



Research Article

Heat Stress and Adaptation Strategies of Outdoors Workers in the City of Bulawayo, Zimbabwe

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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. With the current political upheaval 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.

Keywords: Climate change; Health; Heat-related illness; Heat stress; Outdoor street worker

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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 [1]. 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) [2]. 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 [3,4].

The frequency of extreme heat waves has been increasing, leading to excess morbidity and mortality, particularly in developing countries [5]. The burden of heat-stress-related illness is predicted to rise due to climate change effects [6-8]. 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 [3]. 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 [9].

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 [4,10,11]. 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 [12]. In developing countries such mortalities may be misdiagnosed or not recorded due to lack of knowledge amongst health professionals and the population [2].

Studies have shown that hot summer temperatures in Zimbabwe from 1955 to 2003 increased by 1.86°C per decade [13]. 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 [2].

Bulawayo was the principal industrial hub of Zimbabwe in 1980's, 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 [14]. This cohort of workers is particularly susceptible to heat exposure as the city environment is also impacted

by the urban heat-island effect [8]. Working long hours suggests that these people 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 [15]. 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 would 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 [7].

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 [4,10,16-18]. It is therefore anticipated that an increase in the frequency of heat waves will impact significantly on this vulnerable sector of society in the future [19].

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 interventions such as provision of shade and cool potable water as well as health-promotion actions directed at building resilience and coping strategies as well as informing vendors when and how to seek early medical attention should it be required [8,20].

In developed countries, strict labour legislation guidelines regulate work in extreme heat and there are defined adaptation strategies that protect workers [17]. However, in most developing countries such as Zimbabwe, there is lack of public awareness and policy considerations regarding heat exposure [8,21]. Management of heat stress requires a consultative approach with all stakeholders to make decisions that may influence policy changes towards minimizing the hazard. According to Huang et al., [20], developing countries should include adaptive capacity building and adaptation implementation engagements to minimize 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. Organized land use and improved design plans of buildings, air conditioning use and adjustment to conditions are significant in prevention of heat effects [11,20]. 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.

Materials and Methods

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 [22] 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% [23], however for saturation, a total of 123 participants were recruited to strengthen and increase the credibility of findings.

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.

Results

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 people in this cohort had attained a good education and under better economic conditions they would probably 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, new and second-hand clothes for their livelihood.

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.

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 heat waves have become more common in the last two years. The majority of the 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 sick and are more likely to die during summer than winter.

As demonstrated in figure 1, when questioned on their workplace conditions in summer, 98 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.

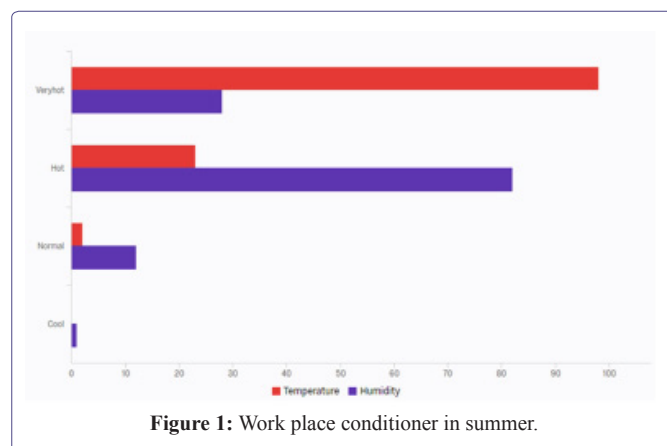


Figure 1: Work place conditioner in summer.

Heat-related illnesses

Participants interviewed had heard of heat-related illnesses, but were unsure on the various conditions associated with heat exposure. Of the respondents, 58.0% had heard about heat stress and 42.0%

had never heard of it. This was evident when people 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, 4.9% cited humidity. When questioned about the types of heat-related illnesses, 50.01% did not know them, 22.13% mentioned heat stroke, 12.30% heat exhaustion and 15.57% stated heat cramp. When asked to elaborate on symptoms of heat stress, 85.6% cited confusion and high temperature.

Developed illness in summer

More than half of the respondents (57.02%) reported that they got sick 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.

When suffering from the heat-related symptoms, 63.93% reported that they self-treat themselves, 31.15% get 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% got spiritual help, 2.50% reported having no medical aid and 0.84% reported as it not being necessary to seek treatment (Figure 2).

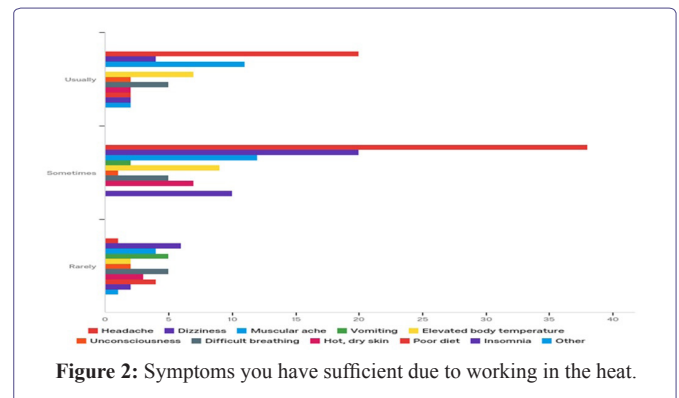


Figure 2: Symptoms you have sufficient due to working in the heat.

The respondents had a surprisingly good understanding of first aid measures they would apply if someone suffered from heat stroke, as shown in figure 3.

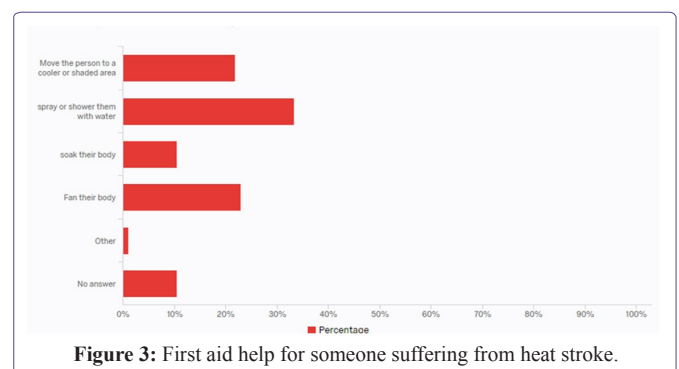


Figure 3: First aid help for someone suffering from heat stroke.

Assessing heat stress risk amongst outdoor workers in the city of Bulawayo (Table 1)

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

	2	3	6
Metabolic work rate	Light <input checked="" type="checkbox"/>	Moderate <input type="checkbox"/>	Heavy <input type="checkbox"/>
Sub-total B			2

	1	2	3	4
Apparent temperature	< 27°C <input type="checkbox"/>	> 27°C ≤ 33°C <input checked="" type="checkbox"/>	> 33°C ≤ 41°C <input type="checkbox"/>	> 41°C <input type="checkbox"/>
Sub-total C				2

Table 1: 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 [22].
A=15; B=2; C=2; therefore basic thermal risk=(15+2)×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 reflects that street workers in Bulawayo are exposed to heat that may cause heat stress.

Outdoor workers' adaptation methods to heat exposure

Observations reflected 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 gets 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% had no response.

When questioned on where the street vendors obtain information relating to heat waves, 68.82% cited the media as their source, 10.02% mentioned friends or colleagues, 20.01% had 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.

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. These workers do not receive legislative protection as their operations are perceived to be illegal and this extremely poor and vulnerable sector of society is at risk of suffering short-or long-term ill-health effects associated with heat waves [24].

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's streets. 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 includes 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 easier 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, 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 and have 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 on daily basis, thus exposing them to risk of dehydration. Their working conditions are generally not conducive to good health. In addition to having to cope with extreme heat in the summer, they are also exposed to air pollution from dust and vehicle emissions, which create further public-health problems.

This study shows that temperature levels and heat events have become more common and cause 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 and have no legal protection and have limited capacity to access health-care. The group has limited choices to mitigate the effects of heat wave 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 is a clear indicator of heat-stress risk. There is lack of knowledge about heat-related illnesses including heat stress amongst this cohort and they do not seek medical help as most cannot afford it. The majority treat themselves and lacks 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 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.

Limitations

This study was confined to assessing heat stress among outdoor street vendors due to time and resource constraints. For it to be holistic it should have covered all outdoor workers, including those operating backyard industries, however the results are still valid and can apply to every outdoor-setting activity.

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 to 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 compare street vendors with other outdoor workers.

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