forecast proved to be accurate almost every time; even the hourly predictions did not go wrong. But recently, I have noticed that the real weather to be different from the predicted one in the weather forecast. I do not know why this is happening. (Lina)

Compared to the nature of heatwaves in both countries, nearly all participants agreed that there are significant differences in heatwave patterns and their intensities. In Bangladesh, participants had never experienced the combination of dry and hot weather that they have experienced during the Victorian heatwaves. The members of this community have also explained that heatwaves in Victoria are 'suffocating' and 'intolerable', and are described by the participants as follows:

¹⁹ *TIBRO GARAM* (Bengali words)

²⁰ *BOIRI* (Bengali words)

I find this heat different from the one we experienced in Bangladesh. In Bangladesh, one can stand under the sun for a few moments if anyone needs to. It wasn't too intolerable there, because it didn't feel like burning my skin. But here it is impossible to stand under the sun... the intensity of the heatwaves is severe. (Nora)

While they experienced excessive sweating in Bangladesh during heatwaves, they feel the weather in Victoria is very dry and burning hot. A participant who has been living in Victoria for two years stated: "*It is entirely different, you can feel the sunburn here if you just stand under the sunlight for 5 minutes and it is very extreme here*" (Ratish). The varying and unpredictable nature of the heatwaves was also recognised by the participants as one of the major barriers to adaptation for Bangladeshi migrants.

5.3 The burden of heatwaves on migrants

The burden of heatwaves is narrated by five subthemes such as physical discomfort and exhaustion, burden on income, burnt and shrunk vegetable patch, lack of sound sleep, and difficulty in accessing public transport (PT) services.

5.3.1 Physical discomfort and exhaustion

Most interviewees said the excessive hot temperature resulted in numerous health-related issues, which were likely to have severe impacts on their daily life. The following list identifies the most common health problems that members of this community attributed to heat-health experience: headache, migraine pain, mood change, weakness, lack of concentration, skin burns and irritated skin, irritable moods, conditions, heat-stroke, dehydration, hypertension, skin rash, faintness and dizziness, physical weakness, and vomiting.

Some of them mentioned that they experienced severe health impacts during heatwaves due to their underlying health conditions, including diabetes, heart disease and other heart-related

conditions and kidney conditions. People indicated that the health impacts of heatwaves became more serious as they got older. Jane, a 47-year-old female participant with some underlying health problems, articulated that:

Whenever the temperature goes above 35 degrees, I face heaps of health problems...as I have diabetes and high BP [blood pressure]. I feel headaches, mood changes, I often get worried at small matters, vomiting etc. I feel so much weak, and I cannot even concentrate. (Jane)

Exhaustion, continuous discomfort, irritable mood and disoriented feeling are also very common among the participants during the heatwaves. As a result, physical discomfort lasts longer than usual. One participant said:

The discomfort does not go away, even after coming home... I do not think that only the changing routine is linked with the exhaustion... though the home environment remains cool, the feelings of physical discomfort last long. (Roza)

Describing the physical health impact due to heatwaves another participant articulated:

Though the heatwave lasts for a short time; it should be handled more carefully. The youth can still manage the problems they face, but those who are sick or around 40, 50 years²¹ old or more often faint or may fall ill very quickly. (Joya).

While the participants appeared to be experiencing several health problems during heatwaves in Australia, they shared that the health problems were not too extreme in Bangladesh compared to what they were experiencing in Victoria. The majority of the participants stated that in Bangladesh, the most common heat-health problems they had faced included headache and dehydration due to excessive sweating.

Although the majority of participants felt very uncomfortable and disoriented during heatwaves in Victoria, a few said that they preferred hot weather to cold weather. Both

²¹Considering the life expectancy of Bangladeshis 40/50 years old is recognised as the early stages of old age. The average life expectancy of the people of Bangladesh is 72.3 years (source: <https://www.dhakatribune.com/bangladesh/2019/06/12/average-life-expectancy-of-bangladeshis-rises-to-72-3>)

female participants who have been living here for ten years (Jasmine) and one year (Saha) respectively described:

Considering everything, the weather is very comfortable. We need to do some changes in our lifestyle. If we make a comparison, it is far better than in many countries in the world. (Jasmine)

When the cold was gradually transforming into hot summer days, I found the weather more comfortable than...everyone told me that the heat is intolerable, but I felt better about the heat than the cold. (Saha)

Even though these participants had different perceptions of heatwaves, Jasmine also emphasised that changes in daily routines are essential. Saha, who has been living in Melbourne for only one year, had a different feeling; she regards *'heat better than the cold'*. Perhaps Saha considered hot weather more comfortable than the cold because she has passed just one summer in Victoria and has not adjusted to the Victorian cold weather. This indicates that how people perceive and experience heatwaves in a new geographical location may also be affected by their place-attachment and the duration they are living in a specific location. Therefore, it seems that the longer people live in a place, the better they adjust to local weather.

5.3.2 Burden on income

The cost of energy consumption was a major barrier to heatwave adaptation, especially those with low socioeconomic status (SES) and inadequate housing facilities. Substantial financial impacts during hot conditions include expenses on buying cooling devices, reduced working hours due to changes in sleep routine or health conditions, extra fuel costs due to high use of car air-conditioners, less work productivity for outside workers and loss of working hours due to service disruptions. The increase in electricity bills has a

significant impact on household income, especially for people of low SES. For example, one participant shared his observation of the changes in the electricity bill as:

Over the last six months, I am feeling this. For example, just a year back, I paid \$84 per month, whereas now I have to pay \$150 or more. The electricity bill has increased drastically, but there is no increase in our income. So, attention should be paid on it. Sometimes, I just keep the AC (air conditioner) on to cool the room down, and once the temperature becomes comfortable, I turn the AC off so that the AC may not consume more energy. This has an impact on our lives. (Jewel)

Due to the high use of electricity, gas, and water during heatwaves, members of this community emphasised that extra utility bills placed extra economic pressure on them. One female participant (*Mira*) described that she was worried about the water bill as she had to spray water in her garden three to four times a day to protect her plants from heat. The following quotes were typical expressions of their frustrations about these impacts:

As the energy bills increases during that time, we need to balance cost and usage. That is really a burden. (Riad)

I think the government should think about giving subsidies in the energy sector and making these electronic devices more energy efficient, though it requires long-term planning...Now I think subsidy should be provided on energy consumption, at least during the two months of summer for everyone. (Haque)

One participant further indicated that the level of income has a connection with how people are impacted by the negative consequences of heatwaves (*Hasan*). Heatwaves have more impacts on vulnerable groups in the population, especially senior citizens, and pensioners. A participant (*Pam*) who works in a city council office shared her experience with working with aged people during heatwaves:

The senior citizens and pensioners are lonely and more vulnerable to the adversities of a heatwave. Some of them cannot even afford an AC (air conditioner). So, I think the government should do something for them, for example, give subsidies in terms of using coolers, AC etc...we are often encouraged by the Department of Health to go to shopping malls during heatwaves if we do not have AC in our houses. The seniors have

to do so as well. However, they have to go there by public transport, which is also suffering for them. I wonder if many deaths of the senior citizens are linked with extreme heat-related health complications. (Pam)

Several participants also shared that financial instability occurs when outdoor work remains suspended during extremely hot weather. That financial insecurity may also turn into additional mental stress for people engaged in outdoor work. Hasan added that the family of his friend who was working as a construction worker had to go through a huge financial crisis during heatwaves in 2018. He described the scenario as follows:

It is a major concern for those who work outside. People working outside, especially in construction sights certainly faces a lot of difficulties... last year (2018) one of my friends was working with a construction company. He had a serious heat-stroke, luckily, he survived...that was a terrible time for all of us, especially for his family. (Hasan)

The majority of participants also showed their concern about people who are working outside, especially in fruit and vegetables wholesale markets and the construction sector.

Another participant described it this way:

It is a big issue for those who work outdoor... some works are postponed due to excessive heat. This causes grave misery for them who work for hourly payment. Their financial condition deteriorates. But their employers do not pay any compensation for that. I think this discontinuity in work is due to extreme weather. (Haque)

Thus, the result indicates that outdoor workers experienced several challenges in their life during heatwaves, especially casual workers.

5.3.3 Burnt and shrunk vegetable patch

The majority (both the renters and owners) of interviewees showed their passion and love for growing vegetables in their backyard. The participants reported that one of the major impacts of heatwaves is on their garden health. One female participant expressed it in the following way:

...the plants get damaged and burnt because of extreme heat. Last year, the tender leaves of the Gourd plant I planted got burnt and shrunk like an aluminium foil, this hurt me badly. That was a new plant, and I didn't know how to save it. These things are painful. (Joya)

Likewise, impacts on the backyard garden or little veggie patch were considered a major effect of heatwaves by the participants. Moving from the garden health, the next section considers the impact of heatwaves on physical health.

5.3.4 Lack of sound sleep

Changes in daily activities are very common during heatwaves, for example, sleep routines change, avoiding travel and avoiding some recreational activities. Several participants argued that the changes in sleep routine or disruptions in sleep have a great impact on their work schedule, and to some extent on health and economy. For example, one participant expressed her frustration:

I cannot have a sound sleep at night due to the heatwave, and sometimes I can't even sleep until the environment becomes cool. As it impacts on sleep, it affects the next day's working schedule. Many of my friends also share the same feelings as me. (Jane)

Other participants said that due to the routine changes, often they reduced their expectations on work productivity or cancelled their work, which impacted on their income (especially Jane, Joya & Pam). These participants were involved in casual and part-time work in a retail shop, training institute and call centre respectively.

5.3.5 Difficulties accessing Public Transport (PT) services

Travel time and distance were another concerning aspect for the participants during heatwaves. Most participants argued that the public transport timetable usually varies a lot during hot days. However, they felt that inside the train and tram, the temperature is much

more comfortable than buses. One participant shared that the temperature inside buses is uncomfortable and suffocating during peak hours (Joya). Other examples include:

During the extremely hot days ...if I want to travel by public transport, it becomes very difficult, due to the disruptions in public transports schedule and distance to access PT (public transport) station (Stop). (Rajib)

When we have to change public transport, it becomes tough. For example, I need to hurry towards the bus from the train station as the interval is short and bus services are called cancelled any time. I become stiff; sometimes, I feel sick; I feel a severe headache. (Jane)

The above results present a diverse experience of this migrant community during heatwaves. The following analysis focuses on the adaptation practices by the participants based on their pre- and post-migration experiences to cope with heatwaves.

5.4 Coping measures

Based on commonalities and differences of the heatwaves coping strategies used by the participants in two different countries and times, the theme is divided into two sub-themes: pre-migration practices and post-migration practices.

5.4.1 Pre-migration practices

According to the interview data, this community has learnt a number of strategies to adapt to heatwaves before migrating here. In Bangladesh, using or having an air-conditioner (AC) is not widely expected. However, there are many strategies that the participants used to apply to cope with heatwaves in Bangladesh. One participant stated that:

Not every house has AC, so we used to take a shower at least twice a day, occasionally even thrice. We used to sit in the terrace on a mat before sleeping, sleep on the terrace, sleep in balcony using a mosquito-net as the home environment seemed stuffy. But it was ok...that are memories. (Joya)

Likewise, almost every participant re-called at least two to three strategies that they had used in Bangladesh, some of which they have used to adapt to heatwaves in Victoria.

Previous approaches and practices to heatwave adaptation in Bangladesh included:

- Using ceiling and pedestal fans
- Taking an umbrella while going out
- Sleeping on a mat on the terrace during the night
- Drinking more water including homemade juice or lemonade
- Avoiding alcohol
- Keeping windows open during the heat to increase air circulation
- Eating more vegetables and fruit during the heatwave
- Avoiding going outside at mid-day
- Avoiding unnecessary outdoor visits
- Sharing information through talking to each other (family, friends, and neighbours)
- Wearing cotton dresses and using cotton bed sheets and bed covers
- Using a bucket of water or wet clothes on the floor
- Taking shelter under a tree
- Washing hands and feet to feel a bit chilled
- Drinking home-made saline that is made with sugar and salt only

Further, while in Bangladesh, they used to follow three rules while they needed to work outside: (i) start their work early in the morning (ii) stay in a shaded place or indoor during mid-day and (iii) finish their work early in the afternoon.

5.4.1 Post-migration practices

To adapt to the heatwaves in Victoria, the members of the community seem to apply several behavioural, technical, and cultural adjustments. The most common strategies include controlling body temperature by changing drinking and eating habits, making changes in daily routines, maintaining indoor temperature, using sunburn protection measures, and trying to gather information regarding heatwaves.

The majority of the participants reported that changing drinking habits and drinking more water are essential strategies to keep their body hydrated and chilled. As part of changing drinking habits, a participant articulated that:

I do not drink alcohol anyways. I drink coffee too much. During these days, I buy iced coffee or iced tea from shops and have them. (Saha).

Saha's statement reflects on both of her drinking habit and the understanding of health problems due to alcohol consumption during heatwaves. Even though this particular community does not appear to be drinking alcohol regularly due to their cultural background, some of the members who are fond of alcohol seem to reduce the frequency of alcohol consumption during heatwaves deliberately. Drinking iced or cold drinks was the most stated technique to adapt to extreme heat. However, a few participants specified that drinking cold drinks could be one of the reasons to get sick quickly. Sharing his experience, Rajib explained:

...what happened the day before yesterday, and I was feeling very sick after drinking cold drinks with ice. But I think, getting cold, throat pain and fever occasionally occurs after drinking too much cold drinks during heatwaves. (Rajib)

Drinking cold water immediately after coming back from outside during a heatwave was considered a reason for getting cold, runny nose, chesty cough, and fever by the participants. Furthermore, participants recommended not drinking cold or icy water or any other drinks immediately after coming back from extremely hot weather as some participants experienced a cold and sore throat if they did so. One participant expressed his perception as follows:

I try to avoid drinking cold water just after coming home. If I do that it can cause sickness. I try to be alert about balancing cold and heat. (Haque)

People also consider their physiological conditions. They shared that understanding one's physiological condition and balancing cold and hot with one's body is essential to be fit and healthy during heatwaves. For example, one participant said that she had a kidney problem with a limit on drinking fluid up to one litre maximum per day (Jane). Hence, she needed to be very careful while changing her drinking habits.

Using ceiling and pedestal fans at home was another common strategy during extreme heat. Even though more than half of participants (n=12) said that they put curtains and awnings down during heatwaves, a number of participants (n=8) expressed that they prefer to keep their window and door open to increase the air circulation. One participant said:

When I come from outside and go home or get in my car, I feel a sudden headache... the doctor identified excessive heat to be the reason. That happened last Thursday. When the windows of the home and the car are closed, the temperature increases inside, that cannot be tolerated easily by normal people. Those who are born here may find it easier, but this is very tough for us... (Mira)

A good number of participants preferred not to keep their doors and windows open, as they thought it might cause some health problems. Keeping the window or doors open to increase air circulation is a technique they used to adapt to the heat in Bangladesh. However, residents in Australia are advised not to keep the doors or windows open when the air is very hot outside. In addition to these adaptation strategies, two interviewees shared two new techniques, namely putting a bowl of icy water in front of pedestal fan and putting ice cubes in the bathtub:

I used to use the pedestal fan and a bowl of icy water in front of the fan to make the room cooler. I use this here also. I place cold water or sometimes a bowl of ice cubes. (Lily)

Another female participant shared that one of her friends, who did not have air-conditioning facilities at home, sometimes came to her place during the extreme heatwave and used a few techniques at her home. The participant said:

I have also heard that my friend had to turn on the AC of her car and stay inside as it is too hot outside as well as her house. She also shared to me that sometimes she put ice cubes in the bathtub to keep their houses cool. (Jani)

Further, planning for the day was also found to be another good way to adapt to heatwaves. One participant highlighted the importance of planning their day around heatwaves:

...based on my experience we shouldn't go out frequently during hot days, planning for the day is essential. (Jane)

Moreover, using an umbrella for shade when outdoors was another strategy to adapt to heatwaves used by several participants (i.e. Joya, Saha, Lina, Jewel, Mark, Haque). During the interviews, participants also shared several opportunities and challenges to adapt to the heatwaves in Victoria.

5.5 Information accessibility and awareness

People's access to information, knowledge, education, and awareness has a significant impact on how they experience and prepare for heatwaves. Participants shared their experience regarding available information about heatwaves and their consequences from TV news, newspapers, mobile apps and radio. Most participants appeared to have limited awareness of the adverse conditions due to the extended period of hot weather; what they need to do in such circumstances, and the second-order risks of heatwave exposure. One female participant, who has been living here for 12 years, stated that:

I know about extreme weather information or alerts. But what is the importance of these alerts? ... the various social programs from the councils should be stating about the adverse impacts on our family, environment and our health in a convenient, accessible and inclusive manner. (Jane)

Some participants said that they know there are some negative consequences of heatwaves, however they are not well informed about the depth and consequences of the problem. Another participant (Rajib), who was working as a health researcher, stated:

I believe many migrated people do not even know about all these incidents...they need clear knowledge about the heatwave and its consequences. Once I saw some slides in a workshop, and I noticed heatwaves dealing strategies there. Then I came to know about this in detail...Australians know a lot about heatwaves. I have seen that when there is any chance, they leave the office early during heatwaves, but Bangladeshis are not concerned about the depth and consequences of the problem. (Rajib)

Several participants also mentioned that city councils across Melbourne have some specific programs regarding heatwaves. They believe that if they get the information regarding heat-health consequences and different scientific strategies on how people can make their home or work environment more adaptive in such a hot condition, this could reduce vulnerability to heatwaves. A community member put his ideas in this way:

I think the local city council and the hospitals can jointly arrange an awareness program addressing the health issues during heatwaves (Jewel)

Furthermore, another participant stated that:

In the case of adaptation...we are not much exposed to media, so we do not get the information. Firstly, we do not know the approximate time of the heatwave, and secondly, we did not learn the strategies for adaptation the way a non-migrant did since their birth. (Hasan)

Hasan further added that more information on the consequences of heatwaves would help him enrich his existing knowledge and get well prepared for the adverse impacts of heatwaves. Most participants argued that the awareness and wider dissemination of information regarding heatwaves and their consequences are essential to help communities become resilient to heatwaves. One participant who experienced a bushfire very close to her home nearly a week before the interview described the warning messages, its accessibility and importance. She said:

...warning message regarding the heatwaves in the form of a leaflet would have been more beneficial... Five to six days ago there was a red alert in this area due to nearby bushfires. I was terrified on that day since my newborn baby is three months old. I was worried about him during bushfires. I did not understand what to do with the child or

where to go. While there was much information on the internet and the weather apps, sometimes we are unable to follow news and apps information during such a situation, as we get panicked. (Jasmine)

In the following quote, another participant also articulated that immigrants, especially, those who are recently arrived, are not sufficiently aware of the consequences of heatwaves:

I have seen migrants who are new here, and they go outside anytime in a day during heatwave without applying sunscreen. When they come back home, they complain about the skin burn. The thing is as we are used to the heatwave in Bangladesh; differently, we take the temperature or heatwave here very lightly. But, practically, it does not work well. (Nora)

Learning new things to adapt to a different environment is a major challenge to Bangladeshi migrants. Lack of information and knowledge towards heatwave adaptation can make migrants more vulnerable to extreme temperature in the site of their relocation. One participant expressed:

As migrants, we need to learn different strategies. For instance, we did not know the use of awnings, and local people would not face this problem. So, as we migrated here in our adulthood, we have to learn many things on our own which we might not need to do if we get to learn this during our childhood, from our parents. But we didn't face this, only because we were brought up in a different environment. (Hasan)

Despite the fact that using sunscreen is one of the essential techniques to avoid UV exposure and sun-burn during heatwaves, this is not a common practice in Bangladesh; so, this represents a barrier for implementing this practice in Victoria. Most participants said that they usually forget to use sunscreen. One participant uttered boldly:

...almost all of us forget about applying the sunscreen as we are not used to it. (Shabib)

Another participant described the practices by community members in general as:

Some do not understand the importance of using sunscreen and the amount of using it. Some do not know about the requirement of separate sunscreen for babies as well. I think this attitude is a barrier. We do not have enough information. I think information

should be made more available to people. This information can be circulated through buses, trams etc. (Nora)

Thus, education and awareness are essential to reduce adverse impacts during heatwaves. While education is essential for adaptation, the technical language of awareness messages was considered a significant barrier to adaptation. Most participants said that early warnings regarding heatwaves contain mostly technical terms, which are barriers not only for the Bangladeshi migrants but also for other migrants:

Some of them may not have language skills appropriately. If there is English news on television about heatwaves like 'today is Total Fire Ban', and the people do not know the English technical terms, they can still be cooking using fire or even doing barbeque (laugh). This is not only the case for Bangladeshi, but also people coming from other parts of the world...there are some difficult technical terms and Australian accents which are also confusing and difficult to understand sometimes...like if they are using the term (Total Fire Ban), some people may not understand what it even means. (Rajib)

I think that language is a barrier. But if the local media uses visual representation instead of using these technical terms, it will be easier for the migrant communities with extended family members and also family members with special needs to understand the early warnings. (Jewel)

There are also several challenges reported by the participants, such as confusing weather reports, lack of adequate information, and houses without in-built cooling systems. The following quote made by a participant indicates how access to information and mismanagement of transmission of public transport Victoria messages can make people more susceptible to heatwaves:

I would like to share an incident...the temperature rose to 42 degree Celsius in the last week of January, last year (2018), the tram service was suddenly shut. I along with other people, kept waiting at the stoppage for the tram. Three trams crossed us, but they did not stop at the stoppage. They were going inside the depot. We walked 3-4 kilometers under that hot summer sun for a tram. Moreover, there was mismanagement. The first tram driver did not tell us why he was not taking passengers.

Finally, the last driver told us that they were not taking passengers because there was extreme heat outside. (Nora)

Lack of awareness was another barrier to adaptation. Migrants, especially the new migrants, may not be aware of the consequences of heatwaves. The following quotes are examples of participants' views on this issue:

Migrants, who come from Asian countries like us, predict heatwaves differently... In those countries like Bangladesh, the heatwave is not like this... They think it is very normal, it is not a big deal... But as we are staying for two years, we can now guess what can happen in the summer... those who are new and some other people (who has been living here for a long time), and who do not know anything about this, cannot feel the importance of adaptations and consequences of heatwaves exactly. (Jane)

It is deadly... I have never heard that someone has died in the hot summer in Bangladesh due to heat. But many people die in the heatwave in Australia... if there is severe heat, people can think that they may have a sunburn, but they are totally unaware that they can have heat stroke due to extreme heat and this is beyond control. (Rajib)

In general, the interviewees shared their experiences of heatwaves by highlighting their concerns on various aspects of their everyday-life and access to information. The next theme presents participants' accounts of their preparedness for heatwaves as a migrant in Victoria.

5.6 Cultural beliefs: *'We survived on our own'*

Several participants suggested that migrants have a robust psychological ability to survive in extreme conditions in the site of their relocation. While sharing their opportunities, the participants considered their previous knowledge and experiences towards heatwave adaptation as their capacities. One participant explained:

...we the migrants can go to almost every extent to survive. Our adaptation capability is quite good indeed, but need some more education, practice and knowledge in the current context. (Hasan)

Most participants considered migration an opportunity to adapt to circumstances. Some highlighted their ability to survive with extreme heat - '*we survive our own, and we are connected as a community*' - others emphasised migrants' capacities:

I see my cultural background as an opportunity. As Bangladesh is a hot country... to some extent, Bangladeshis are privileged as they are used to hot temperature. (Rajib)

I think the migrants are more positive and strong-minded. They already have that mental preparation to struggle as they are leaving their roots and heading to a new country. (Joya)

Migrants coming from a hot place like Bangladesh have some skills and experience to adapt with heatwaves in Victoria. Several participants stated that they could perceive some of the risks caused by the heatwaves in Victoria as they experienced heatwaves in Bangladesh. Moreover, the interviewees also expressed that length of residence shapes migrants' capacity to adapt to heatwaves.

The participants were asked to discuss their ability to adapt to heatwaves in Victoria. Several participants stated that migrants are adaptive, but they need time to acclimatise to the heatwaves. The majority of participants who had been living in metropolitan Victoria for more than six years stated that their friends and family who have lived here longer are better adapted to extended periods of hot weather. One participant shared her experience in the following way:

Adaptation capability is created slowly when someone stays in a place for a long time...since the heatwave is extreme, there is no problem in normal summer. (Jasmine)

Others shared that for migrants who came here recently, or even a few years ago, it is very hard for them to know about and adjust to heatwaves. It seems that new migrants are more susceptible to heatwaves rather than those who have been living here for a longer time. The following responses are examples of participants' feelings about this aspect of adaptation:

It takes 10, 15 or even 30 years to change the attitudes and habits to adapt to environmental changes; this varies individual to individual according to their ability to cope. Everyone doesn't have the same coping or thinking ability. (Mira)

One needs time to adjust in a different place, different weather...I did not have any idea about the heatwave when I first came here. But after staying here for a while, I got to know different things about it. It is not easy to learn all those things. (Mark)

In addition, some participants argued that the cultural and religious trends to wear long and covered dresses during heatwaves often make it difficult to adapt to the temperature. Generally, Bangladeshi people wear light clothes (e.g. linen, thin cotton fabric), shorts, short-sleeved or sleeveless dresses during hot weather. However, despite being aware of the comfort, many participants, especially women, tended not to wear such clothes due to cultural and religious beliefs. Nora's statement explains her feelings of respect for her culture as follows:

I am habituated wearing full-sleeved dresses. Actually, I started it since my secondary school years in Bangladesh. I don't feel much discomfort with these clothing when it's very hot. But I know my community might get hurt if I wear the typical summer dresses here...it's uncomfortable and sort of hurting my own feeling too, if don't care about my tradition. (Nora)

From a religious point of view, another participant who has been wearing *BORKHA* (A long cover-up dress for Muslim women) for many years said:

I have never found it difficult to wear Borkha in hot temperature. Rather, I think it is better to use Borkha because it covers my body, and I don't get a sunburn. (Jani)

Even though the adaptability varies from individual to individual, migrants like Bangladeshis appeared to have some capacities to adapt to heatwaves in Victoria. Especially their 'can do' attitude and the acceptance of new changes seem to enable them to cope with the new environment. At the same time, there are some social, environmental and economic challenges to heatwave adaptation. The following part of this analysis presents the relationship between tenancy status (owner & renter) and heatwave adaptation.

5.7 House occupancy patterns and thermal adaptation: some insights

The above analysis indicates that economic conditions, employment type and status, access to information and duration of residency in Australia significantly impact adaptability to heatwaves in Australia. The Australian housing systems and residents' tenancy status was also found to have a considerable contribution to people's vulnerability or ability to adapt to heatwaves. In Victoria, new houses are equipped with air conditioners and weather-appropriate insulation systems. The reflective foil insulation is widely used in new homes. However, older houses may not have upgraded insulation or ventilation systems. Participants who live in older rented house said that it was very difficult to stay in their home during heatwaves. One participant noted *'there are no such facilities of insulation. As it is near the University, the house owner is getting rent without any investment, and there is no such monitoring or fair assessment process'* (Rajib). Another participant who recently purchased a new house, and moved from her rented property, shared her experience with rented accommodation:

I remember an incident from 2009 heatwave, which is known as the Black Saturday now. My husband called and told me that it is going to be very hot that day, and unfortunately, many bush fires already took place. He told me not to stay home as there was no AC or good insulation system, and the house was old...the house got very hot in normal day hot days. I clearly remember that day, and I had to go to my relative's house. (Mira)

The insulation system of a house is essential to cope with the radiant heat. Poor or low thermal rating makes people more vulnerable to heatwaves. Some participants indicated that this needs to be monitored and assessed, particularly for rental properties. One participant said:

Awareness-raising is important. But monitoring and assessing the insulation system is more significant in respond to heatwave impacts... the government should take care of

the insulation system of every house, especially for renting houses and the old houses, where the insulation system is very poor. (Sakib)

People with low SES may have more difficulties, especially when they live in a rented house due to economic constraints. Participants described it as:

Those who have low income and cannot afford AC faces many problems. Especially, those who live in a rented house if their landlords do not arrange AC and the tenants cannot do it as well. (Jani).

Other participants stated that as a tenant, they could not report problems to the Residential Tenancies Bond Authority (RTBA) or Housing Victoria, as the process contains a lot of documentation and communication barriers. Referring to a conversation with her property manager during a regular inspection, a participant shared that there was no viable option to report them. She noted:

We have been living here for four years. The house is quite old, and the insulation system doesn't work well to reflect the heat. There is no air conditioner, as well. I requested the property manager to take a further step. But she refused and told me to use a portable cooler and suggested me to find another house alternatively. (Lina)

Another participant (Sakib) said that home insulation is a key factor for coping with extended hot weather. He shared his experience:

I do not remember exactly, but three or four years ago the temperature raised around forty-seven degree Celsius, insulation system of our house was not well (rented house). So, we suffered a lot that day; we moved to a shopping mall for safety. But after 5pm we had to come back home as the shopping mall closed. It was a very tough time. (Sakib)

Migrants living in rented houses are not allowed to make any changes to the built-in design. However, there are some building codes and thermal regulation protocols, which are not known to the migrants. For example, the outside blind or awnings are one of the basic requirements for the houses to protect from excessive sunlight or heat. However, the majority of old houses and rented homes do not have adequate external coverings, which often remain

unnoticed or unexpressed by the migrants, possibly due to their lack of knowledge about building codes and thermal regulation protocols.

To sum up, despite having a slightly different nature of heatwaves in Bangladesh (i.e. more humid weather) compared to Australia (i.e. more dry weather), the participants appeared to share some commonalities including extremely high temperature (above 35°C) and consecutive hot days (3 or more days) which provide evidence that the community retains previous knowledge of similar kind of heatwaves. The analysis reveals that their previous knowledge and experience of heatwaves in Bangladesh made heat a bit easier to manage in Australia. Accordingly, the participants appeared to be familiar with several adaptation strategies, some of which they previously used in Bangladesh. Community connectedness and knowledge of traditional coping strategies are also found as the opportunities for the migrants with low socio-economic conditions during heatwaves in Victoria. Even though participants shared that their experience and adaptation knowledge increase their adaptive capacity, there are significant new challenges in Australia including the lack information accessibility, poor insulation systems, burden on income due to work loss or reduced work hours, language barriers, technical terms used in early warnings, lack of knowledge about building thermal regulation protocols and lack of awareness. Poor-insulation systems of rented houses, mismanagement of public transport information dissemination and some of their daily activities further lead people to some health impacts, they are not used to.

Chapter 6

Discussion

The previous chapters (4 and 5) presented both quantitative and qualitative findings. This chapter summarises and discusses the findings. Even though the findings of both quantitative and qualitative results are similar, the in-depth analysis shows some differences between results. For example, while the quantitative findings reveal that outdoor work during heatwaves is not considered a challenge for respondents, participants' narratives show that working outdoors does affect their life and livelihood. The qualitative data particularly highlighted that people in rental houses experience numerous challenges during heatwaves due to poor insulation, absence of an indoor cooling systems, lack of monitoring by housing authorities, and tenants' unwillingness to report problems to the RTBA because of the unwelcoming attitudes of the property managers. Another important finding from survey respondents was the inaccessibility of information regarding heatwaves and their consequences. While media representation was found an effective means of disseminating information about extreme calamities (McManus, 2000 & 2015; Yan, et al., 2019), this study found that it is difficult for some households with extended families or with people with special needs to follow electronic and print media. This study also identified some particular coping strategies used by this migrant community. Access to public transport and limited information regarding altered public transport timetables were found to be challenges for some. The following discussion of the findings from both qualitative and quantitative results provides further insights on some major aspects of the Bangladesh-born Victorian migrant community's memories while living in Bangladesh and post-migration experience in Victoria during heatwaves.

6.1 Memory of heatwaves in Bangladesh

Pre-migration experience of culturally diverse communities influences human behaviour to climate change adaptation. The findings indicate that migrants' previous knowledge is an effective foundation for adopting broader heatwave adaptation measures in the site of relocation. This finding also accords with the observations of some other scholars, who show that people's previous experience and knowledge of hazards help them understand the cause-and-effect relationships between environmental risks and social responses (Adger et al., 2013; Frondel et al., 2017). As Bangladesh is a hot and humid country, the participants used to practice various adaptation strategies to adjust to extreme environmental events. Studies suggest that people who have acclimatized previously to hot temperature tend to experience less heat-related impacts (Barret et al., 2015; Esplin et al. 2019; Hansen et al., 2011). The participants of this study argued that in Bangladesh, people do not die due to heatwaves. However, heatwaves are considered a deadly climate hazard in Australia and many other countries (Coates et al., 2014; Zhang et al., 2018b). Compared to migrants' heatwave experience in Bangladesh, heatwaves in Australia are considered very intense, harmful, suffocating and intolerable. It is interesting to note from the participants' view that in Bangladesh, despite extremely hot days even when it reaches more than 35 degree Celsius, the temperature goes down in the afternoon, whereas in Australia they experience a different trend of heatwaves.

Community connectedness was one of the strategies to get updated information and to act upon that to cope with the impacts of heatwaves. For example, quantitative results confirm that the majority of the respondents occasionally check in with their family, friends and neighbours during heatwaves; participants' narratives further show that they help their friends and neighbours, who do not have any cooling facilities at home during heatwaves by inviting them to use their cool house. The sense of social connectedness and peer-

relationships influences the community in response to heatwaves and climate change adaptation (Chavis & Wandersman, 2002; Eady et al., 2020; Ebi & Semenza, 2008; McMillan & Chavis, 1986; Pamungkas et al., 2017; Sampson et al. 2013). In addition, socio-economic conditions also have an enormous influence on adaptation behavior; they shape the economic viability of heatwave adaptation. It is evident that the residents of low- and middle-income countries often face challenges to afford a cooling technology (such as AC and portable coolers) during heatwaves (Kjellstrom et al., 2020; Lundgren-Kownacki et al. 2018).

This study also found that the participants experienced a minimum to moderate level of impacts on their lives and livelihoods due to heatwaves in Bangladesh; a significant number of adaptation strategies were used to reduce the adverse impacts of heat on everyday life. Increasing air circulation by leaving a window or door open was one of the techniques to adapt to extended hot weather. Going to a cooler place such as a shopping mall, community centre or local library was not a typical way to cope with the impacts of heatwaves in Bangladesh. However, they used to use several traditional coping measures such as taking an umbrella when going out, sleeping in the terrace at night and staying under a big tree at mid-day, using cotton bed sheets and bed covers and washing hands and feet to feel a bit chilled. Similar findings have been found in a few other studies (e.g. Ashraf & Faruk, 2018)

Individuals' past experience, environmental knowledge and socio-cultural values influence climate change adaptation behaviours (Becker et al., 2017; Demuth, 2018; Demuth et al., 2016; Esplin et al., 2019; Kellens et al., 2013; Lindell & Perry, 2012; Sampson et al., 2013). The findings of this study also demonstrate that the pre-migration experiences and knowledge of this community help cope with temperature extremes in Australia. Climate mitigation and adaptation planning is required that takes an inclusive approach, in which level of knowledge of risks, risk perception, cultural practices, norms and values are important aspects (Adger, 2006; Smith et al., 2016). The following section discusses the post-

migration heatwave experience and adaptation by exploring risk perception, adjustment practices, cultural and other factors.

6.2 Post-migration experience

This study contributes to heatwave adaptation research by analysing migrants' self-reported adaptation practices and adaptability, based on their current heatwave experience in Australia. Almost all participants (96%) had experienced one or more heatwaves in Victoria. The majority (62%) of participants were always concerned about the risks of severe heatwaves for their daily life. The trend of increasing and unpredictable heatwaves was another major issue of concern among this community based on both the qualitative and quantitative findings. The results indicate that many community members perceive current and future risks based on their observation on the intensity and the frequency of heatwaves. As mentioned in the literature review, risk perception is an important factor in response to the threats of heatwaves (Ban et al., 2019; Esplin et al., 2019; Hansen et al., 2011; Liu et al., 2013; Sampson et al. 2013). Therefore, it can be urged that migrants with an experience of similar kind of climate hazard have an advanced risk perception capacity. However, statistical analysis (one-way ANOVA) showed that people's understanding of heatwave risks at the site of resettlement depends on their age, educational qualifications, and years of living; gender, family size and employment did not show any statistical significance. For example, people aged between 38-47 years perceived a higher level of risks associated with heatwave consequences. This finding is somewhat contrary to previous studies (Abrahamson et al., 2009; Beckmann & Hiete; 2020) which have suggested that people aged between 72-94 years and 18-29 years are most likely to perceive heatwaves as risky. This finding could relate to the other subsequent studies in Australia and many other countries (Arriagada et al.,

2020; Hansen et al., 2011; Loughnan et al., 2014; Xiao et al., 2017) showing that age is one of the important factors influencing heatwave risk perception adaptation.

Length of residence also influences heatwave risk perception. The findings demonstrate that the longer people live in Victoria (their site of relocation), the better they understand the climate risks associated with heatwaves. Further, migrants living in Victoria for more than ten years have an ability to perceive heatwave risks more than those who have been living here for less than ten years. Thus, the length of residence (and of heatwave exposure) and age influence individuals' capabilities to adjust to the climate.

Further, the Bangladesh-born migrants reported a high level of concern relating to health risks due to heatwaves. Heat causes more death in Australia than any other climate hazard (Coates et al., 2014). Findings also show that participants experience several health problems during heatwaves, including headache, feeling dizzy, heat stress, shortness of breath, heat stroke, heart conditions, loss of balance and anxiety. Participants who have underlying health conditions (e.g. diabetes, heart problems, renal or kidney disease, and hypertension) encounter more challenges during heatwaves. Other studies have also discussed the human health impacts of hot weather (Khalaj et al., 2010; Lim et al., 2020; Macnee & Tokai, 2016; Wolf et al., 2010). In addition, the impact of a higher level of heatwave on the backyard garden, daily routine (including sleeping routine, and outdoor activities), on income and budget, eating and drinking habits and immediate family members were reported by the participants. Further, members of this migrant community are also concerned about the thermal environment of their home and workplace environment, reporting feelings of being uncomfortable, disoriented, unwell and distressed. Similar findings are echoed in various studies (Haldi & Robinson, 2010; Lam et al., 2019; Saman et al., 2013; Soebarto & Bennetts, 2014).

This study finds that participants apply a range of adjustment actions in their daily life activities to adapt to heatwaves in Australia: avoiding alcohol, using cold water splash to keep the body cool, moving to a cooler room in the house, changing drinking habits by avoiding hot drinks and avoiding physical activities. People are willing to avoid alcohol not only because of their religious beliefs but also their habit from their cultural practice in the country of origin.

Applying various technological adjustments such as using a ceiling or pedestal fan at home, closing indoor blinds and curtains to keep the sun out and spending less time in the car during heatwaves were the strategies used to maintain both the body and indoor temperatures. However, the participants had a tendency to use air-conditioners or coolers at a lower frequency to maintain the room temperature. Increased energy bills with an impact on their household budget were reported as one of the major barriers. However, they applied their previous knowledge to keep the indoor environment cool where there is poor insulation, or low-income. These techniques include putting ice-cubes in the bathtub or in a container and putting a dish of cold water or ice-cubes in front of a pedestal fan. These are cost-effective, convenient and environmentally friendly coping strategies. However, few people go to a cooler public place such as shopping mall, community centre or local library; instead, they prefer to go to friends' and relatives' houses. When community members find someone struggling to cope with heatwaves with a low SES, they support them by offering to come to their place, to go shopping or using their cars in case of an urgent situation. About half of the participants strongly agree that their cultural values help them adapt to heatwaves in Australia. Further, the majority strongly believe that they are accustomed to environmental risks, as in Bangladesh they experienced many disasters and hazards since their childhood.

Although this community believe that their cognitive mapping based on their spatial knowledge help them adapt to heatwaves in Australia, a range of obstacles hinder them from

implementing the adjustments effectively, especially, regarding technological and personal adjustments. High energy bills, age, underlying health problems, language and the nature of heatwaves are the key barriers towards heatwave adaptation. Despite being willing to use cooling technologies, increased energy bills during summer are a barrier to heatwave adaptation. The frequency of use of air- conditioners or portable coolers is very low and high energy bills is one of the major barriers towards using cooling devices during heatwaves. Similar findings were reported in several studies on heatwave vulnerabilities and energy bills in Australia and worldwide (Cornwell et al., 2016; Liddell & Morris, 2010; Nicholls et al., 2017). As mentioned earlier, age is a significant factor to adaptation; the findings show that majority of the migrants strongly believed that aged and younger people are the most vulnerable to heat-related health problems. Also, a household with these two groups of people experiences more challenges during that time. The narrative findings indicate that new migrants who have been living here for one to three years found it difficult to cope with the heat. Language was found to be one of the major barriers when disseminating and broadcasting heatwave messages through public media. For example, messages containing technical terms such as ‘Total-fire Ban’ were unclear to many people during the first few years of their settlement. ‘Technical tone’ has been identified as one of the potential barriers towards conveying relevant scientific to the communities (Iping et al., 2019). Information dissemination and accessibility is one of the barriers for the people who have less access to technology, problems with the subscriptions of news portals and other vulnerabilities. This study also shows that the different nature of heatwaves (dry, burning, hot air and high UV) in Australia create barriers to coping, especially for new migrants, aged and younger people and migrants with underlying health problems.

One of the significant barriers revealed through the qualitative data is linked with ‘house occupancy’ types. The migrant community found it extremely hard to cope with

heatwaves living in a rented house. A large number of community members said that most of the rental houses they were living in and used to live in a year or two ago incorporate a very poor insulation system. There was no centralised cooling system or good insulation for using a portable cooler. Hence, there could be a relationship between building design, house occupancy patterns and heatwave adaptation. Various studies on housing design and insulation, and climate change and heatwave adaptation also report similar findings (De Cian et al., 2019; Saman et al., 2013; Steenbergen et al. 2012; Vandentorren et al., 2006; Viguie et al.; 2020)

The findings of qualitative data also described that some experience an unhelpful conversation while conversing with property agents regarding cooling and insulation systems. For example, tenants received verbal notice to find another house if they cannot cope with it. While poor insulation was considered one of the main determinants of overheating of residential houses (Mavrogianni et al. 2012; Saman et al., 2013), findings showed that many renter migrants often found themselves underprivileged or unprivileged to discuss those issues due to their circumstances. However, their strong mind, cultural beliefs and commitment to adjusting to the destination country confer important strengths and capabilities.

The findings also demonstrate that migrants' heatwave risks perception and their previous heatwave adaptation practices (in Bangladesh) significantly influenced their heatwave adaptation practices in Victoria. It implies that participants with more ability to perceive heatwave risks along with previous knowledge about heatwave adaptation were more likely to apply various coping strategies during heatwaves in Victoria. Studies on risk perception indicate previous experience and knowledge of heatwaves are significant factors for heatwave adaptation (Akompab et al., 2013a; Eady et al., 2020; Esplin et al. 2019; Sampson et al., 2013; van Valkengoed & Steg, 2019; Whitmarsh, 2008). In addition, years of

living in Victoria, as a demographic variable, is also found to be a significant factor in participants' heatwave adaptation practices in Victoria. This indicates that migrants who have been living in Victoria for a longer period were more likely to practice heatwave adaptation techniques more often compared to those who have lived in Victoria for a shorter period. .

6.3 Conclusion

This study set out with the aim of exploring migrants' experience of, and adaptation to, heatwaves in the site of relocation. The study found that Bangladeshi migrants have been experiencing heatwaves in Victoria in many ways. Their experiences of heatwaves in Victoria were slightly different to, and more uncomfortable than, those in Bangladesh. However, based on their previous experience, they adapt to heatwaves using various traditional coping measures along with the modern coping approaches. Difficulties with rental housing, casual outdoor work, high energy bills, language issues in early warnings, lack of risk communication, and mismanagement in information dissemination represent barriers to adaptation strategies during heatwaves.

This study thereby suggests that more awareness programs regarding heatwaves and their consequences are needed for the migrant community to adapt to heatwaves. Therefore, some strategies for enhancing individuals' knowledge and awareness based on the findings which emerged from participants' narratives to address cultural diversity would be:

- Send text message/leaflets regarding heatwaves to the households as early warnings
- Schools, city councils, and hospitals can organize programs to raise awareness about heatwaves, especially for vulnerable people
- Identify cultural communities' practices regarding heatwave adaptation
- Provide awareness packages or fridge magnets that contain information on adaptation strategies and emergency help services
- Develop and implement national level policies for identifying less adaptive houses and providing retrofitting facilities for those houses.

- Conduct workshops / training regarding work-place responses to heatwaves for employees
- Declare national holidays during extreme weather events
- Provide an authentic weather app to predict weather
- Institute programs to raise community level awareness

6.4 Implications, recommendations, and limitations

Although several policies and programs provide information about heatwaves and their consequences to the community, it is also necessary that stakeholders address the vulnerabilities and capacities of migrant communities to implement measures to reduce heatwave impacts. Notably, if the very well-educated Bangladeshi community (tertiary education: 95%) are having trouble with the various government early warnings, it is likely that other communities will experience even more difficulty. In addition, despite the fact that migrants having previous experience of heatwaves possess the ability to predict risks and to make some adjustments to cope, it is unclear how migrants without previous heatwave experience perceive the risks of heatwaves. Therefore, the two-way learning process would open possibilities for mutual learning among other communities towards heatwaves or climate change adaptation in Australia for building community resilience.

Future studies are therefore recommended, especially studying the experiences of migrants of heterogeneous characteristics with such kinds of hazards, for planning and implementing an inclusive heatwave adaptation plan. The scope of this study was limited in terms of participants' heterogeneity, considering the scale of cultural diversity in Australia. In addition, this study demonstrates that Bangladeshi migrants practice more sustainable heatwave adaptation strategies (using light clothing, ice cubes/icy water in the bowls and fans, ice cubes in the bathtub, talking cool splash etc.), rather than practices with high-energy consumption such as the use of air conditioning. Even though in some instances, the results did indicate that participants were influenced by their socio-economic conditions towards

sustainable practices, it does not enable conclusions about what would happen if people's financial situation changed. Moreover, the findings also reinforce the importance of a future longitudinal study examining how experiences change over time and among new and old migrants. To sum up, this study strengthens understanding of post-migration experiences of heatwaves and considers the ways in which adaptation is intertwined with pre-migration experience of migrant communities in Australia.

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Appendices

Appendix 1: Ethics Approval

13 December 2018

Prof Lesley Head
School of Geography
Faculty of Science
The University of Melbourne
Parkville 3052
VIC Australia

Dear Prof Head,

I am pleased to advise that the Faculty of Science Human Ethics Advisory Group has approved the following Minimal Risk Project on 13-Dec-2018.

Project title : **Experiencing and adapting to heatwaves: A study of Bangladesh-born migrants in Victoria**
Researchers : **Prof Lesley Head, Dr Celia Mcmichael, Dilruba Khanam**
Ethics ID : **1853191.1**

The Project has been approved for the period: 13-Dec -2018 to 31-Dec-2019.

It is your responsibility to ensure that all people associated with the Project are made aware of what has been approved.

Research projects are normally approved to 31 December of the year of approval. Projects may be renewed yearly for up to a total of five years upon receipt of a satisfactory annual report. If a project is to continue beyond five years a new application will normally need to be submitted.

Please note that the following conditions apply to your approval. Failure to abide by these conditions may result in suspension or discontinuation of approval and/or disciplinary action.

(a) Limit of Approval: Approval is limited strictly to the research as submitted in your Project application.

(b) Amendments to Project: Any subsequent variations or modifications you might wish to make to the Project must be notified formally to the Human Ethics Advisory Group for further consideration and approval before the revised Project can commence. If the Human Ethics Advisory Group considers that the proposed amendments are significant, you may be required to submit a new application for approval of the revised Project.

(c) Incidents or adverse effects: Researchers must report immediately to the Advisory Group and the relevant Sub-Committee anything which might affect the ethical acceptance of the protocol including adverse effects on participants or unforeseen events that might affect continued ethical acceptability of the Project. Failure to do so may result in suspension or cancellation of approval.

(d) Monitoring: All projects are subject to monitoring at any time by the Human Research Ethics Committee.

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(e) Annual Report: Please be aware that the Human Research Ethics Committee requires that researchers submit an annual report on each of their projects at the end of the year, or at the conclusion of a project if it continues for less than this time. Failure to submit an annual report will mean that ethics approval will lapse.

(f) Auditing: All projects may be subject to audit by members of the Sub-Committee.

Please quote the ethics registration number and the name of the Project in any future correspondence.

On behalf of the Faculty of Science Human Ethics Advisory Group I wish you well in your research.

Yours sincerely,



A/Prof Peter Christoff
Chair Faculty of Science Human Ethics Advisory Group

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Appendix 2: Plain Language Statement (Bangla/Bengali)

সাধারণ ভাষায় গবেষণা সংক্রান্ত বিবৃতি

স্কুল অব জিওগ্রাফি

গবেষণার শিরোনাম: অতি তাপমাত্রা সম্পর্কিত অভিজ্ঞতা ও অভিযোজন কৌশল: ভিক্টোরিয়ান বাংলাদেশি বংশোদ্ভূত অভিবাসীদের ওপর একটি গবেষণা

গবেষক বৃন্দ

তত্ত্বাবধায়ক

অধ্যাপক লেজলি হেড, প্রধান, স্কুল অব জিওগ্রাফি

ফোন: +৬১ ৩ ৮৩৪৪৬৪ ৭৯, ই-মেইল: lesley.head@unimelb.edu.au

ড. সিলিয়া ম্যাকমাইকেল, সিনিয়র লেকচারার, স্কুল অব জিওগ্রাফি

ফোন: +৬১ ৩ ৮৩৪৪৬৭০৪, ই-মেইল: celia.mcmichael@unimelb.edu.au

শিক্ষার্থী

দিলরুবা খানম, এমফিল প্রার্থী, স্কুল অব জিওগ্রাফি

ফোন: +৬১ ৪২৬২৩৬৯৬৫, ই-মেইল: khanamd@student.unimelb.edu.au

ভূমিকা

গবেষণায় অংশগ্রহণের আগ্রহ প্রকাশের জন্য আপনাকে ধন্যবাদ। পরবর্তী কয়েক পাতায় গবেষণাটি সংক্রান্ত বিস্তারিত তথ্য প্রদান করা হয়েছে যা আপনাকে এই গবেষণায় অংশগ্রহণ করা বা না করার ব্যাপারে সিদ্ধান্ত নিতে সাহায্য করবে।

তথ্যগুলো মনোযোগসহকারে করুন। কোনো কিছু বুঝতে না পারলে বা কোনো বিষয়ে আরো জানতে চাইলে আপনি প্রশ্ন করতে পারবেন।

গবেষণাটিতে আপনার অংশগ্রহণ সম্পূর্ণভাবে স্বেচ্ছাসেবামূলক। আপনি অংশগ্রহণ করতে না চাইলে কেউ আপনাকে বাধ্য করবে না। এমনকি অংশগ্রহণ শুরু করার পরও যেকোনো সময় তা বন্ধ করতে পারবেন।

গবেষণাটি কী বিষয়ে?

এই গবেষণার প্রধান উদ্দেশ্য হলো ভিক্টোরিয়ান বাংলাদেশি বংশোদ্ভূত অভিবাসীদের ওপর অতি তাপমাত্রার প্রভাব এবং এ বিষয় সম্পর্কিত অভিজ্ঞতা জানা। তাদের দৈনন্দিন জীবনের বিভিন্ন কাজকর্মে অতি তাপমাত্রার প্রভাব মূল্যায়ন ও অতি তাপমাত্রায় তারা কীভাবে নিজেদেরকে মানিয়ে নেয় তা এই গবেষণার মাধ্যমে অনুসন্ধান করা হবে। এছাড়াও পরিবর্তিত পরিস্থিতিতে নিজেদেরকে মানিয়ে নেয়ার জন্য ভিক্টোরিয়ান বাংলাদেশি বংশোদ্ভূত অভিবাসীদের পূর্ববর্তী (বাংলাদেশে থাকা কালীন) অভিজ্ঞতা, জ্ঞান, দক্ষতা ও মূল্যবোধ কীভাবে সাহায্য করেছে এ বিষয়গুলো অনুসন্ধান করা হবে।

আমাকে কী করতে বলা হবে?

আপনি কি এই গবেষণায় অংশগ্রহণ করতে সম্মত আছেন?

হ্যাঁ

না

আপনি গবেষণায় অংশগ্রহণ করতে সম্মত হন তাহলে আপনার করণীয় সম্পর্কে জানতে মনোযোগ সহকারে পরবর্তী প্যারাগুলো পড়ুন:

গবেষণাটি দু'টি অংশে বিভক্ত যথা: ক) সার্ভে ও খ) সাক্ষাতকার। সার্ভেতে অংশগ্রহণ করার ক্ষেত্রে আপনাকে একটি প্রশ্নমালা পূরণ করে তা একটি ফেরত খামে (গবেষক কর্তৃক প্রদেয়) গবেষক বরাবর পাঠাতে হবে।

সাক্ষাতকারে অংশগ্রহণের ক্ষেত্রে কিছুটা পূর্বে নির্ধারিত বিষয়ে বিভিন্ন প্রশ্ন সম্পর্কে আপনার অভিমত জানতে চাওয়া হবে। সাক্ষাতকারের সময় ও জায়গা আপনার সুবিধামত নির্ধারণ করা হবে। সাক্ষাতকার শুরুর পূর্বে একটি ফর্মে আপনার অনুমতি নেওয়া হবে। সাক্ষাতকারটি আপনার অনুমতিক্রমে অডিও-রেকর্ড করা হবে। সাক্ষাতকারটি আনুমানিক ৩০-৪০ মিনিট পর্যন্ত চলবে।

এখানে সম্ভাব্য কী সুবিধাদি রয়েছে?

গবেষণাটিতে আপনার অংশগ্রহণ সম্পূর্ণভাবে স্বেচ্ছাসেবামূলক।

এখানে সম্ভাব্য কী ধরনের রিস্ক (risks) রয়েছে?

এ গবেষণায় অংশগ্রহণে কোনো ধরনের রিস্ক নেই। কারণ, অংশগ্রহণকারী সকলেরই বয়স ১৯ বছরের ওপরে এবং কোনো ধরনের স্পর্শকারত বিষয়ের অবতারণা হবে না।

আমাকে কি অংশগ্রহণ করতেই হবে?

না। অংশগ্রহণ সম্পূর্ণভাবে স্বেচ্ছাসেবামূলক। আপনি যেকোনো সময় নিজেকে অংশগ্রহণ থেকে তুলে নিতে পারেন।

গবেষণার ফলাফল সম্পর্কে কি আমি জানবে পারবো?

গবেষকদের ইচ্ছা আছে গবেষণার ফলাফল বিভিন্ন জার্নালে প্রকাশ করার। প্রকাশিত হলে আপনি জার্নালগুলো থেকে এই গবেষণার ফলাফল জানতে পারবেন।

আমার প্রদত্ত তথ্যগুলোকে কী করা হবে?

আপনার কাছ থেকে প্রাপ্ত তথ্যগুলো ব্যবহারের ক্ষেত্রে আপনার পরিচয় সম্পূর্ণভাবে গোপন রাখা হবে।

প্রাপ্ত তথ্যগুলো মেলবর্ন ইউনিভার্সিটির স্কুল অব জিওগ্রাফি-এর একটি ফাইল কেবিনেটে তালাবদ্ধ কমে রাখা হবে। ইলেক্ট্রনিক তথ্যাদি পাসওয়ার্ড দিয়ে নিরাপত্তা বিধান করা হবে।

প্রাপ্ত তথ্যগুলো মেলবর্ন ইউনিভার্সিটির নীতিমালা অনুযায়ী ৫ বছর পর্যন্ত সংরক্ষণ করার পর তা বাজেয়াপ্ত করা হবে।

এখানে কোনো কনফ্লিক্ট অব ইনটারেস্ট রয়েছে কি?

না।

আমি কোথায় আরো তথ্য পেতে পারি?

দিলরুবা খানম, এমফিল প্রার্থী, স্কুল অব জিওগ্রাফি

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এ গবেষণা সংক্রান্ত কোনো উদ্বেগ থাকলে কার সাথে যোগাযোগ করবো?

গবেষণা প্রকল্পটি মেলবর্ন ইউনিভার্সিটির হিউম্যান রিসার্চ এথিক্স কমিটি কর্তৃক অনুমোদিত। এ গবেষণা সংক্রান্ত কোনো উদ্বেগ থাকলে যদি আপনি তা উল্লিখিত গবেষণা দলের সাথে আলোচনা করতে না চান, তাহলে নিম্নলিখিত ব্যক্তি বরাবর যোগাযোগ করতে পারেন:

ম্যানেজার, হিউম্যান রিসার্চ এথিক্স কমিটি, মেলবর্ন ইউনিভার্সিটি, ভি.আই. সি-৩০১০.

ফোন: +৬১ ৩ ৮৩৪৪২০৭৩, ই-মেইল:

সকল প্রকার কম্পেন্সন-এ গোপনীয়তা রক্ষা করা হয়। যোগাযোগের সময় গবেষণার শিরোনাম, আইডি নম্বর বা গবেষণা দলের নাম উল্লেখ করুন।

Appendix 3: Plain Language Statement (English)

Plain Language Statement

School of Geography



Project Title: *Experiencing and adapting to heatwaves: A study of Bangladesh-born migrants in Victoria*

Responsible Researchers

Supervisors:

Professor Lesley Head, Head, School of Geography

Tel: +61 3 8344 6479 Email: lesley.head@unimelb.edu.au

Dr. Celia McMichael, Senior Lecturer, School of Geography

Tel: +61 3 8344 6704, Email: celia.mcmichael@unimelb.edu.au

Student Researcher:

Dilruba Khanam, MPhil Candidate, School of Geography, University of Melbourne

Mbl: (+61) 426236965 Email: khanamd@student.unimelb.edu.au

Introduction

Thank you for your interest in participating in this research project. The following few pages will provide you with further information about the project, so that you can decide if you would like to take part in this research.

Please take the time to read this information carefully. You may ask questions about anything you don't understand or want to know more about.

Your participation is voluntary. If you don't wish to take part, you don't have to. If you begin participating, you can also stop at any time.

What is this research about?

The purpose of the research is to know the experiences of Bangladesh-born community in Victoria about the way they are dealing with extreme heatwaves. It will also collect information about how heatwaves hamper various activities in their everyday life as well as what action they take to cope with heatwaves. This particular community has experiences of facing extreme climate in Bangladesh. So, another purpose of this research is know whether and how their past experience and knowledge influence their capacity to deal with heatwaves in Victoria.

What will I be asked to do?

Would you agree to participate? Yes No

If you agree to participate, please read carefully the following paragraphs to know about your tasks:

As a survey respondent, you will be requested to complete a paper format survey for the purpose of data collection. You will be also requested to return the completed survey questionnaires via stamped envelopes or to a convenient secured location as discussed with the researcher. The duration of completing the survey will be approximately 25-30 minutes.

As an interview participant, you will be requested to participate in a semi-structured interview. After obtaining your consent, the time and place will be fixed at your

Plain Language Statement

School of Geography



convenience. The duration of the interview will be approximately 30-40 minutes. The conversation between you and the student researcher will be recorded by using a voice recorder during the interview.

What are the possible benefits?

Participation is completely voluntary.

What are the possible risks?

The project poses minimal risks to the participants, because the potential participants are matured adults (above 19 years old) and there will be no sensitive or distressing topics to be discussed with the participants.

Do I have to take part?

No. Participation is completely voluntary. You are able to withdraw at any time

Will I hear about the results of this project?

You will be able to hear the result by accessing the particular journals, as the researchers intend to publish the results in peer-reviewed journals.

What will happen to information about me?

A paper format survey questionnaire will be designed to ensure respondent anonymity (participants cannot not be identified). A consent form will be used for the interviewees for obtaining permission and maintain their privacy and confidentiality. Interviews will be audio-taped with the permission of the participants as well.

Data will be stored in a locked filing cabinet at the office of the student researcher in the School of Geography, the University of Melbourne. Electronic files will be stored in a password protected computer.

Data will be stored for five (5) years according to the research governance arrangement of the University of Melbourne.

Is there any potential conflict of interest? *NO*

Where can I get further information?

If you would like more information about the project, please contact the following researcher;

Student Researcher:

*Dilruba Khanam, MPhil Candidate, School of Geography, University of Melbourne
Mbl: (+61) 426236965 Email: khanamd@student.unimelb.edu.au*

Who can I contact if I have any concerns about the project?

This research project has been approved by the Human Research Ethics Committee of The University of Melbourne. If you have any concerns or complaints about the conduct of this research project, which you do not wish to discuss with the research team, you should contact the Manager, Human Research Ethics, Research Ethics and Integrity, University of Melbourne, VIC 3010. Tel: +61 3 8344 2073 or Email: HumanEthics-complaints@unimelb.edu.au. All complaints will be treated confidentially. In any correspondence please provide the name of the research team or the name or ethics ID number of the research project.

Appendix 4: Consent Form-Interview

Consent Form Interview

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Project Title: *Experiencing and adapting to heatwaves: A study of Bangladesh-born migrants in Victoria*

Responsible Researcher: **Student Researcher:** Dilruba Khanam

Supervisors

Principal Supervisor: Professor Lesley Head, Head, School of Geography

Co-supervisor: Dr. Celia McMichael, Senior Lecturer, School of Geography

Name of Participant: _____

1. I consent to participate in this project, the details of which have been explained to me, and I have been provided with a written plain language statement to keep.
2. I understand that the purpose of this research is to investigate the participants' *experience and adaptation strategies of heatwaves or extended periods of hot weather in Victoria and Bangladesh.*
3. I understand that my participation in this project is for research purposes only.
4. I acknowledge that the possible effects of participating in this research project have been explained to my satisfaction.
5. In this project, I will be required to participate in semi-structured interview.
6. I understand that the duration of the interview will be approximately 30-40 minutes
7. I understand that my interviews may be audio-taped by using a voice recorder.
8. I understand that my participation is voluntary and that I am free to withdraw from this project anytime without explanation or prejudice and to withdraw any unprocessed data that I have provided.
9. I understand that the data from this research will be stored at the University of Melbourne and will be destroyed after 5 years.
10. I have been informed that the confidentiality of the information I provide will be safeguarded subject to any legal requirements; my data will be password protected and accessible only by the named researchers.
11. I understand that after I sign and return this consent form, it will be retained by the researcher.

Participant Signature: _____ **Date:** _____

Appendix 5: Consent Form-Survey

Consent Form_Survey

School of Geography



Project Title: *Experiencing and adapting to heatwaves: A study of Bangladesh-born migrants in Victoria*

Responsible Researcher: **Student Researcher:** Dilruba Khanam
Supervisors
Principal Supervisor: Professor Lesley Head, Head, School of Geography
Co-supervisor: Dr. Celia McMichael, Senior Lecturer, School of Geography

Name of Participant: _____

1. I consent to participate in this project, the details of which have been explained to me, and I have been provided with a written plain language statement to keep.
2. I understand that the purpose of this research is to investigate the participants' *experience and adaptation strategies of heatwaves or extended periods of hot weather in Victoria and Bangladesh.*
3. I understand that my participation in this project is for research purposes only.
4. I acknowledge that the possible effects of participating in this research project have been explained to my satisfaction.
5. In this project, I will be required to complete a paper format survey.
6. I understand that the duration of completing the survey will be approximately 25-30 minutes
7. I understand that I will be required to returned the completed survey via stamped envelopes or to a convenient secured location as discussed with the researcher
8. I understand that my participation is voluntary and that I am free to withdraw from this project anytime without explanation or prejudice and to withdraw any unprocessed data that I have provided.
9. I understand that the data from this research will be stored at the University of Melbourne and will be destroyed after 5 years.
10. I have been informed that the confidentiality of the information I provide will be safeguarded subject to any legal requirements; my data will be password protected and accessible only by the named researchers.
11. I understand that after I sign and return this consent form, it will be retained by the researcher.

Participant Signature: _____ **Date:** _____

Appendix 6: Survey questionnaire



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Section A: Demographic information

Direction: This part of the survey involves some background information about you as a respondent. Please tick (✓) the relevant box.

1. **What is your gender?**

- Male Female Rather not say Other _____ (please specify)

2. **What is your age range?**

- 18-27 years 38-47 years 58-67 years
 28-37 years 48-57 years 68+ years

3. **What is your highest level of education?**

- Postgraduate degree
 Graduate diploma and Graduate certificate
 Bachelor's degree
 Advanced diploma
 School and college education only
 Not stated

4. **What is your employment status?**

- Employed Retired/Pensioner Not applicable
 Unemployed Student Other _____ (please specify)
 Self-employed Business

5. **If you are in paid employment, what is your occupation?** _____

6. **How long have you been living in Victoria?**

- Less than 1 year 6-10 years 16-20 years 25+ years
 1-5 years 11-15 years 21-25 years

7. **Which of the following best describes your household composition (i.e. the people you currently live with)?**

- Single
 Couple with no children
 Couple with children
 Single-parent household
 Extended family household with children
 Extended family household with no children
 Not applicable
 Other _____ (please specify)

8. **Have you experienced heatwaves in Victoria?**

- Yes No

9. **If yes, please write few words about your experience.**

Please Cont. »

Section B: Experience & adaptation strategies in Victoria



Part-1: Heatwave risk perception

This part of the survey includes items describing experiences of heatwaves particularly your perception of heatwave risks. Each item has six options. Please circle ONE option for each item that best reflects your true feelings. Please note there are no right or wrong answers.

No	Statements	1	2	3	4	5	6
		Never	Very Rarely	Rarely	Occasionally	Very Frequently	Always
1.	I am concerned that heatwaves cause negative impacts on my life	1	2	3	4	5	6
2.	I am concerned that heatwaves will increase in the future	1	2	3	4	5	6
3.	I am concerned that heatwaves cause negative impacts on other communities	1	2	3	4	5	6
<i>Please rate your level of concern about the impact of heatwaves on the following aspects of your daily life (i.e. questions 4-17 below):</i>							
4.	Your health	1	2	3	4	5	6
5.	Your sleeping routine	1	2	3	4	5	6
6.	Your personal comfort (i.e. body temperature)	1	2	3	4	5	6
7.	Your drinking habits (i.e. staying hydrated)	1	2	3	4	5	6
8.	Your drinking habit (i.e. avoid hot drink)	1	2	3	4	5	6
9.	Your drinking habit (i.e. avoid alcohol)	1	2	3	4	5	6
10.	Your daily routine	1	2	3	4	5	6
11.	Outdoor activities (e.g. exercise, other outdoor tasks)	1	2	3	4	5	6
12.	Your family members	1	2	3	4	5	6
13.	Your garden, due to the hot weather	1	2	3	4	5	6
14.	Eating habits (i.e. avoid hot meal)	1	2	3	4	5	6
15.	High energy bills due to increased use of cooling systems	1	2	3	4	5	6
16.	Mode of travel (to workplace or other)	1	2	3	4	5	6
17.	Travel time	1	2	3	4	5	6
18.	I feel uncomfortable during heatwaves	1	2	3	4	5	6
19.	I feel disoriented due to heatwaves	1	2	3	4	5	6
20.	I feel unwell during heatwaves	1	2	3	4	5	6
21.	I enjoy heatwaves	1	2	3	4	5	6
22.	I feel distressed due to heatwaves	1	2	3	4	5	6
23.	I am informed about heatwaves	1	2	3	4	5	6
24.	I am informed about the consequences of heatwaves	1	2	3	4	5	6
25.	During a heatwave, I receive adequate information from both electronic and print media (e.g. TV news, newspaper, leaflet, radio, text messages)	1	2	3	4	5	6
26.	I follow the news regarding heatwaves and their consequences	1	2	3	4	5	6

If you would like to add anything regarding your experience of heatwaves, please describe below:

Please Cont. »



Part-2: Heatwave adaptation strategies in Victoria

This part of the survey includes items that describe strategies to cope with heatwaves. Each item has six options. Please circle **ONE** option that best reflects your true feelings about each statement. Please note there are no right or wrong answers.

No	Statements	1	2	3	4	5	6
		Never	Very Rarely	Rarely	Occasionally	Very Frequently	Always
1.	I plan my day in a way that reduces my exposure to the heatwave	1	2	3	4	5	6
2.	I stay at home during heatwaves	1	2	3	4	5	6
3.	I avoid physical activities (e.g. workout, exercise, strenuous activity)	1	2	3	4	5	6
4.	I move to a cooler room in my house	1	2	3	4	5	6
5.	I wear protective clothing (e.g. hat, sunglasses) when I go out	1	2	3	4	5	6
6.	I avoid alcohol consumption	1	2	3	4	5	6
7.	I change my drinking habits by avoiding hot drinks	1	2	3	4	5	6
8.	I drink more water to keep hydrated	1	2	3	4	5	6
9.	I change my eating habits by avoiding hot meals	1	2	3	4	5	6
10.	I spend less time in the car during heatwaves	1	2	3	4	5	6
11.	I take frequent shower to cool myself	1	2	3	4	5	6
12.	I use cold water splash to cool myself	1	2	3	4	5	6
13.	I place a wet cloth on my face or neck to cool down	1	2	3	4	5	6
14.	I wear lighter colored and cooler clothes	1	2	3	4	5	6
15.	I use an air conditioner at home	1	2	3	4	5	6
16.	I use a portable cooler at home	1	2	3	4	5	6
17.	I use ceiling or pedestal fan at home	1	2	3	4	5	6
18.	I increase air circulation by leaving a window or door open	1	2	3	4	5	6
19.	I use shade cloths, awnings or external blinds	1	2	3	4	5	6
20.	I close indoor blinds and curtains to keep the sun out	1	2	3	4	5	6
21.	I go to a cooler place (e.g. shopping mall, community center or local library)	1	2	3	4	5	6
22.	I go to my friends' or relatives' house	1	2	3	4	5	6
23.	I go to a swimming pool	1	2	3	4	5	6
24.	I spend more time in my workplace because it is cooler/air-conditioned	1	2	3	4	5	6
25.	I spend more time working from home	1	2	3	4	5	6
26.	I change my appointments	1	2	3	4	5	6
27.	I sit in the car with the air-conditioning on	1	2	3	4	5	6
28.	I use an air diffuser to keep myself clam or relieve stress	1	2	3	4	5	6
29.	I avoid cooking	1	2	3	4	5	6
30.	I reduce my meal preparation time	1	2	3	4	5	6
31.	I change my sleep time	1	2	3	4	5	6
32.	I leave my kid (s), adult (s) and/or pet (s) in the car with air-conditioning running	1	2	3	4	5	6
33.	I check on others (family/relatives / friends/ neighbors) to offer help	1	2	3	4	5	6

If you would like to add anything else regarding adaptation techniques to heatwaves or extended period of hot weather, please write here

Please Cont. »



Part- 3: Challenges towards the implementation of the adaptation strategies

This section includes items that describe challenges to adaptation strategies. Each item has six options. Please circle **ONE** option that best reflects your true feelings about each statement.

No	Statements	1	2	3	4	5	6
		Strongly disagree	Disagree	Disagree somewhat	Agree somewhat	Agree	Strongly agree
1.	The costs of energy consumption prevent or limit me from using cooling technologies during heatwaves	1	2	3	4	5	6
2.	Sometimes cultural or religious norms do not allow people to wear light and cool clothes	1	2	3	4	5	6
3.	I believe that older people are the most vulnerable group of people during heatwaves	1	2	3	4	5	6
4.	I believe that children are the most vulnerable group of people during heatwaves	1	2	3	4	5	6
5.	Underlying health problems (e.g. diabetes, high blood pressure, heart attack, stroke, kidney problems, mental health condition) are barriers to heatwave adaptation	1	2	3	4	5	6
6.	The different nature of heatwaves in Australia makes it difficult for the Bangladeshi migrant communities to adapt	1	2	3	4	5	6
7.	Lack of proficiency in English is a barrier to accessing information relating to heatwave adaptation	1	2	3	4	5	6
8.	Houses without built-in cooling technology are less able to cope with heatwaves	1	2	3	4	5	6
9.	Pensioners or people with low income are vulnerable to heatwaves	1	2	3	4	5	6
10.	People with mobility issues have trouble reaching a cooler place during a heatwave	1	2	3	4	5	6
11.	My work requires me to spend time in direct sunlight or outdoors, and this means I am exposed to heatwaves	1	2	3	4	5	6

If you would like to add anything else regarding the barriers towards adaptation techniques to heatwaves or extended period of hot weather, please write here

This is the End of Section B: Victoria (Experience & Adaptation)

Please Cont. »

Section C: Bangladesh



Part-1: Cultural factors towards heatwave adaptation

This part of the survey includes items that describe your previous knowledge and culture related issues of heatwaves when you were living in Bangladesh. Each item has six options. Please circle ONE option that best reflects your true feelings about each statement.

No	Statements	1	2	3	4	5	6
		Strongly disagree	Disagree	Disagree somewhat	Agree somewhat	Agree	Strongly agree
1.	My cultural values help me adapt to extreme weather	1	2	3	4	5	6
2.	As a Bangladeshi, I am accustomed to environmental risk; this enables me to adapt to heatwaves	1	2	3	4	5	6
3.	I learnt adaptation strategies to cope with heatwaves in Bangladesh	1	2	3	4	5	6
4.	My previous experience of heat in Bangladesh helps me cope with hot weather in Victoria	1	2	3	4	5	6
5.	I believe it is harder for migrants to cope with heatwaves in Australia than it is for non-migrants	1	2	3	4	5	6
6.	I believe heatwaves in Australia are worse than they are in Bangladesh	1	2	3	4	5	6
7.	In Bangladesh we helped each other by sharing our knowledge and experience of heatwave adaptation	1	2	3	4	5	6

If you would like to add anything else regarding your previous experience and knowledge of adaptation to heatwaves, please write here:

Please Cont. »



Part-2: Previous heatwave Adaptation strategies in Bangladesh

This part of the survey includes items that describe strategies to cope with heatwaves in Bangladesh. Each item has six options. Please circle ONE option that best reflects your true feelings about each statement. Please note there are no right or wrong answers.

No	Statements	1	2	3	4	5	6
		Never	Very Rarely	Rarely	Occasionally	Very	Always
1.	I used to plan my day in ways that reduced my exposure to heatwaves	1	2	3	4	5	6
2.	I used to stay at home during heatwaves	1	2	3	4	5	6
3.	I used to avoid physical activities (e.g. workout, exercise, strenuous activity)	1	2	3	4	5	6
4.	I used to move to a cooler room in my house	1	2	3	4	5	6
5.	I used to wear protective clothing (e.g. hat, sunglasses) when I went out	1	2	3	4	5	6
6.	I used to avoid alcohol consumption	1	2	3	4	5	6
7.	I used to change my drinking habits by avoiding hot drinks	1	2	3	4	5	6
8.	I used to drink more water to keep hydrated	1	2	3	4	5	6
9.	I used to change my eating habits by avoiding hot meals	1	2	3	4	5	6
10.	I used to spend less time in the car during heatwaves	1	2	3	4	5	6
11.	I used to take frequent shower to cool myself	1	2	3	4	5	6
12.	I used to splash with cold water to cool myself	1	2	3	4	5	6
13.	I used to place a wet cloth on my face or neck to cool down	1	2	3	4	5	6
14.	I used to wear lighter colored and cooler clothes	1	2	3	4	5	6
15.	I used to put on an air conditioner at home	1	2	3	4	5	6
16.	I used to operate my portable cooler at home	1	2	3	4	5	6
17.	I used to turn on my ceiling or pedestal fan at home	1	2	3	4	5	6
18.	I used to increase air circulation by leaving a window or door open	1	2	3	4	5	6
19.	I used to cover the windows with shade cloths, awnings or external blinds	1	2	3	4	5	6
20.	I used to close indoor blinds and curtains to keep the sun out	1	2	3	4	5	6
21.	I used to go to a cooler place (e.g. shopping mall, community center or local library)	1	2	3	4	5	6
22.	I used to go to my friends' or relatives' house	1	2	3	4	5	6
23.	I used to go to a swimming pool	1	2	3	4	5	6
24.	I used to spend more time in my workplace because it is cooler/air-conditioned	1	2	3	4	5	6
25.	I used to spend more time working from home	1	2	3	4	5	6
26.	I used to change my appointments	1	2	3	4	5	6
27.	I used to sit in the car with the air-conditioning on	1	2	3	4	5	6
28.	I used to turn on the air diffuser to keep myself clam or relieve stress	1	2	3	4	5	6
29.	I used to avoid cooking	1	2	3	4	5	6
30.	I used to reduce my meal preparation time	1	2	3	4	5	6
31.	I used to change my sleep time	1	2	3	4	5	6
32.	I leave my kid (s), adult (s) and/or pet (s) in the car with air-conditioning running	1	2	3	4	5	6
33.	I check on others (family/relatives / friends/ neighbors) to offer help	1	2	3	4	5	6

If you would like to add anything else regarding the adaptation techniques to heatwaves or extended period of hot weather, please write here: _____

This is the end of the survey Thank you very much for your participation in this research

Thank you very much for your participation in this research

We plan to contact participants to conduct interviews. If you would like to be involved further, please complete the following section:

Name:	
Email:	
Phone /Mobile:	

Or

Email me: khanamd@student.unimelb.edu.au

Or

Text me: 0426236965

Please return the completed survey to the student researcher by using any of the following options

1. Please *call* me on 0426236965 to collect

Or

2. Please *use* the prepaid postage envelope to post it (provided)

Or

3. Please *Scan and email* me at khanamd@student.unimelb.edu.au

Appendix 7: Interview protocol



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“Experiencing and adapting to heatwaves: A study of
Bangladesh-born migrants in Victoria”
A guide to **Semi-Structured Interview**

Semi-Structured Interview Guide

Date:

/ /

Introduction of the interviewer

Hello, my name is Dilruba Khanam, and I'm the primary researcher of this study.

Interview introduction

Length: 30-40 minutes

Primary goal:

I would like to ask you about your experiences and adaptation strategies of heatwaves or extended periods of hot weather in Melbourne/Victoria and Bangladesh.

Verbal consent

Would you like to participate in this interview?

Yes

No

Background Information

During the interview, I would like to discuss the following topics:

- Experience of heatwaves in Victoria
- Strategies/techniques to adapt/ to cope with heatwaves.
- Opportunities and barriers to coping with heatwaves
- Your past experience of heat waves in Bangladesh.
- Adaptation techniques to heatwaves in Bangladesh.

Definition of Heatwaves

In this study we are defining heatwaves as a prolonged period of excessively high temperature (above 35°C), over three or more consecutive days within a particular region.

(Bureau of Meteorology [BOM], 2017)

Ice-breaker questions

- How long have you been living in Victoria?
- Where did you live in Bangladesh?

Experience of heatwaves or extended periods of hot weather in Melbourne/Victoria

- How do you find the weather in Melbourne/Victoria?
- Since moving to Melbourne, have there been any times when you experienced extended hot weather or heatwaves? If so, when, how often, and what was it like?
- How would you define or describe a heatwave?
- What is it like in your home when it is really hot, or when there is a heatwave?
- How well do you think your house is designed for coping with heatwaves (cooling, ventilation etc.) (*probe for details – did they retrofit, did house come as is, extra features they would like*)?
- Would you please describe your experiences of heatwaves at your workplace? (e.g. environment, facilities, work patterns, restrictions, transport etc.)
- Do you think heatwaves or extended hot weather in Melbourne are a matter of concern? (Why?)
- What do you think are the main health impacts of heatwaves or extended hot weather?
- How are your daily activities and routines affected by heatwaves or extended hot weather? (As examples)

Adaptation strategies/opportunities to cope with heatwaves

- What strategies do you use to cope with heatwaves?
- Do you make any changes in your daily activities and routines during heatwaves (e.g. time spent indoor-outdoor, food and drink habits, shopping habits etc.)?
- How and where do you get information, if any, about heatwaves and coping strategies? (media, work, friends, family etc.). Do you receive any information or resources through your workplace that enhance your capacity to cope with extreme weather?
- How useful is this information; what have you learnt that you didn’t already know?
Is there any information, services or resources that you think could help you cope better with heatwaves in Australia?
- As a Bangladeshi migrant to Australia, do you think there are particular things that enable you to better to cope with heatwaves than the non-migrant population? (e.g. knowledge, attitude, living and working conditions, language etc.)

Challenges/barriers towards implementing adaptation strategies

- Is there anything about you or your life that means it is difficult to cope with heatwaves? (i.e. ethnicity, housing, different climate, language, socio-economic status, knowledge about heatwaves, adaptation capacity, age etc.)
- Can you describe a particular time when you found the heat difficult to manage?
- Do you think migrants experience challenges or barriers to adapting to heatwave (e.g. due to ethnicity, cultural background, social custom and regulation, language)?
- How much do you think economic status affects people’s ability to adapt to heatwaves (e.g. cost of thermal environmental control)? Has your economic status had any impact on your ability to cope with heatwaves?
- Do you feel that you have adequate information to enable you to cope with heatwaves, or not? What further information do you think would be helpful, if any?
- Would you like to add anything else in terms of opportunities/ barriers to adapting to heatwave?

Heatwaves in Bangladesh

- Is there anything you learnt in Bangladesh about coping with heat and other environmental hazards that has been useful in Australia?
- Did you experience heatwaves in Bangladesh? When and what was it like? (*DESCRIBE experience*)
- Do you think heatwaves in Bangladesh and Australia are similar or different? (*ask for explanation*)
- How did you and your family cope with heatwaves or hot weather in Bangladesh? Please describe some strategies
- Is there anything you learnt in Bangladesh about coping with heat and other environmental hazards that has been useful in Australia?
- Are there any coping strategies you learnt in Bangladesh that you have found to be useful during heatwaves in Australia?
- Are there any coping strategies you learnt in Bangladesh that you have found to be useful during heatwaves in Australia?

Final Question

- Would you like to add any further information about heatwaves and adaptation strategies both in Australia and Bangladesh context?

Clarifying Questions

- Could you expand a little on this?
- Could you please give me some examples?
Would you like to add anything else in terms of your experience?

Background questions

- Why did you move here?
- Who do you live with?
- Where do you live in Victoria?
- What do you do for living?
- What do you like/not like about living in Victoria?

Appendix 8: Generation of the item pool and Content validation (example of HRP measure)

The instrument follows the same process of scale development offered by DeVellis (2017). The process of HRP scale development involved several steps including generation of pool, content validation, and determination of factors.

Generation of the item pool

Two sources provided initial ideas for generating a good pool: a comprehensive review of the literature (Nitschke et al., 2013; Hansen et al., 2013; Saman et al., 2013; Humphreys & Nicol, 1998) and focus group discussion (FGD) with the participants. While literature review provided some core aspects of perceived risks and challenges regarding heatwaves and/or extremely hot temperatures across the world, the FGDs (n = 2), consisting of 8-10 persons each, offered a range of ideas and insights about heatwave risk perception from the specific cultural group, Bangladesh born migrants in Victoria. A list of 40 items was generated from the literature review and FGD data analysis.

Content Validation

The draft pool (38 items) was sent to a panel of experts (n=4) in the field of heatwaves and climate change adaptation for review. The experts were provided with a format to give their feedback. They were asked to rank the relevancy of the items based on a 3-point scale (1=not relevant, 2= partially relevant, 3= fully relevant). They were also asked to provide some comments on the overall accuracy and coverage of the items to investigate the construct. Based on the feedback, the pool was revised. Several items needed revision and 8 items were dropped because of lack of relevance to the construct. At this stage, a revised questionnaire containing 30 items was prepared to distribute for piloting.

Selecting the appropriate response format for the HRP scale was another aspect which needed substantial literature review. Reviewing the preferences of quantitative researchers to

use various kinds of Likert type scales, Infosurv (2006) found that five-point scales were widely favoured by researchers. However, there is huge criticism of using an odd number scale in academia. Because of a 'neutral' or 'uncertain' category, use of a five- to seven-point response format is often discouraged as these types of central anchors attract participants' responses (Cummins & Gullone, 2000; Feuerborn, Tyre & King, 2015). Researchers argue that the 'uncertain' or 'neutral' option may involve equal appropriateness for both agreement and disagreement (Balon, Franchini, Freeman, Hassenfield, Keshavan & Yoder, 1999; Bond & Fox, 2001; DeVellis, 2017). Therefore, in line with past psychometric studies (see Anguiana-Carrasco et al., 2015; Lu & Yeo, 2015), a six-point Likert type scale was selected for the study: Never (1), Very rarely (2), Rarely (3), Occasionally (4), Very frequently (5) and Always (6).

Pilot testing

The 30-item questionnaire was pilot tested with a number of Bangladeshi migrants in Victoria (n=20) who were selected based on convenience sampling and were not included in the main study. The participants at this stage were also requested to give their opinion on the draft questionnaire regarding the difficulty of the items, language used, and any addition and removal of the items. Based on their feedback, the wording of 5 items was modified, and 4 items were removed. Finally, a 26-item questionnaire was finalized in English and administered to 393 Bangladesh born migrants in Victoria.

Data analysis techniques

Several statistical procedures were utilised to analyse data for this study. The eligibility of the data for factor analysis was screened out with the Kaiser-Mayer-Olkin (KMO) coefficient and Bartlett's Sphericity test. In order to determine the factor structure of the TASIB scale, the principal component analysis method was used with varimax rotation, as it is suggested that varimax rotation allows for less correlation between factors (Pallant, 2020). Further, the

number of factors retained was determined by several procedures that considered eigenvalues, scree plotting, and parallel analysis.

Results

Prior to conducting any further analysis, the reliability of the s of HRP scale was calculated by Cronbach's alpha, showing a value of 0.89. Generally, a value of 0.70 or above (Cronbach's alpha) is accepted for determining the internal consistency of a Likert-type scale (DeVellis, 2020). All s of HRP scale had -scale correlations of 0.40 and above.

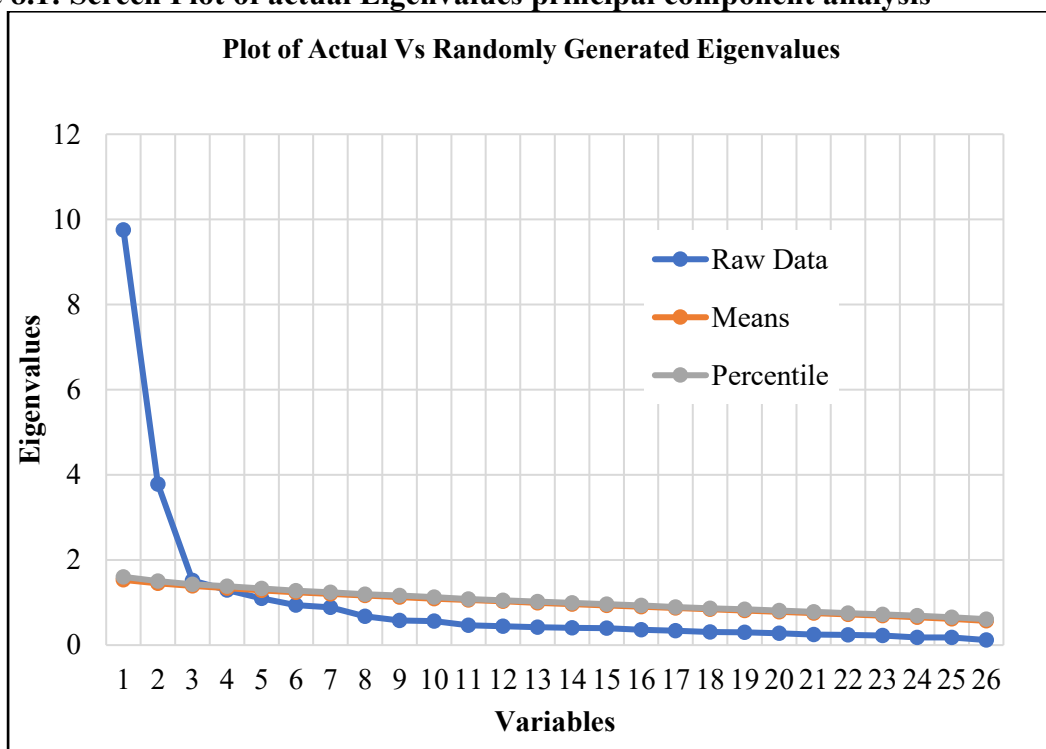
The data collected 393 responses which were used for performing an exploratory factor analysis (EFA), which consists of three stages: (i) variables selection and measurement; (ii) determining the number of factors; and (iii) interpreting the factors (Pohlmann, 2004). EFA helps the researcher to identify the latent dimensions of the variables that are thought to be linear with the observed variables (Denis, 2019). That simply refers to the statistical analysis procedure that finds a certain group of questions, which seem to cluster together, or in other words 'dimension reduction' of the questionnaire. The exploratory factor analyses of the data (n=393) helped identify a number of factors.

The possibility of the factor analysis was determined by Kaiser-Meyer-Olkin (KMO) and Bartlett's test score. The KMO value was 0.917 exceeding the recommended value of 0.6 (Kaiser, 1974). The Bartlett's Test of Sphericity (Bartlett, 1954) was statistically significant ($p=.000$) indicating that factor analysis is appropriate (Tabachnick & Fidell, 2007).

The number of factors was determined by examining eigenvalues and scree plot analysis. Factors with eigenvalues greater than one were retained (Henson & Robert, 2006). Principal component analysis (PCA) reveals the existence of three elements with eigenvalues above one. The scree diagram (Figure 8.1) for determining the number of components shows the existence of 3 factors. Using the eigenvalues from the PCA, the screen test- drawing a straight line through the lowest eigenvalues, provide a decision. The threshold is where the line in the diagram separates from the eigenvalue line, which confirms that there are 3

specified factors. The first factor (with eigenvalues 9.75) explains 37.5% of the variance, the second factor (with eigenvalues 3.78) explains 14.6% of the variance, and the third factor (with eigenvalues 1.51) explains 5.9% of the variance. Therefore, the identified factors combined to explain 58% of the total variance, which is widely recommended as an accepted value (Ugulu, Shahin & Baslar, 2013). A parallel analysis was also undertaken to determine the actual number of meaningful factors, as this is considered to be more accurate compared with eigenvalues and scree plot analysis (Hensen & Roberts, 2006).

Figure 8.1: Screen Plot of actual Eigenvalues principal component analysis



The result shows that the first three eigenvalues obtained from Principal Component Analysis were larger than the first three values from the random eigenvalues by parallel test (Table 8.1). This analysis suggests that the first three factors should be accepted.

Table 8.1 Determination of factors considering parallel analysis

Factors	Eigenvalues from PCA	Criterion values from parallel analysis	Decision
1	9.75	1.60	Accept
2	3.78	1.44	Accept
3	1.51	1.43	Accept
4	1.29	1.37	Reject

Structuring the factors to better interpret the pattern of loadings is an integral part of the analysis (Pallant, 2020). In order to determine factor structure, EFA of the correlation matrix using a PCA with varimax rotation with a .40 cut off was utilised. Items for relevant factors were specified based on the highest loading for each (Table 8.2).

Factor 1 constitutes the highest number of items (n=17), most of which are related to *concern about heatwaves*. Factor 2 and Factor 3 consist of 5 and 4 items, respectively. Based on the themes of the items of factor 2 and factor 3, they were termed *feelings during heatwaves* and *access to heatwave information* respectively.

Table 8.2 Factors Heatwave Risk Perception scale

No.	Themes	Factor loadings		
		Factor 1	Factor 2	Factor 3
Concern about heatwaves = 0.90				
2	Impact of heatwaves on others	.802		
3	Increasing trends of heatwaves	.788		
13	Garden, due to the hot weather	.765		
9	Avoiding alcohol consumption	.753		
8	Avoiding hot drink	.748		
12	Family members	.688		
1	Impacts of heatwaves on self	.668		
11	Outdoor activities (e.g. exercise, other outdoor tasks)	.661		
14	Avoiding hot meal	.595		
15	High energy bills due to increased use of cooling systems	.589		
6	Personal comfort (i.e. body temperature)	.557		
5	Sleeping routine	.509		
10	Daily routine	.461		
16	Mode of travel (to work or other)	.456		
4	Health impacts	.435		
7	Staying hydrated	.422		

17	Travel time	.421		
Feelings during heatwaves=0.69				
19	Disoriented		.845	
20	Unwell		.789	
22	Distressed		.768	
18	Uncomfortable		.603	
21	Enjoy heatwaves		.483	
Information accessibility=0.90				
24	Informed about the consequences of heatwaves			.892
25	Awareness about heatwaves			.888
26	Followed news regarding heatwaves			.883
23	Informed about heatwaves			.797

Once the factors of the HRP scale were determined, the reliability of the subscales were also calculated by Cronbach's alpha, showing 0.90 for concern about heatwaves , 0.70 for feelings about heatwaves and 0.90 for access to heatwaves information.

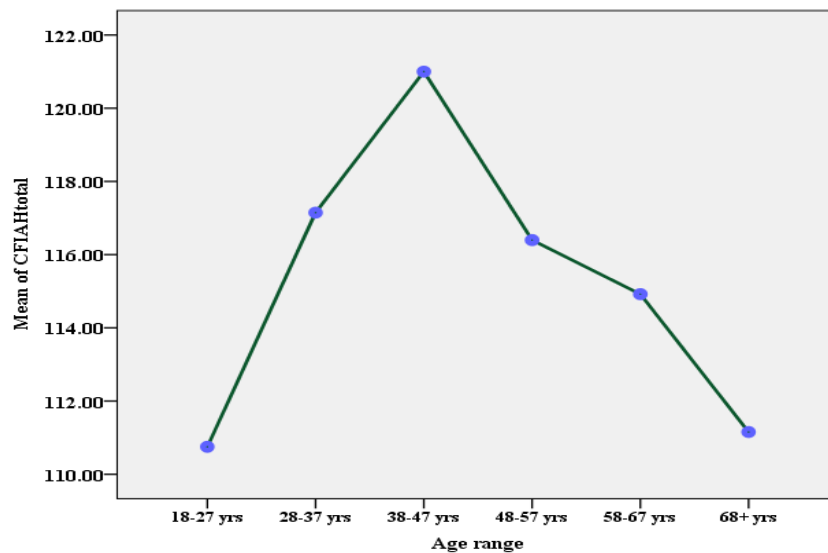
Appendix 9: Detailed analysis relating to demographic variables and comparison of adaptation measures

Appendix 9a Heatwave risk perception (HRP)

Age

Respondents were divided into six age-groups (i. 18-27 years, ii. 28-37 years, iii. 38-47 years, iv. 48-57 years, v. 58-67 years, vi. 68 years and above). There were statistically significant differences ($p < 0.05$) in HRP scores ($F(5, 385) = 3.38, P = .00$). Despite reaching statistical significance, the actual difference in mean scores between the groups for HRP scores was small. Participants aged 68 years and above were different in their perception of heatwaves risks compared to other age groups. The effect size calculated using ‘Eta squared²²’ for the HRP was 0.04 suggesting a small but statistically significant.

Figure 9a.1 Response variances based on Age on the mean scores of HRP total



Even though there is variance in responses among the six age groups (Figure 9a.1) based on their heatwave experiences, the Post-hoc comparisons using the Tukey-HSD test for

²²Eta squared- Pallant, 2020, p 268 & Cohen, 1988, p 284-287

HRP scale indicated that the mean score for Group iii ($M = 121.00$, $SD = 15.57$) was significantly different from Group vi ($M = 111.15$, $SD = 9.86$) with a mean difference 9.85 (Table 9a.1). Other groups did not differ statistically significantly from one another for their experience, that is, the responses of the migrants aged between 38 to 47 years varied compared to other age groups, especially with individuals aged 68 year and above. It could be argued that the exposure to heatwaves of this age group is more than the other age groups.

Table 9a.1 Multiple Comparisons Tukey HSD

Dependent Variable: HRP total					Factor: Age	
Age group	Age range	Mean Difference	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
38-47 yrs	18-27 yrs	10.25000	3.93029	.098	-1.0069	21.5069
	28-37 yrs	3.85185	1.91197	.336	-1.6243	9.3280
	48-57 yrs	4.60256	2.10816	.248	-1.4355	10.6406
	58-67 yrs	6.08000	3.23481	.416	-3.1849	15.3449
	68+ yrs	9.84615*	3.18170	.026	.7333	18.9590

*. The mean difference is significant at the 0.05 level.

Educational qualifications

There were statistically significant differences at the $p < 0.05$ level in HRP scores ($F(4, 384) = 3.60$, $P = .00$) for the five groups (i. postgraduate degree, ii. Graduate diploma and Graduate certificate, iii. Bachelor's degree, iv. Advanced diploma and v. School and college education only) based on the respondents' educational qualifications. Therefore, the effect size calculated using 'Eta squared' (Pallant, 2020, p 268 & Cohen, 1988, p 284-287) for the experience was 0.04, indicating that respondents' educational qualifications have a small effect on the mean scores of the HRP measures. This means that educational qualification influences how people experience heatwaves in a different geographical location.

Post-hoc comparisons using the Tukey-HSD test for HRP scale (table 9a.2) indicated that the mean score for Group v ($M = 132.25$, $SD = 12.28$) was significantly different from Group iv ($M = 107.67$, $SD = 23.81$) with a mean difference 24.58. That is meant that, although there is a difference in responses of the participants based on their educational

qualification for each group, Group iv and Group v have statistically significant differences in the pattern of the responses, that is, the community members with ‘advanced diploma’ and ‘School and college education only’ experience heatwaves differently.

Table 9a.2 Multiple Comparisons Tukey HSD

Dependent Variable: HRP total		Factor: Educational qualification				
Level of education	Educational Qualification	Mean Difference	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
School and college education only	Postgraduate degree	14.03205	7.51351	.337	-6.5609	34.6250
	Graduate diploma and Graduate certificate	13.47449	7.60062	.391	-7.3572	34.3062
	Bachelor’s degree	19.42073	7.80507	.095	-1.9713	40.8127
	Advanced diploma	24.58333*	8.60264	.036	1.0054	48.1613

*. The mean difference is significant at the 0.05 level.

Employment status

The one-way ANOVA test displayed statistically significant differences at the $p < 0.05$ level in the mean scores of HRP scale ($F(7, 384) = 3.60, P = .01$) based on the employment status of the survey population (Table-5). The effect size calculated using ‘Eta squared’ (Pallant, 2020, p 268 & Cohen, 1988, p 284-287) for all of the scales was 0.05, indicating the actual differences in mean scores between the groups was small. There were eight groups based on the participants' employment status (i. Employment, ii. Unemployed, iii. Self-employed, iv. Retired/Pensioner, v. Student, vi. Business, vii. Not applicable and viii. Other).

Table 9a.3 One-Way ANOVA of experience by employment status

		<i>df</i>	<i>Sum of Squares (SS)</i>	<i>Mean Square (MS)</i>	<i>F</i>	<i>p</i>
HRP total	Between Groups	7	4074.81	582.12	2.63	.01
	Within Groups	384	85005.025	221.37		
	Total	391	89079.837			

The Tukey HSD test for HRP scale indicated that, for employment status, the mean score for Group vi ($M = 119.98$, $SD = 12.83$) was significantly different from Group vii ($M = 100.00$, $SD = 12.82$) with a mean difference of 19.98 in their responses towards heatwave experience in Victoria.

Years of living in Victoria

Results revealed that there are statistically significant differences were found at the $p < 0.05$ level in Concern, Feelings and Information Accessibility about Heatwaves (HRP) scores ($F(6, 385) = 4.33$, $P = .00$) based on the years of living in Victoria of the respondents surveyed. ‘Eta squared’ (Pallant, 2020, p 268 & Cohen, 1988, p 284-287) calculation scored 0.06, representing as a medium effect size on experience scores by the years of living in Victoria of the respondents. This implies that the experience of heatwaves of the migrants vary significantly based on how many years they have been living in the current location.

The mean score was calculated by Post-hoc comparisons using the Tukey-HSD test for HRP scale (Table 9a.4) based on seven groups (i. >1 year; ii 1-5 years; iii. 6-10 years; iv. 11-15 years; v. 16-20 years; vi. 21-25 years; vii. 25+ years) of the years of living in Victoria. The results indicated that the mean score for Group iv ($M = 121.48$, $SD = 16.18$) was statistically significant from Group i ($M = 103.86$, $SD = 13.53$) and Group vii ($M = 109.45$, $SD = 13.58$). Bangladeshi migrants, who have been living Victoria for 11-15 years experienced heatwaves differently compared to other groups, especially those who have been living here for less than one year and 25+ years.

Table 9a.4 Multiple Comparisons Tukey HSD

Dependent Variable: HRP total				Factor: Years of Living in Victoria		
Group	Years of living in Victorial	Mean Difference	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
11-15 yrs	>1 year	17.62220*	5.72388	.036	.6566	34.5878
	1-5 yrs	6.88843	2.59209	.112	-.7945	14.5714
	6-10 yrs	3.53541	1.95394	.543	-2.2561	9.3269

16-20 yrs	4.13085	2.25312	.526	-2.5474	10.8091
21-25 years	6.75712	3.71968	.538	-4.2680	17.7823
25+ yrs	12.03106*	3.04426	.002	3.0079	21.0543

*. The mean difference is significant at the 0.05 level.

Family size

In order to explore, if the family composition of the respondents was significantly associated with their experience, both the Pearson product-moment correlation coefficient tests and ANOVA were performed. The results revealed a nonsignificant association.

This community has a diverse experience in adapting to the negative impacts of heatwaves in their everyday life. The following sections correspond to the adaptation strategies they use as their versatile actions towards heatwave adaptations.

Appendix 9b Adaptation

Gender

The independent sample t-test was conducted to compare Heatwave Adaptation Strategies (HAS) scores for males and females. Result shows that there was no significant difference in mean scores for males ($M= 132.51$, $SD=18.92$) and females ($M= 131.20$, $SD=18.53$); $t(391) = 0.795$, $p=.43$, two-tailed. The magnitude of the differences in the means (mean difference =1.50, 95% CI [-2.22, 5.22]) was very small (eta squared=0.006).

Further, one-way between-groups ANOVA with post-hoc comparisons using a Tukey HDS test was conducted to measure the influence of age, educational qualifications, years of living in Victoria, employment status and family composition on the frequency of usage of adaptation strategies.

Age

One-way between-groups ANOVA with Post-hoc comparisons using a Tukey-HDS test shows that there were statistically significant differences at $p<0.05$ level in adaptation (HAS) scores ($F(5, 385) = 2.46$, $P = .03$) for the six age groups (Table 9b.1). Despite reaching statistical significance, the actual difference in mean scores between the groups for HAS scores was quite small. The effect size calculated using ‘Eta squared’ (Pallant, 2020, p 268 & Cohen, 1988, p 284-287) of age for adaptation was 0.03. Respondents were divided into six groups according to their age (i. 18-27 years, ii. 28-37 years, iii. 38-47 years, iv. 48-57 years, v. 58-67 years, vi. 68 years and above). Post-hoc comparisons using the Tukey HSD test for the age groups showed a statistically non-significant association between the age groups.

Table 9b.1 One-way ANOVA of adaptation by age

	<i>Sum of Squares (SS)</i>	<i>df</i>	<i>Mean Square (MS)</i>	<i>F</i>	<i>p</i>
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Heatwave Adaptation Strategies (HAS) total	Between Groups	3831.926	5	766.385	2.46	.033
	Within Groups	119824.867	385	311.233		
	Total	123656.793	390			

Employment status

The one-way ANOVA test displayed statistically significant differences at the $p < 0.05$ level in the mean scores of HAS (adaptation) scale ($F(7, 384) = 2.78, P = .00$) based on the employment status of the survey population (Table 9b.2). The effect size calculated using ‘Eta squared’ (Pallant, 2020, p 268 & Cohen, 1988, p 284-287) was 0.05, indicating the actual differences in mean scores between the groups was small.

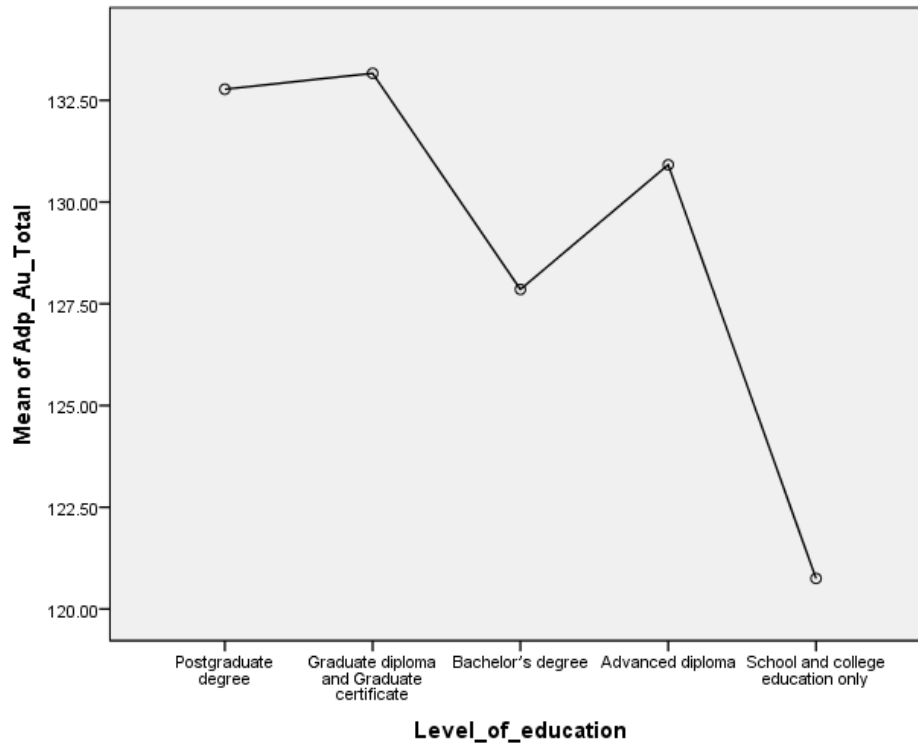
Table 9b.2 One-way ANOVA of adaptation by employment status

		<i>df</i>	<i>Sum of Squares (SS)</i>	<i>Mean Square (MS)</i>	<i>F</i>	<i>p</i>
Heatwave Adaptation Strategies (HAS) total	Between Groups	7	5951.79	850.26	2.78	.00
	Within Groups	384	117633.38	306.34		
	Total	391	123585.17			

Educational qualifications

In order to explore the influence of educational qualification towards participant heatwave adaptability, both the Pearson product-moment correlation coefficient tests and ANOVA were performed. The results revealed a nonsignificant association between two variables. However, the mean plots (Figure 9b.1) show variances in the mean scores of the participants’ responses.

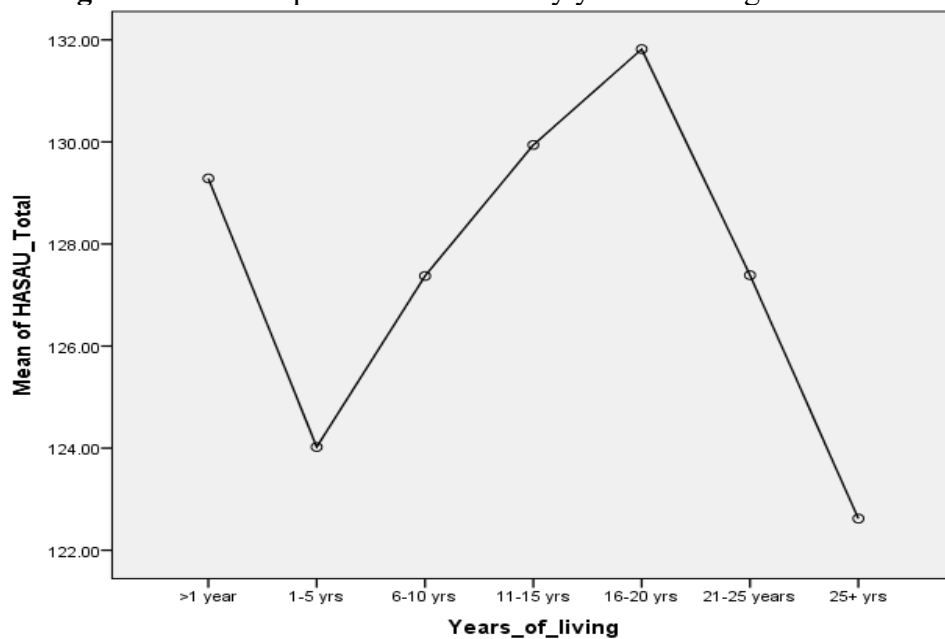
Figure 9b.1 Mean plots of HAS total by educational qualification



Years of living in Victoria

The ANOVA results revealed that there was no statistically significant association between adaptation and years of living in Victoria. However, the mean plots (Figure 9b.2) indicate a variation in the responses of the participants towards adaptation based on how long they have been living in Victoria.

Figure 9b.2 Mean plots of HAS total by years of living in Victoria



Family size

In order to explore if the family composition of the respondents was significantly associated with adaptation to heatwaves in Victoria, a One-way between-groups ANOVA with post-hoc comparisons using a Tukey-HSD test was performed (Table 9b.3). A statistically significant result was found at the $p < 0.05$ level in adaptation (HAS) scores ($F(6, 385) = 2.90, P = .00$) for the seven groups of family composition. The effect size calculated using ‘Eta squared’ (Pallant, 2020, p 268 & Cohen, 1988, p 284-287) was 0.04, indicating a small effect of the groups on the adaptation scores. Respondents were divided into seven groups corresponding to the size of the family (i. Single, ii. Couple with no children, iii. Couple with children, iv. Single-parent household, v. Extended family household with children, vi. An extended family household with no children and vii. Other). The mean difference (29.67) between group iii ($M = 129.92, SD = 19.06$) and group vi ($M = 100.25, SD = 12.97$) was statistically significant at the $p < 0.05$ level indicating that participants living with their partner/husband and children apply adaptation strategies in various ways compared to the ‘Extended family household with no children’.

Table 9b.3 One-way ANOVA of adaptation by family size

		<i>Sum of Squares (SS)</i>	<i>df</i>	<i>Mean Square (MS)</i>	<i>F</i>	<i>p</i>
Heatwave Adaptation Strategies (HAS) total	Between Groups	5530.010	6	921.668	2.904	.009
	Within Groups	122204.021	385	317.413		
	Total	127734.031	391			

Appendix 9c Adaptation comparison

Table 9c.1: Adaptation measure in Victoria and Bangladesh (mean and mean differences)

No	Statements	Adaptation:	Adaptation:	Mean difference
		Victoria	Bangladesh	
		<i>M</i>	<i>M</i>	
20	Closing indoor blinds and curtains to keep the sun out	4.7	3.12	1.58
27	Sitting in the car with the air-conditioning on	4.04	2.67	1.37
15	Using air conditioner at home	4.01	2.64	1.37
18	Increasing air circulation by leaving a window or door open	3.45	4.7	1.25
21	Going to a cooler place (e.g. a shopping mall, community centre or local library)	3.76	2.57	1.19
23	Going to a swimming pool	3.66	2.51	1.15
24	Spending more time in the workplace because it is cooler/air-conditioned	3.73	2.79	0.94
19	Using shade cloths, awnings, or external blinds	3.73	2.82	0.91
5	Wearing protective clothing (e.g. hat, sunglasses) when going out	4.63	3.72	0.91
16	Using a portable cooler at home	3.38	2.47	0.91
29	Avoiding cooking	3.84	3.02	0.82
26	Changing appointments	3.83	3.06	0.77
22	Going to friends' or relatives' houses	3.53	2.77	0.76
25	Spending more time working from home	3.73	3.01	0.72
9	Changing eating habits by avoiding hot meals	4.46	3.75	0.71
30	Reducing meal preparation time	3.76	3.05	0.71
10	Spending less time in the car during heatwaves	4.52	3.81	0.71
4	Moving to a cooler room in the house	4.58	3.9	0.68
7	Changing drinking habits by avoiding hot drinks	4.53	3.85	0.68
3	Avoiding physical activities (e.g. workout, exercise, strenuous activity)	4.52	3.85	0.67
31	Changing sleep time	3.61	2.96	0.65
1	Planning my day in a way that reduces my exposure to the heatwaves	4.41	3.77	0.64
28	Using an air diffuser to keep calm or relieve stress	3.19	2.59	0.6
8	Drinking more water to keep hydrated	4.81	4.21	0.6
2	Staying at home during heatwaves	4.23	3.68	0.55
14	Wearing lighter coloured and relaxed clothes	4.4	3.86	0.54
6	Avoiding alcohol consumption during heatwaves	4.88	4.36	0.52
12	Using cold water splash to keep your body cool	4.61	4.1	0.51
13	Placing a wet cloth on face or neck to cool down	3.99	3.53	0.46
33	Checking on others (family/relatives / friends/ neighbours) to offer help	3.92	3.55	0.37
17	Using ceiling or pedestal fan at home	4.79	5.12	0.33
11	Taking a frequent shower to keep your body cool	4.35	4.03	0.32
32	Leaving kid (s), adult (s) and/or pet (s) in the car with air-conditioning running	1.24	1.37	0.13

Appendix 10 Statistical terms used in this study

The following table (Table 10.1) presents in plain language key statistical terms used in this chapter.

Table 10.1 Defining statistical terms in plain language

Statistical terms	Plain language
Mean (<i>M</i>) & SD (<i>SD</i>)	
i) Mean (<i>M</i>) is the sum of the value of each observation in a dataset divided by the number of observations	*The most common answer
ii) Standard Deviation (<i>SD</i>) measures the spread of the data around the mean	*The distribution of results *Average, lowest & highest scores of the items
Frequency	*Frequencies/ proportions/percentages *Frequency is the number of times value for a variable (data item) has been observed to occur
Variance	The spread of the data around the mean
Normal distribution	The distribution of random variable means.
<i>p</i>-Value	The smaller the <i>p</i> -value, the stronger the relationship among the variables tested. A <i>p</i> -value of ≤ 0.05 is typically considered statistically significant.
Scale reliability	*Internal consistency for the scale with this sample (participants understood items and answered accordingly)
* Reliability is the degree to which the measure of a construct is consistent or dependable based on the total sum of the scale	* Adequacy and consistency of measurement procedures
Regression (Multiple regression):	*To determine the effect (strength & direction) of an IV (Independent variable) on the DV (Dependent variable) after controlling for the effects of other variables
Multiple Linear regression & Hierarchical multiple regression	*To identify the most influential/weakest effect of the IVs on the DVs * How well an IV explains the differences/variations among the cases on the DV
ANOVA (Analysis of variance)	* Are there any significant differences among 3 or more groups for the mean of a variable? *To identify which pairs of groups significantly differ