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Heat exposure and adaptation strategies of outdoor informal sector workers in urban Bulawayo - Zimbabwe

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This thesis is presented in fulfilment of the requirements for the degree of

Doctor of Philosophy

Bigboy Ngwenya

Edith Cowan University

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ABSTRACT

Ambient temperatures have risen over the past few decades and are expected to increase even further due to climate change impacts. Extreme temperatures, accompanied by high humidity levels, will exacerbate occupational heat stress, heat related illnesses and mortality amongst vulnerable groups, particularly among outdoor workers in developing countries in the tropics. In Bulawayo, Zimbabwe, a large portion of the population work outdoors in the informal sector as street vendors (hawkers) due to a lack of employment opportunities. These hawkers spend long hours in the sun or under makeshift sheds with poorly developed adaptation strategies, and no access to cooling systems both at work and at home. This mixed method study, conducted during the summer of 2015, explored heat exposure and adaptation strategies of informal street vendors in Bulawayo. Study participants were exposed to temperatures above 38°C during heat wave events and they were unable to cool down effectively at night due to the condition of their housing. Focus group discussions with health professionals and policy makers identified a lack of policies, programs and resources for heat prevention at local authority and national levels. It was recommended that the Zimbabwe government develop heat prevention policies and strategies in its National Climate Change Strategy and embrace community-based adaptation responses that will address heat related health impacts, particularly amongst people that work in the informal sector, who are deemed most vulnerable.

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Date: 3 March 2019

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CHAPTER ONE

INTRODUCTION

The following chapter outlines the background and scope of the research that was conducted on heat exposure and adaptation strategies of outdoor informal sector workers in Zimbabwe. The study also included a review of government policies and interviews with key stakeholders responsible for public health in the city of Bulawayo. This chapter also defines the thesis outline and its structure, which includes published papers as chapters.

1.1 CLIMATE CHANGE AND HEAT EXPOSURE EFFECTS

Global warming is predicted to increase by between 1.8 - 4.0°C and to impact negatively on populations without heat prevention programs (Frimpong, Eddie Van Etten, Oosthuzien, & Nunfam, 2017; IPCC, 2007). Collective scientific evidence reveals that the impact of extreme temperature exposures, combined with humidity caused by climate change, will burden a number of countries and pose challenges to decision makers on human health, with developing countries being the worst affected (Byass, Twine, Collinson, Tollman, & Kjellstrom, 2010; Limaye, Vargo, Harkey, Holloway, & Patz, 2018). It is predicted that heat related illnesses will increasingly emerge as a public health issue affecting many populations around the globe, in particular those working outdoors under extreme environmental heat load, with limited or no adaptation strategies, theory and practice of assessments in place (Byass et al., 2010; Fussel, 2008; Ngwenya, Oosthuizen, Cross, & Frimpong, 2018). Heat waves are currently surpassing other natural hazards in terms of their human health impact, and therefore pose more health threats to vulnerable populations, particularly those in hot developing regions of the world (Koppe et al., 2004). Heat waves that occurred in Western Europe in August 2003 reflected the realities of the worst effects of climate change and exposed flaws in the management of environmental public health risks with a number of fatalities attributes to heat (Kovats & Hajat, 2008). The extreme heat event that struck Europe in 2003 resulted in 15 000 deaths (Rey et al., 2009). Russia experienced 1 000 deaths in 2011 (Grumm, 2011) and Chicago heat waves had a reported mortality of 800 in 2010 (Hayhoe, Sheridan, Kalkstein, & Greene, 2010). Research has shown, that a lack of intervention plans and coordination between health agencies and social services impacted negatively on the management of these events and this populations lacked

effective adaptation strategies (Kovats & Hajat, 2008; Ngwenya, Oosthuizen, Cross, & Frimpong, 2017). The influences of climate change are envisaged to have the worst heat related health effects in the poorest countries, in particular the developing tropical world with high unemployment and poverty rates, as well as undefined adaptive capacity (Fischer & Schär, 2010; Hales, Edwards, & Kovats, 2003). It can therefore be assumed that severe health impacts and fatalities in developing countries during heat waves may be unavoidable.

In Zimbabwe the unemployment rate is currently estimated to be 95%. The data include both unemployment and underemployment and under the current economic conditions the true unemployment remains unknown, while in other Southern African Development Community (SADC) countries the rates average 18.72%. The Table 1 below shows figures from its four neighbouring countries as at 2018 (ifitweremyhome.com/ZA, 2018).

Table 1

The Unemployment Rates in Zimbabwe and Its Four Neighbouring Regional Peers of Zambia, South Africa, Botswana and Mozambique.

Country	Unemployment rate
Zimbabwe	95%
Zambia	15%
South Africa	25.10%
Mozambique	17%
Botswana	17.8%

(http://www.ifitweremyhome.com/compare/listing/ZA.2018)

The majority of this unemployed group in Zimbabwe, and in many other developing countries located in the tropics, work outdoors in the informal sector and are exposed to extreme environmental conditions, including heat waves. Given their low socio-economic status, this sector of society is particularly vulnerable and at risk of suffering heat stress related health impacts (Hyatt, Lemke, & Kjellstrom, 2010; Kjellstrom, Holmer, & Lemke, 2009; Luber & McGeehin, 2008). In developing countries, there is a lack of knowledge of the impacts of heat stress and heat exposure management is sub optimal (Phuong, Few, & Winkels, 2013). The population appears to rely on acclimatisation and adjustment of human behaviour, which is a challenge with an increase in heat events noted in recent years (Frimpong et al., 2017; Huang et al., 2011; Luber & McGeehin, 2008). Such studies, therefore, have highlighted the need for research on heat stress impacts to provide evidence-based information for decision makers to take responsibility for planning adaptation strategies, raising public awareness and developing

policies. This study aims to provoke further research ideas in the area of heat related issues and increase literature on climate change and human health.

1.2 HUMAN PHYSIOLOGICAL FACTORS AND HEAT EXPOSURE

Excessive heat production or reduced transfer of heat to the environment and failure to maintain a normal body temperature by individuals may result in heat related illnesses, such as heat exhaustion, heat cramps, heat rash, heat oedema, dizziness and fainting due to dehydration. On the more severe end of the scale, heat stroke can be fatal (Leithead & Lind, (1964); Muthers, S., Tarczewski, G., & Matariki, A. (2017). Studies indicate that people with cardiovascular diseases, cerebrovascular conditions and those with depression and diabetes are more prone to suffer from heat related illnesses (Kovats & Hajat, 2008). The effects of chronic dehydration can also lead to severe kidney disease (Crowe, Nilsson, Sjostrom, & Wesseling, C, 2015). Heat adaptation strategies are therefore an important area of research, particularly in developing countries with large numbers of outdoor workers, as in Zimbabwe. (Kjellstrom, 2009b). In contrast, in developed countries, research has identified successful adaptation strategies, such as health promotion interventions, early warning systems for heat events and greening of urban environments to provide shade in cities and combat the heat island effect (Limaye, Vargo, Harkey, Holloway, & Patz, 2018).

Other, less commonly reported effects of heat exposure include a reduction in motor and psychometric functioning, exhaustion and a loss of efficiency, when the core body temperature exceeds 38˚C (Kjellstrom, 2009a). The evaluation of current heat exposure and adaptation efforts is important for the purpose of establishing a baseline of strategies that populations adopt and for the development of appropriate interventions embedded in policies and procedures for the future.

1.3 THE UNIQUE CONTEXT OF URBAN INFORMAL SECTOR WORKERS

The International Labour Organisation (ILO) defines the urban informal sector as "industry units mainly operated and owned by individuals or in partnerships between family members that employ one or more employees"(Chattopadhyay, 2005 p. 46). Charman, Petersen, Piper, Liedeman, & Legg (2017) define informal industry as "unregulated by the institutions of society, in a legal and social environment where similar activities are regulated" (pp. 1-2). These

units operate on a small scale, with a low level of organisational structure and little or no division between labour and capital, the main objective being the generation of employment and basic income for the persons concerned. The majority of these workers engage in the production and distribution of services under extreme and hazardous conditions.

In Bulawayo, outdoor street vendors are considered to be informal sector workers, and their businesses are unregulated. Their social position leaves them vulnerable and they operate with inadequate health and safety standards, and are exposed to numerous environmental hazards, including extreme heat, which is regarded as a health hazard. The situation is exacerbated by a lack of proper shelter and suitable infrastructure (Haines, Kovats, Campbell-Lendrum, & Corvalán, 2006). Phuong et al., (2013) affirm that this group of workers are exposed to heat without access to formally provided adaptive and coping measures, leaving them to formulate their own solutions, which further exposes them to health-related risks. In Zimbabwe and several other developing countries, there is a lack of research on heat exposures experienced by populations, particularly those in the informal sector.

In addition to the environmental factors of ambient temperature, humidity and air circulation, metabolic work load can exacerbate heat related health impacts on exposed workers (Srivastava, Kumar, Joseph, & Kumar, 2000). Heat wave conditions in built up urban environments are exacerbated by the heat island effect, which is associated with increased heat absorption and reflection of the sun on the infrastructure in cities (Phuong et al., 2013).

Furthermore, the majority of these vulnerable people also live in inadequate “informal” housing with no access to cool resting environments. Most have no access to electricity, and those that do can’t afford air conditioning (Holmér, 2010; Hyatt et al., 2010; Kjellstrom, 2009b; Nilsson & Kjellstrom, 2010). It is therefore anticipated that an increase in the frequency of heat waves will impact significantly on this vulnerable sector of society (Young et al., 2010).

1.4 HEAT PREVENTION STRATEGIES

In developed countries it is considered the norm that strict labour legislation guidelines regulate work in extreme heat and there are well defined adaptation strategies protect workers. However, in most developing countries, such as Zimbabwe, there is a lack of public awareness and policy considerations on heat exposure, particularly in the informal sector (Langkulsen,

Vichit-Vadakan, & Taptagaporn, 2010); Phuong et al., 2013). The management of heat stress requires a consultative approach that includes all stakeholders who can influence policy changes aimed at minimising the hazard. According to Huang et al. (2011), policy makers in developing countries should include adaptive capacity building and adaptation implementation engagement to minimise heat stress. Preventive measures to reduce morbidity and mortality of workers, associated with heat stress in developing countries, may include early warnings, health promotion and improved working areas, including provision of adequate shade and ventilation, as well as access to cool sources of potable water. Other strategies include acclimatisation, use of fans, influencing behaviour change patterns, building design improvement and modified urban planning (Huang et al., 2011; Luber & McGeehin, 2008).

1.5 BACKGROUND AND SIGNFICANCE OF THE STUDY

Zimbabwe is a Southern African country that shares its borders with the Republic of South Africa, Botswana, Zambia and Mozambique. The combined land and water area cover 390 757 km^2. Harare is the capital and Bulawayo is the largest industrial city. Being a landlocked country, it is predicted that Zimbabwe will also warm more rapidly in the future than the global average (UNFCCC Zimnc1., 2012). Currently Zimbabwe is experiencing extremely hot seasons. According to the Zimbabwe's National Climate Change Response Strategy (2014), there is an increase in daytime temperatures between the months of September and November, as well as during the wet season, with an average minimum temperature of 12°C and an average maximum of 30°C, with erratic heat waves with temperatures above 35°C, coupled with high humidity events. Zimbabwe's economy has declined since the 1990s and this has resulted in the closure of industries with rising unemployment in the cities. The country also experiences droughts which has decreased its agricultural output, and this has caused many rural people to migrate to the cities in search of work. These marginalized people seek sources of income that invariable is gained in the informal sector where they have limited choices to protect themselves from heat exposure, thus making them more vulnerable to the impacts of climate change. The impact of extreme weather presenting as heat waves, results in thermal stress, and has become a major public health concern (Mpofu, 2010; Rusvingo, 2015; Sithole, Nkala, & Dube, 2012). In developing countries, without strategies and policies the adaptation to climate change effects the reactive or proactive responses cannot be measured. Given this context of a predicted increase in

heat stressful events, it is considered timely and important to provide empirical evidence related to heat exposure in Zimbabwe, which, in turn, will potentially influence the development of policies on the prevention of heat related morbidity and mortality. The process may influence public adaptations introduced and executed by government at all levels taking into consideration of their economic situation.

1.6 THE AIM AND OBJECTIVES OF THE STUDY

The aim of the study was to measure heat exposure levels and adaptation strategies to heat stress by outdoor workers. Governmental policies and strategies to mitigate the effects of heat stress for this vulnerable cohort were also explored. The following were the objectives of the study:

1. Assess the health services support for heat related illness and analyse government policies for managing heat stress in Zimbabwe.
2. Assess the knowledge and awareness of outdoor workers on heat wave risks
3. Measure temperature and humidity in various out-door informal sector workplaces and dwelling in the City of Bulawayo.
4. Explore the impact of heat stress, coping strategies and adaptive methods of outdoor informal sector workers
5. Evaluate the outdoor informal sectors workers' coping strategies
6. Provide recommendations to improve adaptive capacity on managing heat stress in Bulawayo.

1.7 RESEARCH METHODS, DATA COLLECTION AND ANALYSIS

The study employed a convergent parallel design which is a mixed methods research approach that combines quantitative and qualitative data collected at the same time, to merge results for the purpose of drawing conclusions about heat exposure and adaptation strategies of outdoor informal sector workers (Creswell, 2013). In this study, the design utilised the concept of triangulation in research to provide valid and conclusive findings (Charman, Petersen, Piper, Liedeman, & Legg, 2015).The mixed methods approach, as an alternative research paradigm,

detached from the configuration that signifies qualitative or quantitative methods of data gathering, analysis and their combination in this study, helped achieve the objectives (Johnson, Onwuegbuzie, & Turner, 2007). Both quantitative and qualitative strands were implemented at the same time during data collection and analysis.

Quantitative data was derived from the questionnaire interviews with outdoor workers, and thermal data was recorded with the aid of Lascar temperature and humidity sensors and Temp Stress heat stress monitors. The questionnaire used in this study was developed using an instrument (see Appendix A), which was validated by the South Australian Department of Health and the Asian Cities Climate Resilience Network. The questionnaire was translated into the two main languages of Zimbabwe (Ndebele and Shona) and employed a forward, committee and back translation method to ascertain criterion and conceptual equivalence for reliability and validity (Gausia, Fisher, Algin, & Oosthuizen, 2007). In forward translation, the Ndebele and Shona versions were translated by the principal investigator whose first language is Ndebele and who also speaks Shona. The initial versions of the questionnaires were discussed with Ndebele and Shona expert committee, who included language teachers, one nurse, two environmental health officers, one health promotion officer, as well as laypersons in both languages. To ensure validity, the translated questionnaires were translated into English by two independent native English-speaking health professionals conversant with Ndebele and Shona languages. The translated questionnaire was pilot tested on a sample of 20 informal workers prior to administration. The questionnaire interviews showed outdoor informal sector workers' knowledge and understanding of heat exposure, heat stress, and assessed their heat stress coping strategies together with adaptive methods.

In assessing the heat exposures of out-door informal sector workers in the City of Bulawayo (Zimbabwe) in both their work environments and at home, two Lascar heat sensors were deployed to each worker (n=30), to assess their personal exposure levels from air temperature (°C), dew point (RH%) and absolute humidity at work and in their homes. These instruments were pre-set to take a measurement every half hour from 9am to 9pm outdoors and 10pm to 5am in workers' bedroom for the entire hot season (September 2015 – December 2015). They were deployed in three areas of Makhokhoba, Lobengula and Cowdray Park (Bulawayo North) in Bulawayo. Random measurements with a traditional heat monitor (Quest Temptress) were taken to measure Wet Bulb Globe Temperature (WBGT) and correlated to LASCAR data

in order to validate the predicted WBGT from LASCAR data of temperature and humidity. The two types of heat monitors were chosen and used in this study because of their suitability and reliability. The WBGT is an international recognised and recommended occupational heat stress index as detailed by the International Standard Organisation 7933,2004. The Lascar thermal data logger is ideal for use in developing countries as it uses batteries that can last for approximately 11 months and the instruments are small, compact and easy to use. Lascar data loggers have been validated as a tool to assess heat stress and can be used to predict WBGT values from humidity and temperature data (Dozet, & Oosthuizen, 2017).

Focus group discussions with health services providers and policy makers in Bulawayo provided qualitative data. A paper-based checklist was used to collect data from the focus groups members on their knowledge and awareness of climate change, heat waves, heat stress and risks. The checklist also included a section on their knowledge of policies and projects aimed at heat stress prevention. The discussions with officials provided facts and themes that provided considerable insight into government policy and programs related to the management of heat stress, particularly applicable to this vulnerable cohort of outdoor informal sector workers.

The study population comprised one distinct cohort, i.e., outdoor informal sector workers, operating as street hawkers in the city centre and suburbs of Bulawayo. These people work without a defined management structure and are not covered by any legal provisions as technically their business activities are regarded as illegal. The City Council does not have a register of outdoor workers or vendors operating in the city, therefore a convenience sampling technique was used to recruit research participants as there was no sampling frame. This technique allowed the researcher to move around the research site and request subjects to participate. The researcher invited street vendors to participate and explained the scope and the requirements of the research and in particular what would be expected of them. Information letters were left with potential participants for a week, which allowed them some time to decide if they agreed to participate in the research. Those who agreed were requested to sign consent forms. A sample of at least 45 participants was recruited as recommended for administered questionnaire surveys, providing power of 80% and an alpha level of 10% (Morse, 1994). However, there was a high level of interest in the study and 123 street vendors were recruited.

In addition to this group, stakeholders who included health services providers in the city of Bulawayo and City Council policy makers were involved in focus group discussions. The

veracity of good research relies on good sampling strategy, which has transparent process of a sample selection. According to Abrams (2010), the mixed methods sampling approach criteria were appropriate to the research question. The sample was appropriate to generate comprehensive information with realistic explanations, which provided generalisability of findings within the study parameters. The sample also met ethical requirements and was feasible (Abrams, 2010). Invitations to participate and information letters were sent to potential participants a month in advance through the committees' chairpersons and a convenient time and location for the focus groups was negotiated. Participants signed consent forms prior to the commencement of interviews. Focus groups were limited to no more than ten participants (Collins, Onwuegbuzie, & Jiao, 2007). The focus group for the service providers was increased to 15 to cover all departments.

In analysing interview questionnaires, the Qualtrics Survey software was used in conjunction with the thermal risk assessment tool developed by the Australian Institute of Occupational Hygienists (Di Corleto, Firth, & Mate, 2013), to measure the heat exposure and risk of heat stress during summer. Grounded theory methods were used to gathering and analyse focus group data. The theory constructs substantiative data through coding information. The rationale of using this method in this study was to learn more about the cohort using questions to assess repeated ideas and concepts that would result in the construction of theories about their concerns. It encompasses its central criteria of "fit, comprehension, generality and control" which is the idea for focus group data.

1.8 PUBLICATIONS SIGNIFICANT TO THE THESIS

The research study is presented in chapters supported by papers submitted to international peer reviewed journals. The papers and chapters of this study are focussed on the anticipatory adaptation theory which promotes the proactive approach to heat exposure risks. Three papers have been published and one is under review.

1. Ngwenya, B., Oosthuizen, J., Cross, M., Frimpong, K., & Chaibva, C. N. (2018). A review of heat stress policies in the context of climate change and its impacts on outdoor workers: Evidence from Zimbabwe. (Published by *International Journal of Social Ecology and Sustainable Development (IJSESD), 9*(1), 1-11).

2. Ngwenya, B., Oosthuizen, J., Cross, M., & Frimpong, K. (2017). Emerging heat-related climate change influences; a public health challenge to health care practitioners and policy makers: Insight from Bulawayo, Zimbabwe. (Published by *International Journal of Disaster Risk Reduction*).
3. Ngwenya, B., Oosthuizen, J., Cross, M., Frimpong, K. Measurement of ambient temperature and humidity exposure of outdoor street vendors in Zimbabwe: An underrated public health issue. (Submitted to the American Institute of Mathematical Sciences (AIMS) Environmental Science Journal).

4 Ngwenya, B., Oosthuizen, J., Cross, M., & Frimpong, K. (2018). Heat Stress and Adaptation Strategies of Outdoors Workers in the City of Bulawayo, Zimbabwe.(Published by *Journal of Community Med Public Health Care*, *5*, 034).

1.9 THESIS OUTLINE AND STRUCTURE

This research is outlined in chapters; chapter one is a preamble introducing the study. As an introductory chapter it provides an overview of climate change and heat exposure effects on humans. Particular emphasis is placed on a unique cohort of unregulated informal sector workers. It explicates the heat prevention strategies in general. The introduction chapter also outlines the aim, objectives and study methodology. Papers that make up the thesis are laid out according to their status in terms of publications and the chapter also includes the thesis outline and its structure.

The second chapter published by the International Journal of Social Ecology and Sustainable Development is a review of heat stress policies in the context of climate change and its impact on outdoor workers in Zimbabwe. The paper gives a detailed account on the global impact of climate change on public health susceptibility amongst various human populations and their exposure to environmental heat induced conditions. It outlines the impact of climate change on street hawkers, who currently provide an income for many people in developing countries. This group is particularly vulnerable to the effects of heat stress. In investigating Zimbabwe's climate change and heat prevention policies, extrapolations were made from the data pertaining to other countries, with overlaps and gaps using France as a frame of reference from a developed

country context. The French experience of heat waves led to the development of policies through community participation, therefore, this experience was compared with Zimbabwe in terms of strategy. A conceptual framework linking heat exposure to susceptible vulnerable groups and their adaptation strategies, suitable for developing countries such as Zimbabwe, was developed and outlined in this paper.

Chapter Three provides an analysis of the data obtained focus groups discussions with Bulawayo city policy makers and health practitioners regarding their knowledge and awareness of climate change and its health impacts on the target population. The findings of this survey revealed a lack of knowledge, lack of awareness and failure in policy direction and programs aimed at protecting vulnerable groups such as outdoor street hawkers in Bulawayo. The paper is published by the International Journal of Disaster Risk Reduction.

Chapter Four outlines the extent of heat and humidity exposures of outdoor street workers. The paper was submitted to American Institute of Mathematical Science Environmental Science Journal. Lascar EL - USB -5 heat stress monitors were used to measure heat exposure levels experienced by outdoor street hawkers' at their informal workplaces and their homes at night. Wet Bulb Globe Temperature (WBGT) was assessed with a Quest Tempstress monitor. These data were used to validate readings obtained from the lascar sensors during the summer months of September to November 2015 in Bulawayo. The lascar instruments were appropriate for deployment in this study population and the sensors captured micro-climatic temperature and humidity conditions at people's places of work and at home. The results showed that outdoor workers are exposed to high levels of heat and are at risk of developing heat related illnesses.

Chapter Five consists of an outline of a published paper by the Journal of Community Medicine and Public Health Care. The outdoor street workers reported through interview process that high temperatures and heat events were currently common events that were affecting them due to their inadequate coping strategies. They accept the fact that they have an occupation that requires spending long hours exposed to heat and are prone to heat stress and other heat related illnesses. Thermal risk assessment was used to measure the hawkers' situation and it showed the evidence of exposure to heat stress. The street hawkers in Bulawayo showed a lack of knowledge about heat stress, consequently operating without government support and not aware of adaptation strategies.

Chapter Six, as the final chapter, concludes the research study and provides a summary of the findings with recommendations

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A REVIEW OF HEAT STRESS POLICIES IN THE CONTEXT OF CLIMATE CHANGE AND ITS IMPACT ON OUTDOOR WORKERS: EVIDENCE FROM ZIMBABWE

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CHAPTER 4

MEASUREMENT OF AMBIENT TEMPERATURE AND HUMIDITY EXPOSURE OF OUTDOOR STREET VENDORS IN ZIMBABWE: AN UNDERRATED PUBLIC HEATH ISSUE

This chapter was submitted to the AIMS Environmental Science Journal. The paper presents data on measured ambient heat and humidity levels in both outdoor workplaces and in the homes where street vendors rest at night. Lascar EL-USB -5 heat stress monitors were deployed to record thermal data for the duration of the study period. A traditional heat stress monitor (Quest Tempstress Wet Bulb Globe Temperature monitor) was used to validate lascar results.

4.1 ABSTRACT

Extreme climate change induced summer heat events are a cause for concern, particularly for vulnerable groups of people, such as the poor, elderly and those who work outdoors. The occurrence of heat related illness and mortality is predicted to increase in the future. There is a lack of evidence regarding the levels of heat exposure outdoor street hawkers are subjected to. This group of informal workers constitute a large part of the self-employed workforce of many developing countries. This study measured air temperature and humidity experienced by Zimbabwean street hawkers at their workplaces and homes to quantify their levels of heat exposure during the day, as well as at night. The Easy Log USB Software and Heat Stress Software were used to analyse data collected using the Lascar monitors and the QUESTemp QT-34 Wet Bulb Globe Temperature (WBGT) monitor. Two separate heat waves were experienced during the sampling period in October and November. 2015 and temperatures ranged from 38.3°C (day time) and over 22°C at night. Relative humidity ranged from 19.5 % to 76.5%. Among this cohort some did not have access to cooling at night and many live-in inadequate housing. Temperatures in their homes ranged from 23 °C to 31.5°C, with relative humidity 14% - 52%. Public health authorities, particularly those located in the tropics, need to prepare to cope with future impacts heat waves (IPCC, 2007) could have on their populations. Proactive public health approaches towards climate change effects need to address policy, public education and resource mobilisation in an effort to prepare for future weather and climate change heat burdens.

4.2 INTRODUCTION

Climate change effects include extreme heat wave events with high temperatures and humidity combining to create conditions that present a significant public health risk to various societal groups. Currently there is no universal approach for assessing effects of climate change impacts, or a conclusive definition of a heat wave. Various studies utilise regional weather–mortality relationships, or comparison with regions with a similar climate using various metrics (Kinney, O'Neill, Bell, & Schwartz, 2008). Some use temperature thresholds to evaluate the start and the end of the heat wave. This study defines a heat wave based on the average minimum temperature of 23°C and a maximum of 31°C or greater during summer in Bulawayo (Gosling, Lowe, McGregor, Pelling, & Malamund, 2009). Thus, a heat wave is defined in this study, as an extended period of at least three or more consecutive days of extreme maximum day time temperatures above 31°C and minimum night time temperatures of 23°C. Such conditions have health impacts that are considered to be more severe among the poor, especially in developing countries, who do not have access to, or cannot afford electricity for cooling and effective home insulation. Excessive heat exposure due to such a heat wave, particularly when people cannot cool down at night, will inevitably result in cases of heat stress and heat related illnesses. The most vulnerable include outdoor workers, particularly those who work in the informal sector, lower socio-economic groups, the elderly, and those with underlying health issues (Kjellstrom, & Weaver, 2009; Ngwenya, Oosthuizen, Cross, & Frimpong, 2017).

The situation in Zimbabwe is intensified by limited rain due to climate change and the economic decline over the last few decades that caused food insecurity and unemployment (Rusvingo, 2015). Many subsistence farmers from rural Zimbabwe have now migrated to cities such as Bulawayo where they struggle to find work. Many, therefore, end up working in the informal sector as street hawkers, usually working in direct sunlight, in environments that are not able to be cooled, and often with no access to adequate housing, which effectively means people do not have opportunities to cool down at night (Dozet & Oosthuizen, 2017). Working in such extreme heat, impacts negatively on productivity, health and wellbeing (Frimpong, Eddie, Oosthuizen, & Nunfam, 2017; Kjellstrom, Holmer, & Bruno, 2009). This phenomenon is not unique to Zimbabwe, as street hawking (vending) has become the main source of livelihood for many people in tropical countries throughout the developing world

(Gosling et al., 2009; Nilsson, & Kjellstrom, 2010). There is a lack of empirical evidence to quantify the level and impact of high temperatures and humidity on street hawkers and a lack of strategies for managing heat related health effects (Ngwenya et al., 2017; Parsons, 2014). The current trend of increasing extreme heat events will impact populations of developing countries located in the tropics. The situation will be exacerbated by poverty and poorly constructed non-insulated dwellings with inadequate ventilation. These vulnerable people are more likely to suffer heat related illness and are unlikely to access adequate medical treatment. Many urban environments also suffer from heat island effects and city planners and councils do not have the necessary skills and resources to develop urban landscapes that are more conducive to coping with global warming (Ngwenya et al 2017; Kjellstrom & Weaver, 2009). Many studies concur that heat related illnesses and deaths amongst vulnerable groups in urban areas are due to climate change exacerbated by the urban heat island effect (Kovats & Hajat, 2008; Luber & McGeehin, 2008).

In contrast to developed countries, there is little evidence of studies assessing heat related illnesses due to climate change in the agricultural areas of Africa (Frimpong et al, 2017; Kenyon & Hegerl, 2008; Gleeson, 2008) and for outdoor street hawkers (Costello, Abbas, Allen, Ball, Bell, Bellamy, & Lee, 2009; Basu, 2009). Therefore, it is considered vital to gain an understanding of the heat and humidity exposure faced by outdoor street workers during extreme heat events and the ways in which they adapt to alleviate associated health risks (Huang, Vaneckova, Wang, FitzGerald, Guo, & Tong, 2011; Ngwenya, Oosthuizen, Cross, & Frimpong, 2018) and to determine the adaptation strategies to heat stress by this cohort of street vendors in urban Bulawayo during summer.

This assessment of temperature and humidity in the streets and homes in the City of Bulawayo, Zimbabwe provides empirical data on the levels of exposure that street vendors working in the informal sector are exposed to. The results provide baseline data on which to develop practical solutions to mitigate the health risks faced by this vulnerable population, and to guide the development of a heat stress policies which are currently not found to exist (Ngwenya, Oosthuizen, Cross, & Frimpong, 2018). This study was conducted in Bulawayo, Zimbabwe during the summer months of September to November 2015. Historically, Bulawayo had the country's heavy engineering and manufacturing firms and was the feeder city for export to South Africa, Botswana and Zambia by rail network. The industries employed the majority of its population of over half a million. During the decline of the

country's economy, the majority of the working class lost their jobs and joined the informal sector industry that includes street hawking to make a living. Their operations are illegal and have no support from either the government or the local authority (Rusvingo, 2015; Ngwenya et al., 2017). The conditions in which they operate, expose them to heat related illnesses and other environmental hazards which can lead to contracting other communicable diseases.

Prior to commencement, ethics approval was gained through the Edith Cowan University Human Research Ethics Committee.

The objectives of this study were promoted to potential participants along with an explanation of the purpose and use of the Lascar data loggers prior to gaining their consent to participate. Information letters written in their native languages were left with potential participants for a week so that they could discuss the project and have time to decide regarding their involvement.

4.3 MATERIALS AND METHODS

Lascar EL-USB -5 and Quest, Tempstress heat stress monitors were used to assess the thermal environment. The Lascar sensors were programmed to record air temperature (°C) relative humidity (RH%) and dew point (°C) (absolute humidity) every 30 minutes. The instruments have a battery life of 11 months and they are small and portable. Each study participant (n=30) was given two sensors, one to be kept at their workplaces and the other in their homes, for the duration of the study (September – November 2015). The workplace data loggers were programmed collect measurements from 9am to 9pm, and those positioned in bedrooms were set to log data from 10pm to 5am. The sensors were deployed in three areas of Makhokhoba, Lobengula and Cowdray Park (Bulawayo North) suburbs, 18 km apart, and as shown in Figure 3 below.

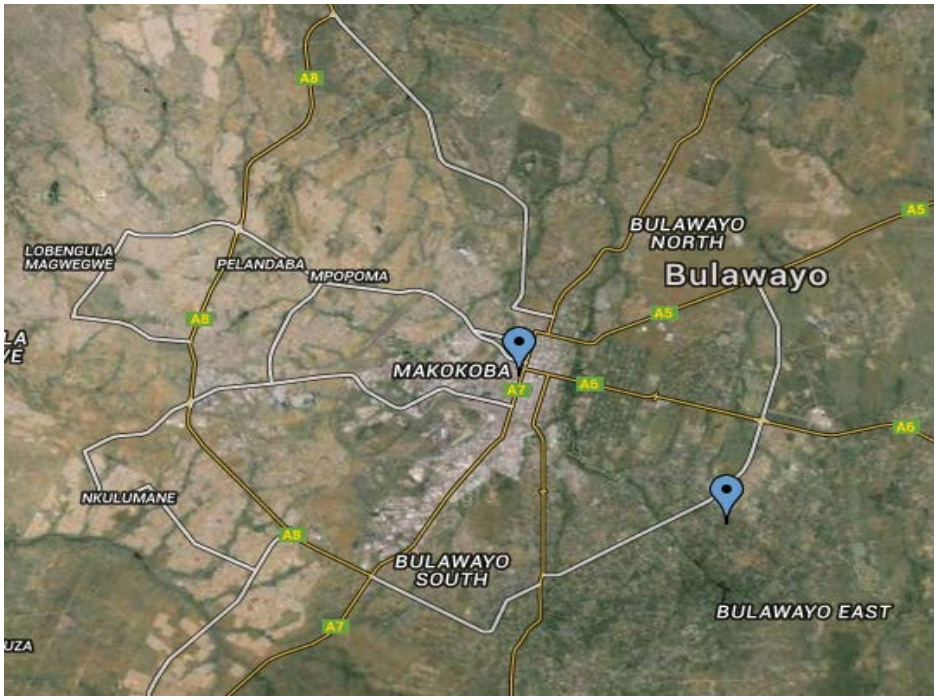

Figure 3. Map of Bulawayo. (http://www.maplandia.com/zimbabwe/bulawayo/bulawayo-urban/bulawayo).

A convenience sample of 30 street hawkers (vendors), who had makeshift sheds in a set location for their business, were the focus of this study; whereas those who moved around during the day peddling their wares were excluded. The Lascar recordings included data collected over 91 days which was considered the peak of summer (1st September to 30th November 2015). Weather conditions were typical for the region with a combination of dry and wet days. Data loggers deployed at both the work sites and houses of street vendors recorded temperature, humidity and dew point every 30 minutes, resulting in 4 344 logged data points. Traditional heat stress monitor, QUESTemp QT-34 Wet Bulb Globe Temperature (WBGT) monitor, was also deployed in close proximity to the vendors during the same summer period of 2015, randomly at different times during the day, to provide validation of the lascar measurements.

Two separate heat waves were experienced during the sampling period in October and November 2015. This was indicated by the Lascar measurements, which recorded a maximum temperature for the three regions of 38.3°C in November; along with a minimum temperature of 18°C. Relative humidity ranged from 19.5 % to 76.5%, and dew point from 0.5°C to 13°C, (see figure 4).

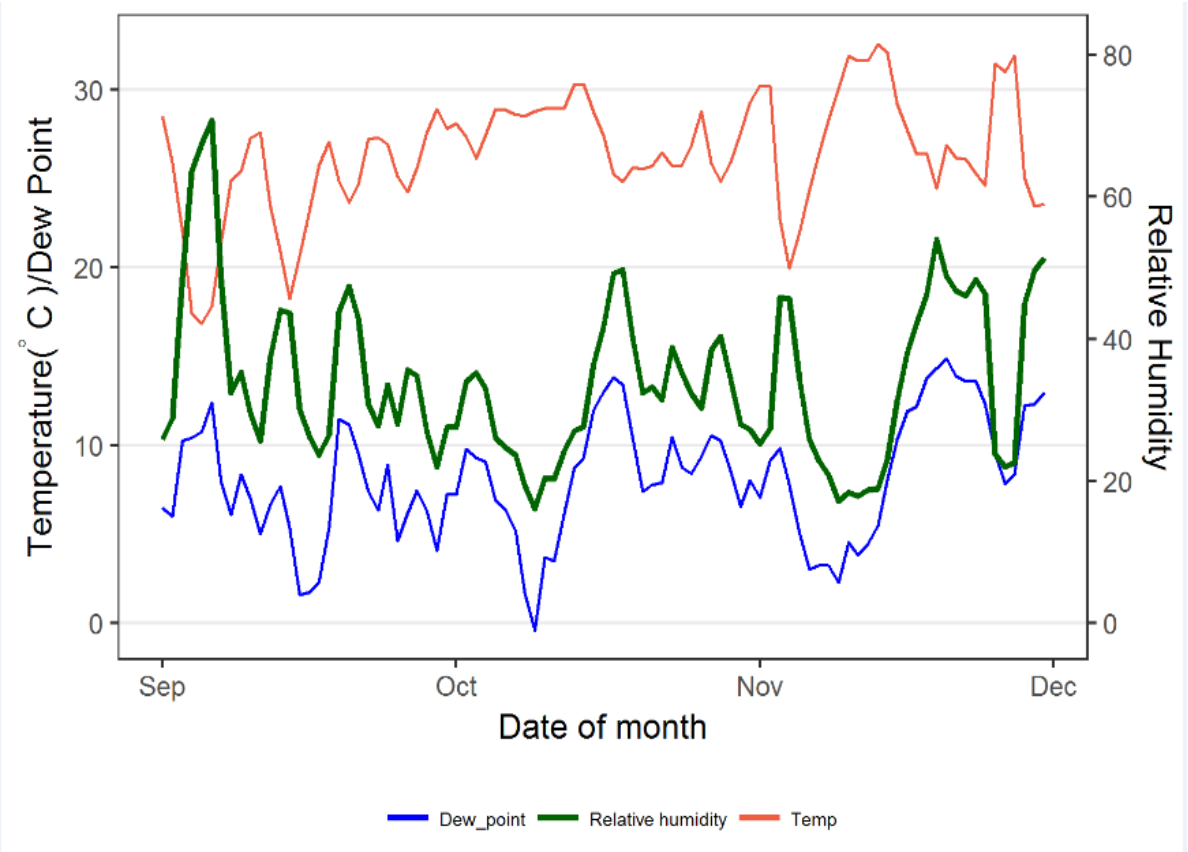

Figure 4. Average outdoor temperature, relative humidity and dew point measures for the 3 regions

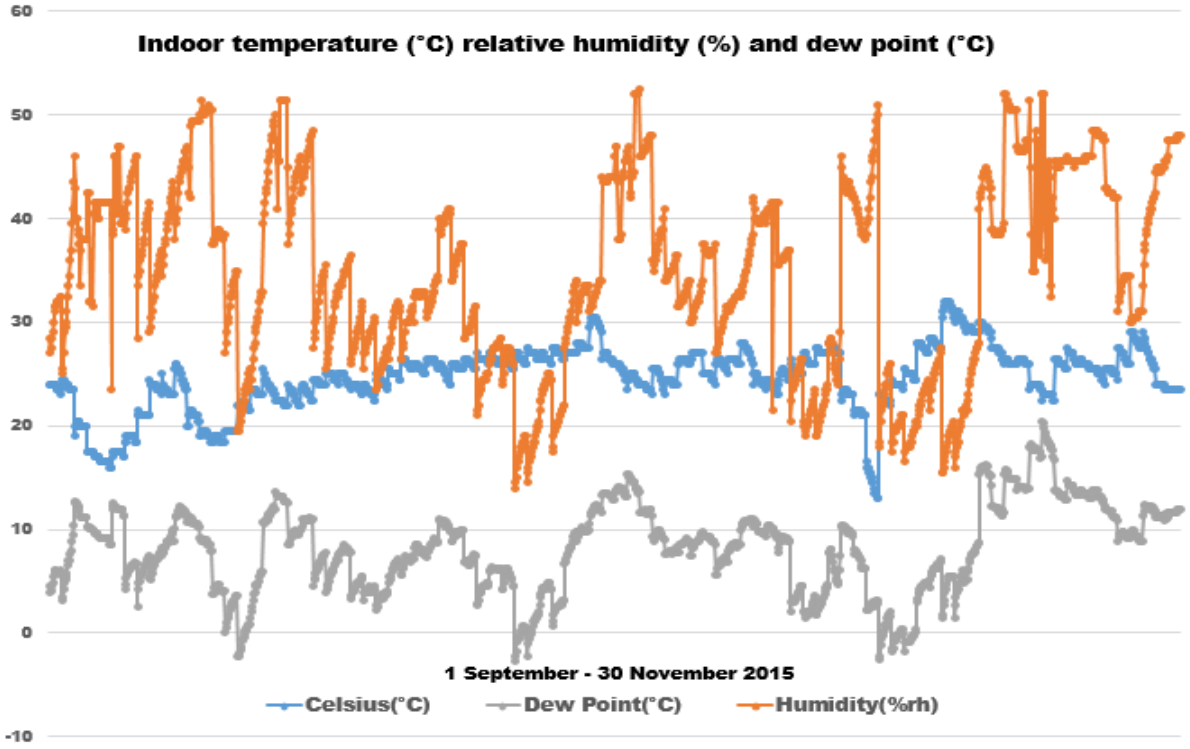

Figure 5. Lascar indoor temperature, relative humidity and dew point measures

Indoor average temperature, relative humidity and dew points results were consistent for the three sites studied. The generally average air temperature was 23 °C with a maximum of 31.5°C, whilst the relative humidity was also between 14% - 52%, as shown in Figure 5 above.

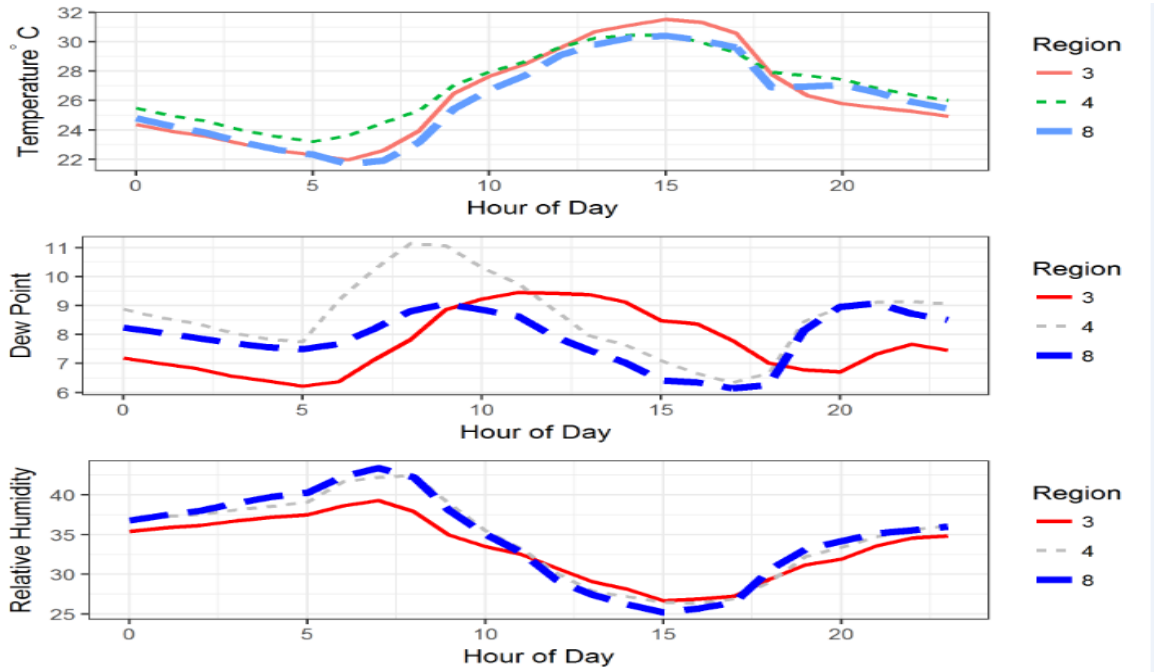

Figure 6. Peak temperature, relative humidity and dew point measurements and regional comparison

In all three regions the average temperature increased after 10AM from between 28 °C – 32°C, reaching a peak at 3PM which from observation appeared to be the vendors' busiest time. The ambient environmental temperature started to cool down after 8PM while the dew point and RH was higher in the mornings before 10AM as shown in Figure 6 above.

The comparison of the Lascar derived the temperature, dew point, and relative humidity measurements for the three regions, (Lobengula – Magwegwe – (Region 3) = 31°C ,9.5°C and RH 37%; Cowdray Park -Bulawayo North – (Region 4) = 29°C, 11°C and RH 44%; Makhokhoba – (Region 8) = 28°C, 11°C and RH 45%). All three parameters were relatively consistent, with Lobengula - Magwegwe showing a lower dew point and relative humidity in the middle of September as compared to the other two regions.

4.3.1 WBGT MEASUREMENTS

In an attempt to validate the Lascar outdoor results, these data were correlated with the QUESTemp QT-34 Wet Bulb Globe Temperature (WBGT outdoor) data. Table 4 shows day time average temperature levels. WBGT is currently the internationally recognised measure of the heat stress and was used for assessment and to substantiate empirical evidence (ISO 7933, 2004).

Table 4

Monthly WBGT Day Time Average Temperatures Range for Summer

Variable	Region	Month		
Averages WBGT outdoor in the shed		September	October	November
	Lobengula - Magwegwe 3	28.4	39.5	40.0
	Cowdray Park - Bulawayo North 4	28.3	38.2	39.1
	Makhokhoba 8	29.3	39.1	38.5

The difference in WBGT results from the three sites was minimal and correlated well with the results derived from Lascar heat monitoring. The temperatures ranged from 28°C to 40°C which is higher than the normal outdoor ambient temperatures during this season in Bulawayo. The peak temperatures of between 31°C - 38°C, over several days constituting a heat wave event, as defined by Beniston, (2004) occurred in October and November 2015.

4.4 DISCUSSION AND CONCLUSION

The results of this study provide evidence of the extremes of heat endured by the street vendors at work during the day time, and during their rest and relaxation period at night time. Bulawayo experienced two heat waves during the months of October and November 2015, and the population of outdoor street vendors experienced excessive temperatures and high humidity conditions. These empirical measures are important in determining the extent of the problem and to inform public health authorities of the extent of this issue so that they are better equipped to develop future plans of managing heat related situations. Interventions to prevent heat stress are necessary, particularly in developing countries in the tropics, where heat wave events are predicted to be on the increase (IPCC, 2007). The findings of this study highlight a requirement for heat illness health surveillance programs, and policies that will enable local health authorities to protect their citizens from heat related illnesses.

This study also established that Lascar Easy Log USB monitors are effective, reliable and valid devices that can be deployed by local health authorities to determine the potential

for heat stress for specific cohorts in the community, particularly those working outdoors and people without electricity and adequately insulated housing. The instruments are relatively inexpensive and not as bulky as the traditional QUESTemp QT-34 Wet Bulb Globe Temperature (WBGT) heat stress monitors. Lascar instruments are easy to use, and provide localized micro-climate data, which is more relevant than utilising generic data from meteorological stations. The Lascar monitor provides a simple and practical way for surveillance of temperature, humidity and dew point. These instruments are particularly well suited for use in developing countries. However, in this study cohort it was necessary to overcome concern of some street vendors that the "gadgets" with their flickering light had some sinister ulterior purposes. This was a particularly sensitive issue due to the political instability in the area, and with the arrival of new Satanism churches levels of suspicion were high, this was heightened by the fact that the study cohort know they were engaged in illegal work. However, the researcher was able to allay these concerns as he was a local person originally from Bulawayo and he was able to explain the operation of the instruments and the purpose of the study.

It has been reported that prolonged exposures of over 12 hours to temperature range of 28°C – 30°C accompanied by days of high humidity are conducive to heat stress, heat related illnesses, heat exhaustion, and potentially heat related deaths (Luber & McGeehin, 2008). The work of static street vendors is considered to be relatively sedentary, thus they do not produce much metabolic heat and this provides the majority of the workers with some level of protection; However, due to their economic status and housing they are not able to escape the heat and cool down effectively; there is no respite as their accommodation is not equipped with cooling systems. The temperatures of 23°C - 31°C is debilitating (Frumkin, Hess, Luber, Malilay, & McGeehin, 2008), particularly at night. Prolonged periods of exposure to excessive heat and high humidity are conducive to heat stress and heat related illnesses, which, if predictions are correct, will be exacerbated due to climate change.

Despite the counter argument that this population will acclimatize over time, the results of this study indicate a possible significant health risk to this cohort of workers particularly for children, elderly workers or those with chronic pre-existing disease.

This study demonstrates that there is a practical way to monitor heat stress using the Lascar temperature, dew point, and relative humidity data loggers particularly for outdoor

occupations such as street hawkers in developing countries. It removes the reliance on the local meteorological data which is imprecise for determining localized heat stress risks. The use of the lascar monitor is a user-friendly way for environmental health and safety practitioners to predict the risk in cities like Bulawayo, to produce evidence based long-term heat stress prevention strategies and health awareness programs. Such a risk assessment coupled with epidemiological evidence of heat-related morbidity will inform policy formulation and infrastructure design for the future and foreseeable climate change impacts.

Various national climate change mitigation strategies have been available in developed countries. However, developing countries face challenges such as scattered vulnerable populations living in underdeveloped areas with no infrastructure in place. This study indicates that there is a heat stress issue and the need for public health action on the climate change effects on human health. Zimbabwe, the subject of this study, and other developing countries need to engage health professionals to conduct health risk assessments in order to build response strategies to climate change. Public health workers require extensive training in environmental monitoring, and risk assessment to help develop and implement climate change mitigation strategies. These professionals have a crucial role to play as they need to inform, educate and empower the local population and elected officials regarding climate change and heat stress mitigation strategies. It may be necessary to call on international institutions to influence the local policy makers and to provide expert advice on mitigation strategies that could help build resilience and self-efficacy among this vulnerable sub-population of outdoor workers who need to develop coping mechanisms and heat adaptation strategies (McGushin, Tcholakov, & Hajat, 2018; Frumkin et al., 2008).

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CHAPTER 5

HEAT STRESS AND ADAPTATION STRATEGIES OF OUTDOOR WORKERS IN THE CITY OF BULWAYO, ZIMBABWE

This chapter outlines the findings from personal interviews with street hawkers in the City of Bulawayo about their workplace conditions, understanding of climate change and heat related illnesses. The interviews also covered their adaptation strategies during the hot summer season. The results showed a lack of understanding of both climate change, heat stress and other heat related illnesses. The hawkers reported operating under unbearable conditions. This chapter was published by the Journal of Community Medicine and Public Health.

5.1 ABSTRACT

Extreme temperatures due to global warming are impacting negatively on the general population in many regions of the world, yet heat-related illnesses remain largely overlooked. Heat-related morbidity and mortality is predicted to increase because of climate change. Environmental heat is emerging as a key public health issue, particularly amongst poor and vulnerable sectors of society in developing countries. This study assessed the exposure of outdoor street vendors in Bulawayo, Zimbabwe, to extreme heat whilst working between seven- and thirteen-hour shifts per day and mostly in direct sunlight during summer months. This group of workers is particularly vulnerable to heat-related and other health problems as they are deemed to be illegal traders and operate without the support of a legislative framework to monitor their health and wellbeing. Due to the increase in temperatures caused by climate change in Zimbabwe, there is an urgent need for government to develop heat prevention policies, heat prevention guidance measures and extensive programs for outdoor workers to increase their knowledge and awareness of the issue. It is also necessary to develop adaptation and coping mechanisms amongst this vulnerable sector of society, while also exploring other preventive measures that could reduce heat exposure more broadly.

5.2 INTRODUCTION

Global warming due to climate change is a topical issue, with average surface temperatures projected to rise by between 1.8–4.0°C by the year 2100 worldwide (IPCC, 2007). As a result, various environmental health hazards and health-related issues including heat-related illnesses will emerge as public health problems in the future, particularly in

developing countries, including the Southern Development Community (SADC) (Langkulsen, Vichit-Vadakan, & Taptagaporn, 2010b) . The impact of climate change and associated heat events on economically disadvantaged groups, particularly in developing countries, needs to be assessed and mitigation strategies must be developed to protect people and alleviate suffering of vulnerable groups, such as those engaged in low-paid jobs and working outdoors (Langkulsen, Vichit-Vadakan, & Taptagaporn, 2011; Nilsson & Kjellstrom, 2010).

The frequency of extreme heat waves has been increasing, leading to excess morbidity and mortality, particularly in developing countries (Koppe et al., 2004). The burden of heat-stress-related illness is predicted to rise due to climate change effects (Ebi, 2008; Phuong et al., 2013). People of low socio-economic backgrounds, outdoor street vendors, and those with cardiovascular, respiratory and cerebrovascular diseases are deemed most vulnerable to the effects of heat waves (Langkulsen et al., 2011). In developing countries, the effects are more pronounced as there is a general lack of understanding of heat-related risks and communities generally have poor adaptive capacity, largely due to their inability to gain access to electricity and air conditioning (Nag, Nag, Sekhar, & Pandit, 2009).

Outdoor street vendors in developing countries, including in the city of Bulawayo in Zimbabwe, comprise a group of occupations that involve spending extended hours exposed to high temperatures and radiant heat without cooling sources or adaptation measures. In addition to the well-documented effects of heat stress such as heat cramps, heat syncope, heat exhaustion, heat stroke and mortality, this cohort will experience these effects in the future (Holmer, 2010; Luber & McGeehin, 2008; Nilsson & Kjellstrom, 2010). There are many more sinister health effects associated with chronic heat exposure and dehydration, particularly kidney disease, which impacts negatively on those exposed to heat (Di Corleto, Firth, & Maté, 2013). In developing countries such mortalities may be misdiagnosed or not recorded due to lack of knowledge amongst health professionals and the population (Ngwenya, Oosthuizen, Cross, & Frimpong, 2017).

Studies have shown that hot summer temperatures in Zimbabwe from 1955 to 2003 increased by 1.86°C per decade (Alexander et al., 2006). Bulawayo, the second-largest city in Zimbabwe, has a sub-tropical climate with semi-arid hot summer temperatures averaging 29°C, however, the recent summers have been much hotter. During 2015, the city experienced two weeks of heat events — one in October and the other in November — with

average daily temperatures of 32°C, and some days reaching 40°C. These temperatures were accompanied by high humidity levels (Ngwenya et al., 2017).

Bulawayo was the principal industrial hub of Zimbabwe in 1980s, however, due to the country's economic meltdown most industries closed, leaving over 130,000 economically active people working outdoors as street vendors, selling new and second-hand clothes, fruits and vegetables (Zim Stats, 2012). This cohort of workers is particularly susceptible to heat exposure as the city environment is also impacted by the urban heat-island effect (Phuong et al., 2013). Working long hours implies that these workers could potentially be suffering from the effects of heat stress.

The most critical factors in determining levels of heat-stress risk include: metabolic workload, average temperature of the surrounding area, humidity, and air circulation (Srivastava, Kumar, Joseph, & Kumar, 2000). Outdoor street vendors do not have high metabolic workloads for most of the day as they are usually seated or standing near their stalls. The physically demanding part of their work would be experienced when transporting their wares to and from their place of business; however, this occurs during the cooler part of the day. Although their work can be described as sedentary, they are generally seated in direct sunlight for many hours exposed to high temperatures and humidity without protection. These workers are also at risk of suffering dehydration due to sweating and lack of access to adequate clean water. These conditions can cause chronic health problems that may affect kidney function (McMichael et al., 2008).

The dilemma of outdoor workers is further exacerbated by the fact that most of the exposed population live in inadequate housing and have no access to cool resting environments. Some people have no access to electricity, nor would they be able to afford air conditioning if they had electricity (Holmer, 2010; Hyatt, Lemke, & Kjellstrom, 2010; Kjellstrom, Holmer, & Lemke, 2009; Nilsson & Kjellstrom, 2010). It is therefore anticipated that an increase in the frequency of heatwaves will impact significantly on this vulnerable sector of society in the future (Young et al., 2010).

To prevent heat-related illnesses, people employed in outdoor occupations, health professionals and policy makers should have adequate knowledge about the public health impacts of heat and the development of heat prevention strategies. In developing countries,

capacity-building across the board can enhance peoples' adaptation methods to the impacts of heat, thus reducing heat-related morbidity and mortality. From a government perspective it is necessary to recognise these 'informal' illegal street vendors, who represent an extremely vulnerable sector of society, and implement relevant interventions such as: provision of shade and cool potable water; health-promotion actions directed at building resilience and coping strategies; and informing vendors when and how to seek early medical attention should it be required (Huang et al., 2011; Phuong et al., 2013).

In developed countries, strict labour legislation guidelines regulate work in extreme heat and there are defined adaptation strategies that protect workers (Kjellstrom, 2009b). However, in most developing countries such as Zimbabwe, there is lack of public awareness and policy considerations regarding heat exposure (Langkulsen et al., 2010b; Phuong et al., 2013). Management of heat stress requires a consultative approach with all stakeholders to make decisions that may influence policy changes towards minimising the hazard. According to Huang et al, developing countries should include adaptive capacity building and adaptation implementation engagements to minimise heat stress. Preventive measures to reduce morbidity and mortality of workers associated with heat stress in developing countries may include early heatwave warnings, health promotion and improved working areas, including provision of adequate shade and ventilation, as well as access to cool sources of hydration. Organised land use and improved design plans of buildings, air conditioning use and adjustment to conditions are significant in prevention of heat effects (Huang et al., 2011; Luber & McGeehin, 2008). However, in developing countries some of these strategies may not apply due to socioeconomic factors. There is lack of studies in developing countries, in particular the SADC, on monitoring heat effects on people and developing adaptation strategies to protect them.

5.2 MATERIALS AND METHODS

5.2.1 Study area and population

This study was conducted in Bulawayo, Zimbabwe, a city with a population of 653,337, during the summer of 2015/2016. A sample (n=123) of street vendors (hawkers) were interviewed to obtain information about their understanding and experiences of heat stress. The study sample comprised adults from the age of 18 years and above working as street vendors. The majority were of low socioeconomic status, as street vending was their only source of income This research examined adaptation methods of outdoor street vendors

to heat exposure in the context of developing countries, where outdoor occupations are a source of livelihood for many people. Quantitative methodology was employed to examine street vendors' adaptation methods to cope with extreme heat events and their coping strategies, using structured interviews.

A basic thermal stress, level 1 risk-assessment tool, developed by Di Corleto, Firth, & Maté (Di Corleto, Firth, & Maté, 2013) in Australia for occupational health stress, was used to estimate street vendors' risk levels.

Street vending is illegal in Zimbabwe and the Bulawayo City Council did not have a register of vendors operating in the city, therefore a convenience sampling technique was used to recruit research participants, who included adult males and females of different age groups. This technique allowed the researchers to move around the city centre requesting subjects to participate. Vendors were invited to participate in the study and the scope and requirements of the research was explained to them, particularly what would be expected of them. Information letters were left with potential participants for a week, which allowed them some time to decide if they wanted to be part of the research. Adult outdoor vendors who have permanent defined work areas in the city centre and suburban areas were targeted. A sample of at least 45 participants was recommended for administering questionnaire surveys of this nature, providing power of 80% and an alpha level of 10% (Morse, 1994), however for saturation, a total of 123 participants were recruited to ensure and increase the credibility of findings.

5.2.2 Data analysis

Qualtrics Survey Software was used to analyse interview questionnaire data and a thermal stress risk assessment tool was used to verify that the outdoor workers were at risk from heat stress during the summer months in Bulawayo.

5.3 RESULTS

5.3.1 Demographic characteristics

A total of 123 street vendors participated in the study. This cohort included 59.35% men and 40.65% women, of which 52.07% were married, 41.32 % were single and 6.61% were widowed, divorced or separated. Most of the respondents (79.67%) had high school education, 16.26% primary education, 2.44% tertiary education, and 1.63% had no formal

education. It is interesting to note that most participants in this cohort had attained a good education level and under better economic conditions they would possibly have been in formal employment. In terms of household status, 80% were heads of households and 20% were not, and 89.35% were self-employed, with only 10.65% working as employees. The participants had spent between two and eleven years working as street vendors for between seven to thirteen hours per day. Monthly income levels ranged from less than USD$50 to $300. The majority, 47.15% earned less than $50, 27.64% had an income of between $51 and $100, and 25.20% received $101–$300 from selling fruits and vegetables, and new and second-hand clothes for their livelihood.

5.3.2 Participants' health assessment

In self-assessing their health, 57.72% considered themselves to be in good health, 21.95% reported to be having reasonable health, 11.38% reported excellent health, 7.32% stated their health status was poor and 1.63% acknowledged having very poor health due to heart-related illnesses and respiratory disease conditions.

5.3.3 Heat exposure risks

Of the participants, 85.5% reported spending long hours under direct sunlight, which reflects a high risk of heat stress and other heat-related illnesses. Meanwhile, 15.5% reported not working under direct sunlight as they managed to obtain vending spaces under shop verandas or in constructed stalls covered with plastic or canvas materials.

More than half of the respondents stated that in the last two years temperatures had increased a lot in Bulawayo, and 82.93% acknowledged that heatwaves have become more common in the last two years. The majority of participants mentioned that heat events cause problems, and 72.80% alluded to the fact that heat events contribute to high mortality as they believe people get ill and are more likely to die during summer than winter.

As demonstrated in Figure 7, when questioned on their workplace conditions in summer, 98 participants reported experiencing very hot temperatures, 23 stated conditions as hot and 2 as normal. In terms of humidity, 28 regarded conditions as very humid, 82 humid, 12 as normal and 1 considered conditions to be cool. When asked to compare conditions at their houses with those at their workplace, 84% stated that their homes were cooler than the workplace because they have chrysolite asbestos roofing, 15% perceived the workplace was cooler than their homes and 1% were unsure.

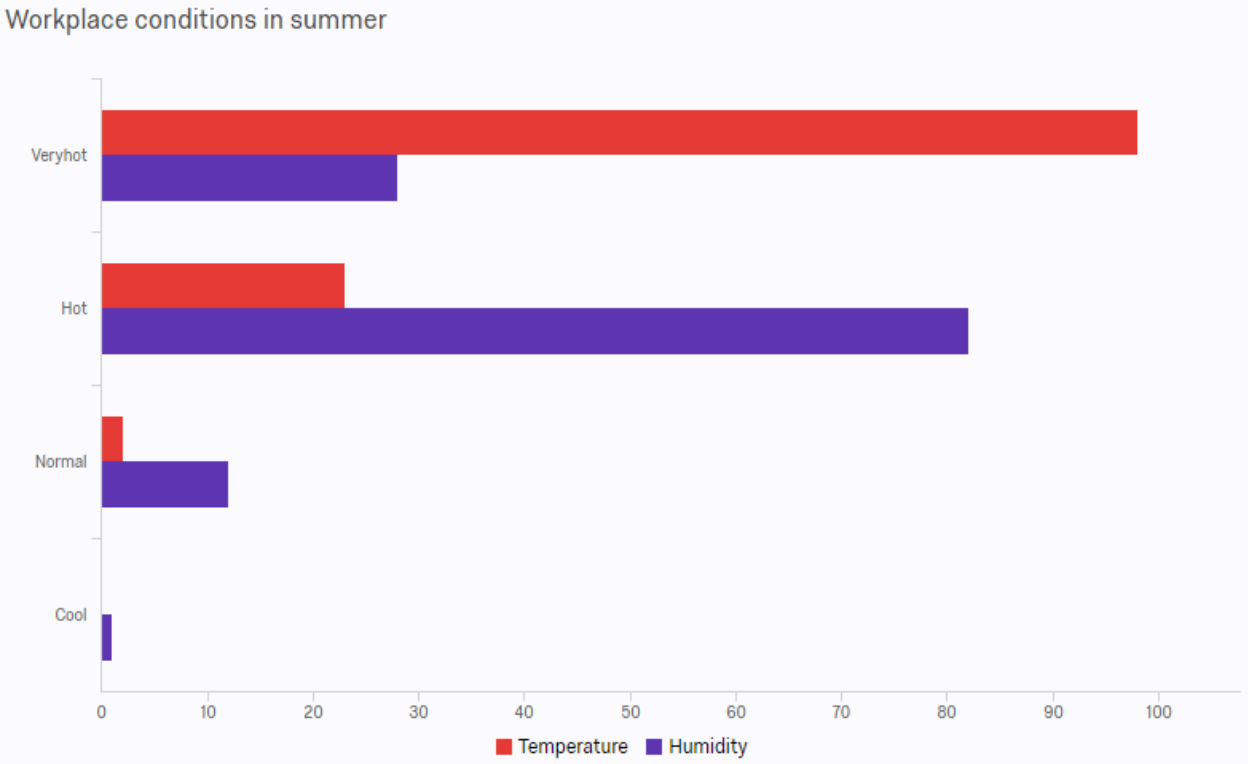

*Figure 7***.** Workplace conditions in summer.

5.3.4 Heat-related illnesses

The interviewed participants had heard of heat-related illnesses but were unsure of various conditions associated with heat exposure. Of the respondents, 58.0% had heard about heat stress whereas 42.0% had never heard of it. This was evident when participants were asked to respond to the causes of heat stress. Almost half the cohort (49.10%) had no answer, whilst 20.66% mentioned temperature, 32.23% direct sunlight, and 4.9% cited humidity. When questioned about the types of heat-related illnesses, 50.01% did not know these, 22.13% mentioned heat stroke, 12.30% mentioned heat exhaustion, and 15.57% stated heat cramp. When asked to elaborate on symptoms of heat stress, 85.6% cited confusion and high temperature.

5.3.5 Developed illness in summer

More than half of the respondents (57.02%) reported that they became ill between September and November whilst working in the heat, and 42.98% reported no illness during the summer. Headache was reported as the most common symptom suffered by participants, followed by muscle aches, elevated body temperature, difficulty breathing, dizziness,

insomnia, and hot dry skin. A few mentioned dizziness, vomiting and poor diet. This indicates that outdoor workers may suffer from heat-related symptoms at one stage during the hot season as shown in Figure 8.

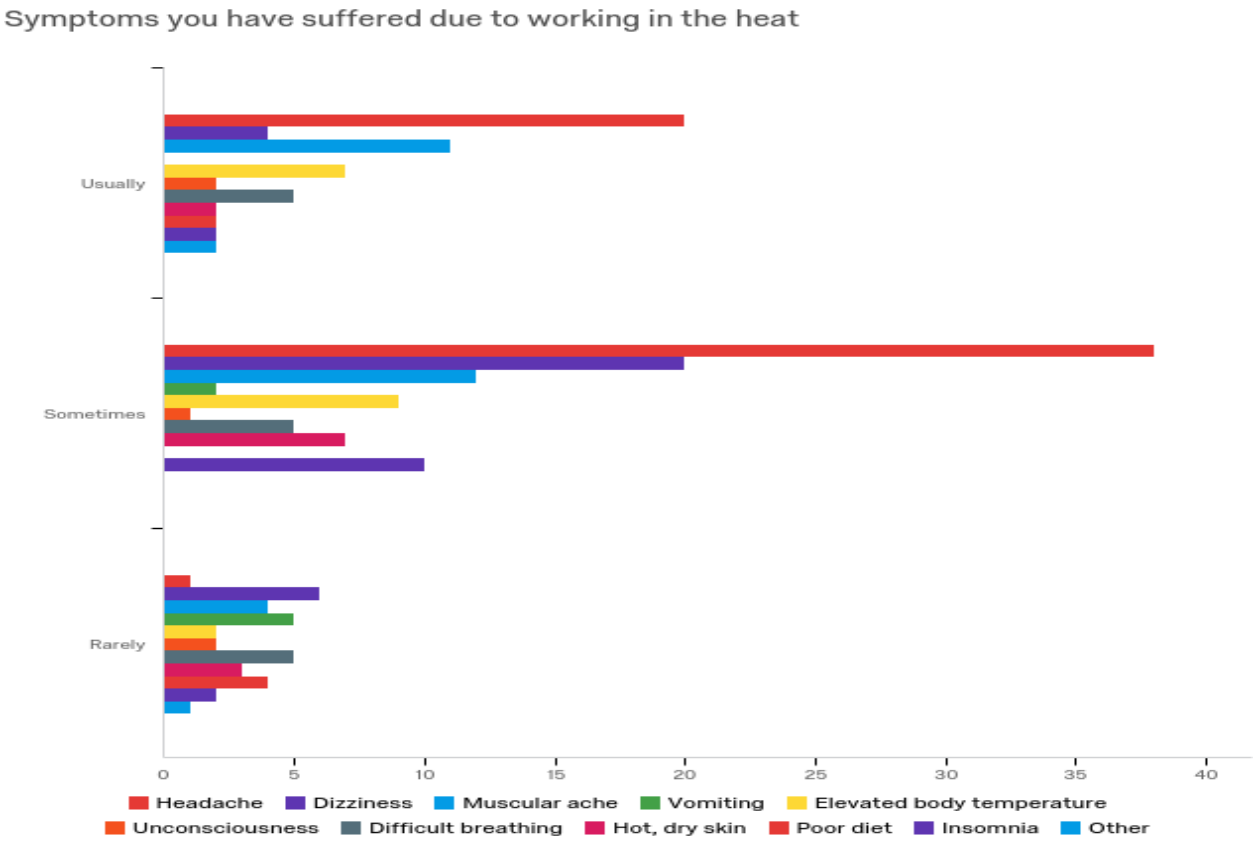

Figure 8. Symptoms of working in the heat.

When suffering from the heat-related symptoms, 63.93% reported that they self-treat themselves, 31.15% receive medical help from the clinic or healthcare provider, 4.10% sought support from friends or neighbours, whilst 1.64% sought support from an employer or other sources. Of the participants, 53.78% were failing to seek treatment because medical fees were unaffordable, 38.66% had no barriers to seeking treatment, 4.20% obtained spiritual help, 2.50% reported having no medical aid, and 0.84% reported as it not being necessary to seek treatment.

The respondents had an unexpectedly reasonable understanding of first aid measures they would apply if someone suffered from heat stroke, as shown in Figure 9.

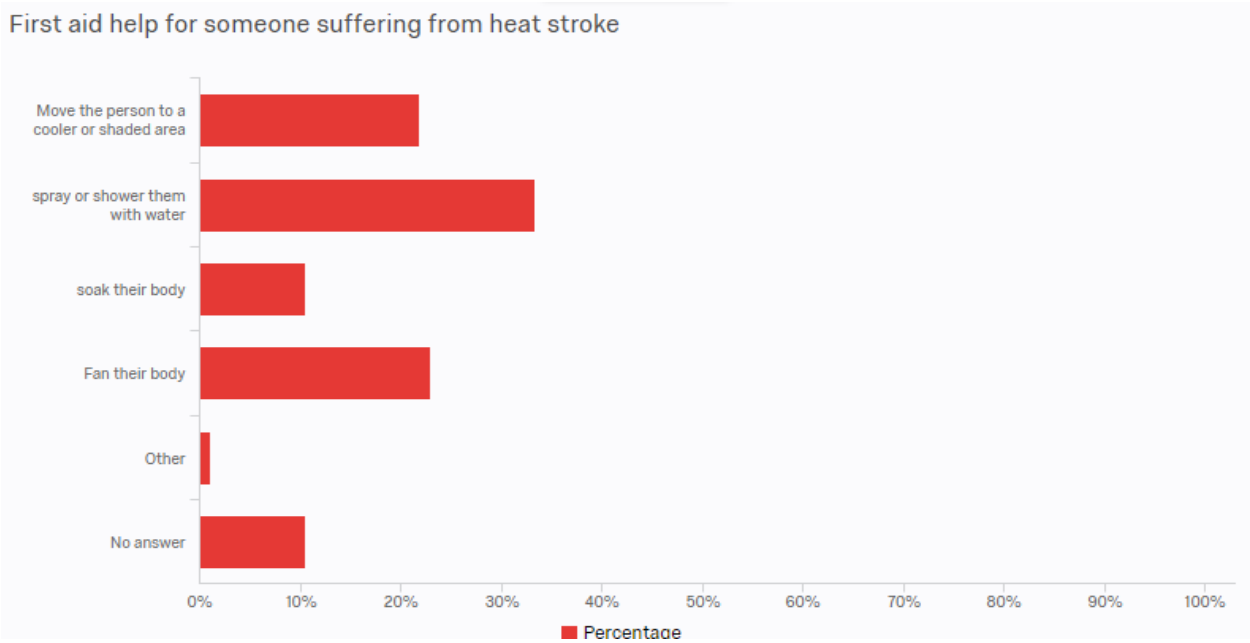

Figure 9. First aid for heat stroke.

5.3.6 Assessing heat stress risk amongst outdoor workers in the City of Bulawayo

Table 5.

An Evaluation of Heat Stress Amongst Street Vendors Using the Basic Thermal Risk Assessment Tool Developed by the Australian Institute of Occupational Hygienists (AIOH) 2013 Heat Stress Guide.

HAZARD TYPE	**Assessment Point Value**			
	0	1	2	3
Sun exposure	Indoors ☐	Shade ☐	Part Shade ☐	No shade ☒
Hot surfaces	Neutral ☒	Warm on contact ☐	Hot on Contact ☐	Burn on Contact ☐
Exposed period	< 30min ☐	30 min–1hour ☐	1 hour –2hours ☐	> 2 hours☒
Confined space	No ☒			Yes ☐
Task complexity		Simple☒	Moderate ☐	Complex ☐
Climbing, up/down stairs or ladders	None ☒	One level ☐	Two levels ☐	> Two levels ☐
Distance from cool rest area	< 10 metres ☐	< 50 metres ☐	50–100 metres ☒	> 100 metres ☐
Clothing (permeable)		Single layer (light) ☒	Single layer (moderate) ☐	Multiple layer ☐
Understanding of heat strain risk	Training given ☐			No training given ☒
Air movement	Strong ☐	Moderate wind ☐	Light wind ☒	No wind ☐
Respiratory protection – negative pressure	None ☒	Disposable Half Face ☐	Rubber Half Face ☐	Full Face ☒
Acclimatisation	Acclimatised ☒			Unacclimatised ☐
		2	4	9
SUB-TOTAL A				15

		2	**3**	**6**
Metabolic work rate		Light ☒	Moderate ☐	Heavy ☐
SUB-TOTAL B				**2**

		1	**2**	**3**	**4**
Apparent Temperature		< 27°C☐	> 27°C ≤ 33°C ☒	> 33°C ≤ 41°C ☐	> 41°C☐
SUB-TOTAL C					**2**

A = 15; B = 2; C = 2; therefore
Basic Thermal Risk = (15+2) x 2 = 34

The total basic thermal risk for Bulawayo street vendors is 34. According to the guide, measures that lie between 28 and 60 can result in heat-related illnesses. This level indicates that street workers in Bulawayo are exposed to heat that may cause heat stress.

5.3.7 Outdoor workers' adaptation methods to heat exposure

Observations indicate that some street vendors implement heat-avoidance strategies such as the construction of illegal shelters made from cardboard boxes, canvas and plastic sheeting. Other adaptive actions the respondents reported included wearing loose-fitting, breathable clothing (65.85%), and 42.28% reported using sunscreen. When it is extremely hot, 59.35% reported taking breaks in nearby shade or cool areas when possible. The majority (74.80%) stated that they drink fluids before feeling thirsty; however, there were conflicting responses when asked on the frequency of drinking water whilst at work: 41% drank water when thirsty, 33% every 20 minutes, 25% every hour and the remaining 1% did not respond.

When questioned on where the street vendors obtain information relating to heatwaves, 68.82% cited the media as their source, 10.02% mentioned friends or colleagues, 20.01% offered no answer and 1.15% said they got information from community meetings and other sources. Regarding heat stress information, 69.02% had no information source, whilst 20.41% reported they had received information from media, 5.05% from friends and 4.03% from healthcare providers.

5.4. DISCUSSION AND CONCLUSION

The economic situation in Zimbabwe and many other developing countries has driven a large sector of the population to engage in informal outdoor employment. Such workers do not receive legislative protection as their operations are perceived to be illegal, and this extremely poor and vulnerable sector of the society is at risk of suffering short- or long-term ill-health effects associated with heatwaves (Mpofu, 2010).

These risks are further aggravated by the effects of climate change that have impacted the agro-based economies of developing countries. Droughts and floods have driven rural populations into the already congested cities, such as Bulawayo, where industries have also closed, forcing the population to work informally in the city streets. It is evident that outdoor street vendors are exposed to environmental and occupational hazards during their daily activities. Heat stress adaptation in humans involves physiological adaptations, referred to as

heat acclimatisation. It is assumed that these street vendors are fully acclimatised from working under such conditions in Bulawayo, as many had been in this current profession for several years.

Other heat adaptations observed include actions taken to avoid heat exposure and to gain protection from extreme temperatures, direct sunlight and humid conditions. In a developed-world context, this is feasible to achieve where most people are able to work in air-conditioned environments or have cooling options readily available. However, for illegal informal traders on the streets of Bulawayo, this is clearly not an option. Additional measures may include the intake of sufficient fluids, being physically fit and active and having a well-balanced diet.

The public health dilemma is that most outdoor street vendors in Zimbabwe conduct their business in the open and in direct sunlight. Due to the impact of climate change, the summer months in Bulawayo have become hotter than previously noted, with high humidity levels. This study demonstrated that street vendors are exposed to heat-stress risks, which are exacerbated by long work shifts of between seven to thirteen hours, often in direct sunlight and without protective measures against the heat. Sources of potable drinking water are not easily accessible to these workers as they are illegal vendors working in undesignated areas with no access to the formal infrastructure in the city. Their monthly income levels range from less than $50 to $300 and they therefore cannot afford to buy drinking water daily, thus exposing them to risk of dehydration. Their working conditions are generally not conducive to good health. In addition to struggling to cope with extreme heat in the summer, they are also exposed to air pollution from dust and vehicle emissions, which results in creating further public-health problems.

This study shows that temperature levels and heat events have currently become more common than in the past, causing suffering and sickness amongst street vendors, who are deemed to be a particularly vulnerable group. Street vendors operate in the informal sector and their activities are deemed illegal, thus they do not benefit from government interventions, have no legal protection and have limited capacity to access healthcare. The group has limited choices to mitigate the effects of heatwave conditions, as they spend long hours under direct sunlight, and most do not have access to electricity or effective means of cooling either at work or at home. The study shows that street vendors suffer from various heat-related symptoms such as headaches, dizziness, muscular aches, elevated body

temperatures and insomnia during the summer, which are a clear indicator of heat-stress risk. There is lack of knowledge about heat-related illnesses including heat stress amongst this cohort, and the workers do not seek medical help as most cannot afford it. The majority attend to the conditions by themselves and lack an understanding about the short- and long-term health effects associated with heat exposure.

Some street vendors have implemented basic adaptive practices, other than acclimatisation, such as wearing light, loose clothing and hats during summer and seeking shade to rest in; some go as far as constructing illegal shelters using cardboard, canvas and plastic.

In addressing this public health dilemma, the government should establish heat-prevention policies to protect the health and safety of outdoor workers. The authorities should develop a comprehensive heat-prevention model that includes all stakeholders, such as government departments, health professionals and the street vendors. The Ministry of Health should be responsible for public health research, health promotion, monitoring, assessments and the provision of environmental health management services, and healthcare provision aimed at developing and strengthening adaptation and coping strategies of heat-related consequences. Technical capacity building should involve provision of guidance materials that increase knowledge among health providers in recognising the risks associated with heat exposure and treating and advising vulnerable communities on heat-related public health effects. Local governments, such as Bulawayo government, should allocate resources to plan, design, develop and provide infrastructure that will protect the outdoor street vendors from heat exposure and provide cooling strategies, such as growing trees and other forms of shade, and the provision of accessible water sources close to outdoor workers' operation areas.

5.5. LIMITATIONS

This study was confined to assessing heat stress among outdoor street vendors within time and resource constraints. For it to be holistic it should have included all outdoor workers, involving those operating backyard industries; however, the results are considered valid and applicable to any outdoor-setting activity.

5.6. FUTURE RESEARCH

As heat-related effects are new phenomena in developing countries, more research is needed on climate change impacts on public health in different community groups and on

developing heat-prevention guidelines appropriate and suitable for developing countries. Further studies can evaluate the monitoring systems used in the country to reduce heat-related risks and measure the current government heat-prevention policies. Other studies can conduct comparison between street vendors and other outdoor workers to obtain more data.

5.7. ACKNOWLEDGEMENT

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CHAPTER 6

SYNTHESIS, FINDINGS, CONCLUSION AND RECOMMENDATIONS

This chapter combines findings, conclusions and recommendations on heat exposure and adaptations strategies of outdoor informal sector workers in Zimbabwe, which can be generalised for the SADC member states particularly in the southern region and other developing countries in the tropics that experience economic hardships and are impacted by climate change. Outdoor workers, in particular street hawkers, are exposed to climate change related heat stressful conditions. This chapter integrates and summarises findings from each chapter of this study, clarifies issues and highlights the need for policy makers to understand the effects of heat exposure on vulnerable groups.

6.1 SYNTHESIS

Zimbabwe's summer temperatures have increased by 1.86°C between 1955 and 2003 (Alexander, 2006 p.55). Bulawayo experienced two weeks of heat waves in the months of October and November 2015 with temperatures exceeding 38°C, thus showing further evidence of increasing ambient temperatures. Heat wave conditions are known to impact on human health and are associated with increased morbidity and mortality, yet this phenomenon is not well researched in developing countries. Ambient heat and humidity data were obtained using 30 Lascar EL-USB -5 heat and humidity sensors and a Quest Tempstress Wet Bulb Globe Temperature (WBGT) monitor during the summer of 2015.

Interviews and focus group discussions with outdoor informal sector workers, policy makers and health professionals in Bulawayo indicated that the population is affected by high ambient temperatures accompanied by high humidity levels. In Zimbabwe, a land locked country, the effects of global warming are being experienced and ambient temperatures are increasing; however, the management of heat stress at a population level remains a challenge. Outdoor street workers (hawkers) who have limited choice of employment opportunities and inadequate knowledge on heat related illnesses are a particularly vulnerable group. Awareness of heat exposure impacts on the wellbeing of individuals is vital for the formulating of adaptation strategies. Health promotional and preventive measures on coping methods need to be developed.

6.2 STUDY FINDINGS

The study found that the Zimbabwe National Climate Change Strategy on heat prevention policy, and those of neighbouring countries in the same region, shows gaps in occupational heat exposure and heat related illnesses, which leaves the population exposed and vulnerable groups at risk of heat stress and other heat related illnesses. Combined with the country's economic challenges, more people are affected by climate change related heat effects which are predicted to increase in the future. The country lacks targeted research on occupational heat exposure and heat related illnesses, which would aim at influencing heat wave management policy development, implementation and evaluation. Although several studies on the effect of climate change have been conducted in the fields of agriculture and water management. Due to massive unemployment many people work illegally in the informal sector as street hawkers. This group of socio-economically disadvantaged people receive no formal recognition from Government as their trade is technically illegal and so they are not covered by any health insurance or compensation policies. The street hawkers spend long hours working in direct sunlight and are at risk of heat related illnesses. This cohort includes the elderly, mothers with small children and individuals with chronic diseases. Informal workers are also generally poor with limited access to electricity, and so have no access to air-conditioning in their homes, which are often also of sub-standard construction, and therefore hot, even at night. It is evident that these people have limited adaptive capacity to cope with heat wave conditions and they fall outside of the conditions of work that regulate formal employment. The heat exposure effects on outdoor informal sector workers have not been well researched and the country's economic decline further exposes the population to physiological and socioeconomic hardships that enhances their risk from a range of health problems, including, and exacerbated by heat related illness.

The research found that Zimbabwe, and Bulawayo in particular has no targeted heat stress prevention policy direction. Heat related illnesses and mortality are not reported by any stakeholders, including the Ministry of Health. It has been found that there is lack of state commitment in terms of knowledge, resources, policy formulation, research, information dissemination, as well as programs aimed at managing the emerging public health concerns caused by climate change, in particular heat related illnesses and mortality. Knowledge dissemination through public campaigns and education are regarded as important in involving communities to manage proactive adaptations. Furthermore, health professionals have not been involved in defining the magnitude of climate change effects on humans in relation to

heat exposure. The most concerning finding is the lack of knowledge amongst the health professionals who are on the front line diagnosing and managing heat related illnesses, and those responsible for environmental monitoring, such as environmental health practitioners.

This research found that street hawkers in Bulawayo and Zimbabwe, and possibly those in some other developing countries, are exposed to extreme heat and humidity during the day while at work under direct sunlight or makeshift sheds. This group, as a norm, work long shifts of more than 12 hours each day with ambient temperatures reaching 38°C on some days, combined with high humidity. Night time temperatures in their homes as high as 31°C, were recorded, thus affording individuals no time to cool down adequately. These temperature levels are most likely causing unrecorded morbidly and mortality amongst this vulnerable population (Luber, 2008; Muthers, S., Tarczewski, G., & Matariki, A., 2017).

These street workers have limited access to potable water, and they need to bring their own daily supply in bottles, consequently increasing their risks of dehydration.

6.3 STUDY CONCLUSIONS AND RECOMMENDATIONS

Current heat exposure levels in tropical countries, such as Zimbabwe are affecting outdoor workers. Heat stress will increase in the future due to climate change factors. Heat prevention and its management policies related to human health are critical and should be developed and incorporated in the National Climate Change Strategy. Currently the strategy is coordinated by different stakeholders with limited accountability and it needs to be revised to include all groups within the population, even those regarded as “illegal” workers. Research to appraise heat exposure should be conducted at a national level to assess all population groups that work outdoors such as road workers, farmers, and miners. This will provide empirical evidence on heat exposure and its magnitude amongst the broader working population. It will also allow for categorising the groups according to their vulnerability and their susceptibility. This study provides a conceptual framework on heat hazards due to climate change, and a link between heat exposure, susceptibility and adaptation strategies for outdoor workers. These can be useful for development of inclusive policies and programs to address the issue of environmental heat and its impacts on the population, with particular attention to the outdoor informal sector workforce, which in reality is one of the largest sources of employment in Zimbabwe, and other developing countries (Chapter 2).

The effect of heat on human health has not been diagnosed and managed in Zimbabwe. Therefore, guidelines for protecting the population from heat need to be developed. The study showed knowledge gaps amongst health professionals who are responsible for monitoring, preventing and treating those with heat stress and other heat related illnesses. The situation is similar for policy makers and members of the multi-stakeholder disaster management committee members. As projected, global climate change is increasing, therefore the country, local authorities and communities should be prepared to deal with heat wave events. There is an expedient need for Ministry of Health to be involved in training staff on the management of heat related illnesses and to provide extensive health promotion programs for communities to be aware of heat stress and coping methods. Education programs need to be developed and put in place for communities. Climate change education, including heat related public health issues, should be incorporated in the education curriculum from primary schools to tertiary institutions.

Heat as an environmental and occupational hazard needs to be monitored and managed appropriately, with adequate resources allocated. Environmental, and Occupational, Health Departments must collaborate with other government departments involved with climate change adaptation to develop a co-ordinated response. Heat exposure trends must be monitored to assist communities to develop appropriate adaptation strategies aimed at reducing heat related health effects. The Lascar EL-USB -5 monitor was shown to be a valid tool to assess heat stress in this and other studies; and is an easy to use, relatively cheap alternative to larger more traditional heat stress monitors. Because the Lascar data loggers are small, lightweight, and tamperproof, they provided a practical means to monitor both personal and locational heat exposures over time. The monitoring results can be utilised at a local authority level to develop appropriate heat stress programs for educating the public on recognising, evaluating and preventing heat illness from working outdoors in hot weather. Ideally the national and local authorities would provide resources such as shelter from extreme heat, adequate drinking water supplies, and access to medical assistance.

6.4 CONTRIBUTION TO KNOWLEDGE

There is strong empirical evidence of the impact of climate change in developing countries of Africa including Zimbabwe, particularly on farming and mining. However, no studies have been conducted on the impact of climate change on outdoor workers (street

hawkers) which encompasses 80% of the Zimbabwe population. As global temperatures rise and are anticipated to increase in the future, this research provides convincing data and evidence for action for the implementation of a program to protect outdoor workers from heat stress.

6.5 STUDY LIMITATIONS AND FUTURE RESEARCH

The following were limitations to the study:

1. There is lack of literature available from the SADC and other developing countries on heat related illness, guidelines and policies that relate to outdoor work as an occupation, and in particular street hawkers.
2. The focus group discussions in this research involved Bulawayo City policy makers and health professionals on their understanding current policies and programs and knowledge about climate change and associated heat related issues for outdoor workers. More groups could have been consulted to provide a wider perspective.
3. The study explored outdoor street workers, however other vulnerable groups exposed to heat, such as construction workers, gold panners, backyard industry workers and farmers are also at risk. A longitudinal study to examine climate change heat related issues in a country with fast changes due to its economic spheres can add valuable data.
4. Accessing meteorological data at local weather stations was impossible due to restrictive request protocols. This data would have been correlated with the study data to give a better understanding of the situation.

Further research that could be conducted includes;

1. Identification of the knowledge, attitudes, and practices, of various population groups in developing countries regarding heat related illnesses and the impact caused by climate change. This will inform the development of appropriate adaptation strategies.
2. Review of the effectiveness of public health heat stress programs for educating the public on recognising, evaluating and preventing heat illness from working outdoors in hot weather, including adaptation strategies and coping methods for vulnerable groups.

3. Evaluation of heat exposure monitoring systems in developing countries in order to facilitate the development of heat prevention guidelines.
4. Assessment of heat related illnesses and mortality during the hot seasons in developing countries, to raise awareness of the magnitude of the climate change health impacts.

6.6 REFERENCES

Alexander, L. V., Zhang, X., Peterson, T. C., Caesar, J., Gleason, B., Tank, A. K., & Tagipour, A. (2006). Global observed changes in daily climate extremes of temperature and precipitation. *Journal of Geophysical Research: Atmospheres*, *111*(D5).

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Luber, G., & McGeehin, M. (2008). Climate change and extreme heat events. *American Journal of Preventive Medicine, 35*(5), 429-435.

APPENDIX A: ETHICS APPROVAL

HUMAN RESEARCH ETHICS COMMITTEE
For all queries, please contact:
Research Ethics Office
Edith Cowan University
270 Joondalup Drive
JOONDALUP WA 6027
Phone: 6304 2170
Fax: 6304 5044
E-mail: research.ethics@ecu.edu.au

1 May 2015

Mar Bigboy Ngwenya
Faculty of Health, Engineering and Science
JOONDALUP CAMPUS

Dear Bigboy

ETHICS APPROVAL Project Code:	12611	
Project Title:	Impact of climate change on public health: Adaptation strategies to heat stress by outdoor informal sector workers in urban Bulawayo - Zimbabwe	
Chief Investigator:	mar Bigboy Ngwenya	
Supervisors	Associate Professor Jacques Oosthuizen Dr Martyn Cross	
Approval Dates:	From: 1 May 2015	To: 14 March 2017

Thank you for your recent application for ethics approval. This application has been reviewed by members of the Human Research Ethics Committee (HREC).

I am pleased to advise that the proposal complies with the provisions contained in the University's policy for the conduct of ethical human research and ethics approval has been granted. In granting approval, the HREC has determined that the research project meets the requirements of the National Statement on Ethical Conduct in Human Research.

All research projects are approved subject to general conditions of approval. Please see the attached document for details of these conditions, which include monitoring requirements, changes to the project and extension of ethics approval.

We wish you success with your research project.

Yours sincerely

[redacted]

Kim Gifkins
SENIOR RESEARCH ETHICS ADVISOR
Project 12611 NGWENYA - 1 May 2015 to 14 March 2017.

Title:

Impact of climate change on public health: Adaption strategies to heat stress by outdoor informal sector workers in urban Bulawayo – Zimbabwe - has been changed to:

Heat exposure and adaptation strategies of outdoor informal sector workers in urban Bulawayo – Zimbabwe

The candidature has been approved based on the new title. The proposal is still the same.

Hi Bigboy

Project: 12611 NGWENYA
Project Name: Heat exposure and adaptation strategies of outdoor informal sector workers in urban Bulawayo – Zimbabwe

Thank you for your email. I have updated the title of your project in your STREAM application.

Kind regards

Rowe

Rowe Oakes
Ethics Support Officer, Office of Research & Innovation, Edith Cowan University, 270 Joondalup Drive, Joondalup, WA 6027
Tel: +61 08 6304 2943 | Fax: +61 08 6304 5044 | CRICOS IPC 00279B

Project Number: 12611 NGWENYA

Project Name: Heat exposure and adaptation strategies of outdoor informal sector workers in urban Bulawayo – Zimbabwe

Thank you for your Annual Ethics Report, our records have been updated to reflect the information provided.

Your request for an extension of ethics approval for this project has been granted until 30 September 2018.

Kind regards

Rowe

Rowe Oakes

Ethics Support Officer

Office of Research & Innovation, Edith Cowan University

Phone: +61 08 6304 2943

Email: research.ethics@ecu.edu.au www.ecu.edu.au/research | [facebook.com/research.ecu]

APPRENDIX B: QUESTIONNAIRE FOR INFORMAL SECTOR OUTDOOR WORKERS (FACE TO FACE INTERVIEW)

Research on heat exposure and adaptation strategies of outdoor informal sector workers in urban Bulawayo – Zimbabwe

General Instructions: Place X in the boxes that matches the answer from the respondent or leave it blank if no answer is given. Respondents can choose more answers in questions that require multiple responses.

(I) Demographics information

1. Gender

1. ☐ Male
2. ☐ Female

2. Current marital status

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

99 ☐ No answer

3. Highest level of education

1. ☐ No formal education
2. ☐ Primary school (Grade 1-7)
3. ☐ High School (Form 1-6)
4. ☐ Polytechnic
5. ☐ University

99 ☐ No answer

4. Are you the head of the household?

1. ☐ Yes
2. ☐ No

5. Average monthly income

1. ☐ less than $50
2. ☐ $60 to $100
3. ☐ $101 to $300
4. ☐ $ 301 to $500
5. ☐ more than $501

99 ☐ No answer

6. What's your employment status in this job?

1. ☐ Employee
2. ☐ Self employed
3. ☐ Both

7. How many years have you spent on the current street vending job (month, years?)

(II) Personal Health Information

8. How would you assess your current health status?

1. ☐ Very poor
2. ☐ Poor
3. ☐ Reasonable
4. ☐ Good
5. ☐ Excellent

99 ☐ No answer

9. Have you ever diagnosed with the following illnesses? (*tick all that apply*)

1. ☐ Heart related illnesses
2. ☐ Dermatology
3. ☐ Respiratory diseases
4. ☐ Others (specify)
5. ☐ No illness

99 ☐ No answer

(III) Heat stress risk assessment

10. Does your work expose you to under direct sunlight?

1. ☐ Yes
2. ☐ No

99 ☐ No answer

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

11.1	Temperature	☐ Very hot	☐ Hot	☐ Normal	☐ Cool
11.2	Humidity	☐ Very humid	☐ Humid	☐ Dry	☐ Very dry

12. Is your workplace hotter than in doors of your home?

1. ☐ Yes
2. ☐ No

99 ☐ No answer

13. Which one below describes your workplace?

1. ☐ Is in the open
2. ☐ Covered by Corrugated Iron sheets
3. ☐ Covered by canvass material
4. ☐ Others

14. What kind of clothing do you usually wear at work?

1. ☐ Protective clothing
2. ☐ Light, loose, clothing
3. ☐ Dark – coloured clothing

99 ☐ No answer

15. How many hours per day do you spend doing your job?

16. Do you use heat/sun protective measures when on the job?

1. ☐ Yes
2. ☐ No

99 ☐ No answer

17. If yes which measures do you use? (tick that apply)

	Items	Sufficient	Insufficient
1	Personal protective equipment (sunglasses, sun cream		
2	Drinking water		
3	Changes to your scheduled working hours		

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

1. ☐ Every hour
2. ☐ Every 20 minutes
3. ☐ When I feel thirsty
4. ☐ Other

99 ☐ No answer

19. What type is your house?

1. ☐ Tiled roof house
2. ☐ Asbestos roof house
3. ☐ Corrugated –iron roof house
4. ☐ Other

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

1. ☐ Ceiling
2. ☐ Fan
3. ☐ Other (specify)

99 ☐ No answer

21. What extent of heat do feel when you are at home?

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

IV. Knowledge of heat waves and heat stress

22. In the last 2 years, has the normal/everyday temperature in your area increased?

1. ☐ Yes
2. ☐ No
99 ☐ Don't know

23. In the last 2 years, how have heat events been in your area?

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

24. Can heat waves cause serious health problems?

1. ☐ Yes
2. ☐ No
99. ☐ Don't know

25. Extreme heat waves/heat events can contribute to a high mortality rate (death rate?).

1. ☐ True
2. ☐ False
99. ☐ Don't know

26. Have you ever heard about heat stress?

1. ☐ Yes
2. ☐ No

27. What contributes to heat stress (*tick all that apply*)

1. ☐ Temperature

2. ☐ Direct sun

3. ☐ Humidity

99 ☐ Don’t know

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

1. ☐ Sunstroke

2. ☐ Heat exhaustion

3. ☐ Heat stroke

99. ☐ Don’t know

29. Have you ever heard of heat stroke?

1. ☐ Yes

2. ☐ No

30. What are the common symptoms of heat stroke (*tick all that apply*)

1. ☐ Having hallucinations

2. ☐ Having increased body temperature

3. ☐ Dry skin

4. ☐ Confusion/dizziness

5. ☐ Chills

6. ☐ Other (specify)

99. ☐ Don’t know

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

1. ☐ Move the person to a cooler or shaded area

2. ☐ Spray or shower them with water

3. ☐ Soak their clothes

4. ☐ Fan their body

5. ☐ Other (*specify*)

99. ☐ Don't know

32. Have you ever heard of heat exhaustion?

1. ☐ Yes

2. ☐ No

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

1. ☐ Heavy sweating

2. ☐ Extreme weakness or fatigue

3. ☐ Dizziness, confusion

4. ☐ Nausea

5. ☐ Other (specify)

99. ☐ Don't know

34. If you are working in a hot place, what should you do to adapt to the heat? (*tick all that apply*)

1. ☐ Wear light-coloured, loose-fitting, breathable clothing (cotton)

2. ☐ Use personal protective equipment (sunglasses, hat)

3. ☐ Drink water frequently before feeling thirsty

4. ☐ Take breaks in the shade or a cool area when possible

5. ☐ Take more breaks in extreme heat and humidity

6. ☐ Other (specify)

99. ☐ Don't know

35. What do you know about climate change (*specify all that apply*)

1. ☐ Temperature increasing

2. ☐ Increasing of natural disaster intensity and frequency (floods, storms etc)

3. ☐ Occurs because of increasing greenhouse gas emissions

4. ☐ Increasing of extreme weather events

5. ☐ Other

99. ☐ Don't know

V. Practices/behaviours

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

1. ☐ Wearing, loose, light- and light-coloured clothing

2. ☐ Using personal protective equipment (sunglasses, hat)

3. ☐ Drinking water frequently before feeling thirsty

4. ☐ Planning heavy activities during the early morning or evening hours

5. ☐ Scheduling rest breaks in shaded areas regularly

6. ☐ Avoiding drinking alcohol or large amounts of caffeine or sugar

7. ☐ Other

8. ☐ Don't do anything

99 No answer

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

1. ☐ Unaffordable

2. ☐ Unnecessary

3. ☐ Unprotectable

4. ☐ Other (specify) _____

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

1. ☐ Yes

2. ☐ No

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

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

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

1. ☐ Moved to a cooler or shady area
2. ☐ Drank plenty water
3. ☐ Went to the clinic/health care provider
4. ☐ Took medication (self-treatment)
5. ☐ Did nothing and continued to work
6. ☐ Others

99 No answer

41. If you continued to work, please explain why?

42. Have you ever applied traditional health treatments for problems related to heat waves?

1. ☐ Yes
2. ☐ No

43. If yes please describe the traditional treatments

44. Have you ever sought support when suffering from health problems related to heat waves?

1. ☐ Friends/colleagues/neighbours
2. ☐ Employer
3. ☐ Clinic/health care provider
4. ☐ Others
5. ☐ No need supports from others

45. What are the barriers to seeking medical treatment when you have heat related illness?

1. ☐ Don't have medical aid
2. ☐ Cannot afford treatment
3. ☐ Don't know where I should go for treatment
4. ☐ Other
5. ☐ Have not experienced problems

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

No	**Resources**	**Information on heat waves/hot days**	**Information on heat stress and heat related illness**
1	Health care provider/clinic		
2	Friends /colleagues		
3	Family members		
4	Mass media		
5	Community meeting		
6	Employer		
7	Others		
99	Don't know		

47. Do you have anything related to heat exposure and working out doors?

APPENDIX C: FOCUS GROUP CHECKLIST FOR HEALTH SERVICES PROVIDERS

Introduction

Heat waves are associated with climate change. Heat waves can have a negative impact on the heath of workers, especially outdoor workers/street vendors. In Zimbabwe, outdoor informal sector workers and or street vendors are the most impacted group because of their vulnerability. This focus group discussion is part of the research on the impact of climate change on public health: Adaptation strategies to heat stress by the outdoor informal sector workers in urban Bulawayo – Zimbabwe. The focus of the discussion is to explore the current knowledge and awareness, policies and regulations of the Zimbabwe Government that related to the management of heat related illnesses and programs to protect outdoor informal workers' health and promote their adaptation strategies to heat waves. I hope you will agree to take part in this focus group. The discussion will take 30 minutes.

1. Knowledge and awareness of key government and local authority officials: climate change and heat waves, heat stress and risks

- What are the existing policies and procedures in Zimbabwe that cover heat stress prevention (heat stroke, heat exhaustion, heat rush, heat cramps etc.) as occupational diseases?
- What's your understanding of climate change, heat stress and heat waves in Bulawayo over the last 5 years?
- Can we share the national health sector action plan that responds to climate change, and embraces heat stress issues?
- If any how does Bulawayo's health sector action plan deal with heat stress issues?
- What is composition of Bulawayo's multi sectoral committee that looks at health and climate change issues and what are its responsibilities? If no – why is it so?

- In Bulawayo, which are the occupation groups that are at risk of heat related diseases?

2. Key programs, policies and projects

- What are the key health and safety programs/projects sponsored by government, council or donors related to outdoor informal sector workers in Bulawayo?
- How do government agencies enforce laws on heat prevention in Zimbabwe?
- What are the specific policies and or regulations about outdoor working conditions standards in Zimbabwe?
- In terms of protecting the health of outdoor workers, what are the policies and/or regulations about access to and use of health services in accordance to the Primary Health Care framework, such as access, affordable, available and acceptable are in place?
- What are the health communication programs for the outdoor informal sector workers/street vendors about adaptation to heat waves? If no, why?
- What strategy does the City Clinics, Hospitals and other health providers in Bulawayo have the capacity to deal with heat related illnesses?
- What is the process of monitoring and evaluating the impacts of heat stress trends in the city? Either conducted by Bulawayo City's Environmental Health services and /or National Social Security Authority (NSSA)
- What are recommendations and additional support needed to deal with heat stress in Bulawayo?

3. Recommendations – Views on heat exposure

- What actions by government agencies including your own and others have taken to support the outdoor workers to adapt to heat waves and heat stress caused by climate change, in terms of policies, services and regulations?

- Research in other countries shows that heat waves are associated with health disorders and other negative impacts such as productivity reduction and occupational injuries. Regarding managing workers' health, do you think we should have regulations which clearly ask employers to ensure appropriate working conditions for outdoor workers and to provide support for employees to adapt to heat waves?
- If such regulations should be developed, what should be included?

APPENDIX D: FOCUS GROUP CHECKLIST FOR POLICY MAKERS

City Council Policy Makers - (Bulawayo City Council Management Team – Councillors and Heads of Departments).

Introduction

Heat waves are associated with climate change. Heat waves can have a negative impact on the health of workers, especially the outdoor workers. In Zimbabwe, outdoor workers and or street vendors are the most impacted group because of their vulnerability. The focus of the discussion is to explore the current policies and regulations of the Zimbabwe Government that regulate the role of employers in providing necessary conditions to protect outdoor informal workers' health and promote their adaptation to heat waves. I hope you will agree to take part in this focus group. The discussions will take 30 minutes.

1. Knowledge and awareness of key government and local authority officials: climate change and heat waves, heat stress and risks

- What are the Labour and Occupational Health and Safety Laws related to heat stress prevention for outdoor working environment?
- What are the employers' health and safety roles and responsibilities and actions to support workers?
- What are the existing policies and procedures in Zimbabwe that cover heat stress prevention (heat stroke, heat exhaustion, heat rush, heat cramps etc.) as occupational diseases?
- What's your understanding of climate change, heat stress and heat waves in Bulawayo over the last 5 years?
- What's included in the national health sector action plan to respond to climate change, that embraces heat stress issues?
- How does Bulawayo's health sector action plan incorporate heat stress issues?

- What is the composition of Bulawayo's multi sectoral committee that looks at health and climate change issues, and what are its responsibilities? If no – why doesn't it have it?
- In Bulawayo, which are the occupation groups that are at risk of heat related diseases?
- What are the monitoring mechanisms conducted by NSSA and Bulawayo City's Environmental Health Services for outdoor workers?

2. Key programs, policies and projects

- What are the health and safety programs/projects sponsored by government, council or donors related for outdoor informal sector workers in Bulawayo?
- How do government agencies enforce laws and what monitoring and evaluation is done?
- What are the specific policies and or regulations about outdoor working conditions standards in Zimbabwe?
- If they are there, how do those policies/regulations regulate the roles of employers in providing enabling environment and equipment for outdoor informal sector workers to adapt and minimise impacts of heat waves?
- Female outdoor workers may be more vulnerable to negative impacts of heat waves, do you think we should have specific regulations to protect them in the context of heat waves?
- What health services are available to groups most vulnerable to heat stress and heat waves in the city, if any? What is the level of quality? Shortcomings and strengths?

3. Recommendations

- What actions by government agencies including your own and others could support the outdoor workers to adapt to heat waves and heat stress caused by climate change,

in terms of policies, services and regulations for small scale informal sector employers?

- Research in other countries shows that heat waves are associated with health disorders and other negative impacts such as productivity reduction and occupational injuries. Regarding managing working – condition standards within enterprises, how do we as policy makers, to ensure appropriate working conditions for outdoor workers as well as provide support for employees to adapt to heat waves?
- If such regulations should be developed, what should be included?
- What are your recommendations to other stakeholders?

APPENDIX E: CITY OF BULAWAYO APPROVAL

City of Bulawayo

The Town Clerk's Department
Municipal Buildings
Fife Street
P.O. Box 591
Bulawayo

All Communications
to be addressed to the
Town Clerk

Tel: (263-9) 75011
Fax: (263-) 69701

Our Reference: TNB/LM. N6A/103 11 May 2015

Bigboy Ngwenya
107 Yindana Boulevard
Lakelands, WA 6180
AUSTRALIA

Dear Sir/Madam

RE: REQUEST FOR PERMISSION TO CARRY OUT A RESEARCH WITHIN BULAWAYO CITY COUNCIL TITLED " THE IMAPCTS OF CLIMATE CHANGE ON PUBLIC HEALTH : ADAPTATION STRATEGIES TO HEAT STRESS BY OUTDOOR INFORMAL SECTOR WORKERS IN BULAWAYO-ZIMBABWE.

Please note that there are no objections to your request to carry out research within Bulawayo City council premises subject to the following conditions:

a) You should submit a copy of your research findings including the executive summary after such an exercise.

b) Council should be indemnified against any accident/injury, which may occur during this period.

Accordingly you may approach any of Council's Service Departments as appropriate for assistance.

Yours faithfully

TOWN CLERK

APPENDIX F: CITY OF BULAWAYO FOCUS GROUP MEETING REQUEST

CITY OF BULAWAYO

Town Clerk's Department

18th November 2015

TO: HIS WORSHIP THE MAYOR AND
MEMBERS OF THE GENERL PURPOSES COMMITTEE

+ HODs

REQUEST TO CONDUCT A FOCUS GROUP DISCUSSION WITH CITY POLICY MAKERS: ON HEAT EXPOSURE AND ADAPTATION STRATEGIES OF OUT DOOR INFORMAL SECTOR WORKERS IN URBAN BULAWAYO: MR BIGBOY NGWENYA, PhD CANDIDATE, EDITH COWAN UNIVERSITY, WESTERN AUSTRALIA.

*** I attach a self explanatory letter from Mr. B. Ngwenya who was authorised by Council (6th May 2015) to carry out a research within Municipal premises subject to the usual conditions. He now wishes to conduct a focus group discussion with City Policy Makers and staff e.g. Town Planning Section, Security and Traffic, Housing issues relating to informal traders/vendors etc and Health Services.

The focus group discussion has been set for Monday 23 November, 2015 in the Committee Room Municipal Building at 2.30 pm (before the scheduled General Purposes Committee meeting).

You are kindly requested to attend this research based meeting

ACTING TOWN CLERK

APPENDIX G: WRITTEN STATEMENTS OF THE CO-AUTHORS

WRITTEN STATEMENTS OF THE CO-AUTHORS

I **Bigboy Ngwenya**, contributed 80% to all components of this research entitled: **Heat exposure and adaptation strategies of outdoor informal sector workers in urban Bulawayo – Zimbabwe**, which also includes below listed publications:

1. Ngwenya, B., Oosthuizen, J., Cross, M., Frimpong, K., & Chaibva, C. N. (2018). A review of heat stress policies in the context of climate change and its impacts on outdoor workers: Evidence from Zimbabwe. (Published by International Journal of Social Ecology and Sustainable Development *(IJSESD)*, *9*(1), 1-11).
2. Ngwenya, B., Oosthuizen, J., Cross, M., & Frimpong, K. (2017). Emerging heat-related climate change influences; a public health challenge to health care practitioners and policy makers: Insight from Bulawayo, Zimbabwe. (Published by International Journal of Disaster Risk Reduction).
3. Ngwenya, B., Oosthuizen, J., Cross, M., Frimpong, K. Measurement of ambient temperature and humidity exposure of outdoor street vendors in Zimbabwe: An underrated public health issue. (To be submitted International Journal of Biometeorology).
4. Ngwenya, B., Oosthuizen, J., Cross, M., & Frimpong, K. (2018). Heat Stress and Adaptation Strategies of Outdoors Workers in the City of Bulawayo, Zimbabwe.(Published by Journal of Community Med Public Health Care, 5, 034).

The co-authors assisted with the editing of the drafts.

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