BINDURA UNIVERSITY OF SCIENCE EDUCATION

DEPARTMENT OF ENVIRONMENTAL SCIENCE

An Investigation On Heat Stress Effects On Employee Health In Fast food outlets. A Case Study Of Bindura

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Declaration

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I, John Masona, declare that this research project is my own work and has not been copied or lifted from any source without the acknowledgement of the source. All information, sources and literature used are indicated in the project. The contribution of supervisors and others was consistent with the Bindura University of Science Education Regulations and Policies.

Signature of the student:  Date: 14/06/2023

DEDICATION

To my family and friends

ACKNOWLEDGEMENTS

I would like to thank my supervisor Dr V. Dudu for the guidance and support during the course of this study. Also, sincere gratitude goes to the management of the fast food outlets and the respondents who participated in this research. In addition, I would like to acknowledge the efforts of Mr Buckley Dzamara in research conceptualisation, and data analysis.

ABSTRACT

Heat waves have been increasing frequently resulting in ill-health and worst cases death especially in economically disadvantaged countries. This is aggravated by working in heat producing workplaces due to high temperatures, such as in large scale-kitchens. However, employees in these workplaces lack proper health and safety knowledge thus are exposed to occupational risks like heat stress. As such, the study sought to determine the heat exposure levels of employees in different sections of three different fast food outlets. In addition, the study investigated the effects of heat stress on employee health, and ascertained the association between employee socio-demographic attributes and knowledge on heat stress effects and its management. The study employed a cross-sectional design with the aid of a questionnaire disseminated to 49 randomly selected respondents. Also, in-depth interviews were done with key informants at each fast food outlet. Heat exposure levels were measured in four sections of each fast food outlet, that is, oven area, chip fryer, meat fryer and food serving section. Results showed that humidity was significantly lowest in the Food serving section of Outlet B (33.8±1.6%) and highest in the Frying section of Outlet A (50.4±1.8%). The WBGT values ranged from 25.2 – 34.0 ^{o}C for all outlets, with the baking and frying sections attaining WBGT values above 30 ^{o}C in all the food outlets. All sections of Outlet A were within the ACGIH limits, whereas the baking and frying sections of Outlet B were above the ACGIH maximum threshold value, whilst the food serving section of Outlet C was below the limit. The most recognized symptoms of heat stress were headaches (20.48 %) and tiredness (19.02 %) whereas fatigue (25.6%) and heat stroke (23.6) were the major known impacts of heat stress. Work section (X^2=16.5; p=0.02), age class (X^2=19.2; p=0.04) and work experience (X^2=20.6; p=0.03), significantly influenced knowledge on heat stress and its management among employees of fast food outlets. As such, it is recommended that fast food outlets should install air-conditioning systems to reduce heat in the various work stations, as well as provide heat resistant clothing. Also, regular training of employees to increase awareness on working in areas with extreme heat should be done.

Key words: fast food outlets, heat stress, knowledge and WGBT.

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LIST OF ACCRONYMS

ACGIH	American Conference of Governmental Industrial Hygienist
APA	American Psychological Association
CBD	Central Business District
EHS	Environmental Health and Safety
ILO	International Labour Organisation
ISO	International Standards Organisation
NIOSH	National Institution of Occupational Safety and Health
NSSA	National Social Security Association
OSHA	Occupational Safety and Health Association
PPC	Personal Protective Clothing
SPSS	Statistical Package for Social Sciences
ZIMSTATS	Zimbabwe Statistics

CHAPTER 1: INTRODUCTION AND BACKGROUND TO THE STUDY

1.1 INTRODUCTION

The impact of climate change and associated heat producing operations on economically disadvantaged groups needs to be assessed and mitigation strategies developed (Lundgren *et al.,* 2013). The frequency of extreme heat waves has been increasing, leading to excess morbidity and mortality, particularly in developing countries (ILO, 2019). These effects can be exacerbated by working in heat producing environments such as restaurants and fast foods operations (Thorzt, 2018).

Zimbabwe is one of the countries with high temperatures and most workplaces have operations mainly associated with emission of heat leaving workers at risk to direct heat contact (NSSA, 2021). Heat is a form of energy which is directly proportional to increase or a decrease in temperature, in addition to that it moves from a high temperature object to a lower temperature object (Jacklitsch *et al.,* 2016).

1.2 BACKGROUND TO THE STUDY

Since 2000, there has been an increase of fast foods operations in Zimbabwe (ZIMSTATS, 2018), attributed to an increase in demand for food among the working population and students. The increase has seen some unregistered and registered fast foods operations including those operated by multi-nationals, with a huge turnover in employment creation (NSSA, 2021). However, most of these companies have not received adequate health and safety attention as they are mostly excluded from mainstream employee health and safety inspections (Ncube and Kanda, 2018). This has the potential to expose workers to occupational risks including heat stress, which is exacerbated by working in heat producing stations such as by the grillers, fryers and ovens (Thorzt, 2018).

Heat stress develops when the body's homeostasis starts to deteriorate (Amine *et al.*, 2021), or when the effects of air temperature, humidity, radiant heat together with work rate and nature of personal protective clothing are combined (Sobolewski, 2021). These environmental conditions can cause body temperature to rise beyond normal, therefore increasing the risk of heat stress among exposed workers, with notable effects such as heat cramp, heat rash and in worst cases, heat stroke (Shah *et al.,* 2019). In addition to its healthrelated consequences, prolonged heat exposure can deteriorate human performance (Kovarts *et al.,* 2009; Kjellstrom *et al.*, 2014).

A combination of heat driven psychological and physical constraints is embodied with reduction of work efficiency, reduced labor skills, muscular fatigue (Xiang *et al.,* 2014), low concentration, and thus, increased frequency of mistakes (Environmental Health and Safety [EHS], 2016). The above mentioned factors can affect worker's health and work capacity, this in turn can affect productivity and increase health associated costs. Studies assessing heat stress in fast food operations in Zimbabwe are limited, and considering this lack of information on heat stress in fast food operations, the present study will assess the effects of heat stress on employees' health and worker capacity in three fast foods outlets in Bindura.

1.3 PROBLEM STATEMENT

Fast foods operations are usually done manually in heat producing environments. Several equipment and machinery used such as chip fryers and baking equipment produce a lot of heat exposing workers to the risk of heat stress. Studies have been undertaken on heat stress in diverse workplaces (Varghese *et al.,* 2018; Green *et al.,* 2020; Amine *et al.,* 2021). Results indicated that workers were exposed to heat environments thus affecting employee health and work productivity. However, there is limited information on the heat exposure levels and its effects on employees in fast food outlets in developing countries such as Zimbabwe. Thus, it is critical to examine fast foods' working environment so that conclusive findings can be realized which can be used by different stakeholders.

1.4 JUSTIFICATION

The study will determine the heat stress exposure in the various sections of fast food outlets, thus create a basis for corrective action. It will aid in raising awareness on the causes and impacts of heat stress as well as the measures to prevent and control heat stress in the workplace. The study findings will assist fast food outlets in establishing strategies of reducing exposure to heat hence improve working conditions. In addition, lost time is reduced and employee absenteeism is also reduced thus improving productivity. Also, the study will increase knowledge on the status of heat levels in fast food outlets hence assist in the formulation of policies for the management of heat stress in heat-prone work stations.

1.5 AIM

To investigate the effects of heat stress on employees' health and worker capacity in fast foods outlets in Bindura, Zimbabwe

1.6 OBJECTIVES

1) To compare heat exposure levels in different sections (peeling, fryer, baking and food serving sections) of different fast food outlets (A, B, and C).
2) To investigate the effects of heat stress on employee health.
3) To determine the association between employees socio-demographic attributes and knowledge on heat stress effects and management.

1.7 RESEARCH QUESTIONS

1) What are the heat exposure levels in different sections of different fast food outlets?
2) What are the effects of heat stress on employee health?
3) What is the relationship between employee socio-demographic characteristics and knowledge on heat stress effects and its managements?

CHAPTER 2: LITERATURE REVIEW

2.1 HEAT STRESS AND ITS OCCURRENCE

According to Aziah *et al.* (2012), heat stress occurs when the body fails to regulate or maintain a normal temperature, resulting in heat related ill-health and or worst case scenario may result in death. The optimum temperature range which yields maximum productivity is 10°C to 21°C and less than 30% humidity (Shah *et al.,* 2019). However, when temperature and humidity surpasses the standard threshold a hazard is created.

Heat stress is a major problem among many employees in different industries for example, agriculture, construction, mining and manufacturing sectors associated with heating or burning processes (Lucas *et al.,* 2014; EHS, 2016; Shah *et al.,* 2019). Heat stress may lead to employee absence from work due to illness resulting in lost time hence productivity is affected. Some of the factors influencing heat stress include high temperature and humidity, high work rates and heavy clothing (OSHA, 2016).

2.2 FACTORS PROMOTING HEAT STRESS

Occurrence of heat stress within workplaces is a result of several factors depending with the operations of the work environment (Aziah *et al.,* 2012; Kjellstrom *et al.,* 2016). These factors include high temperature, high humidity, limited air movement, high work load and clothing (ACGIH, 2016). As such each or a combination of these factors can result in heat stress. The following sections describe how these factors can lead to heat stress.

2.3.1 HIGH TEMPERATURE AND HUMIDITY

Prolonged manual work performance in high temperature environments put workers at risk of elevated body temperature (more than 38°C), this may hamper employee's working capacity, and concentration, increasing the likelihood of accident occurrence, and ultimately, heat exhaustion and heat stroke (Kjellstrom *et al.,* 2016). Also, body temperature is increased by a high metabolism, and heavy clothing giving rise to excessive sweating and eventually dehydration (Lucas *et al.,* 2014). On the other hand, high humidity hinders sweat from evaporating, resulting in the body not being able to cool itself by evaporating sweat. As such, in high humidity can plug sweat glands resulting in heat rush (Sobelewski, 2021).

2.3.3 LIMITED AIR MOVEMENT

Air movement influences heat exchange between environment and the body, and is directly proportional to the rate of heat exchange between the skin surface and the surrounding air (ACGIH, 2016). As such, body/skin temperature varies with air movement, with an increase in air movement promoting evaporation of sweat from the body. Thus, with limited air movement, the ability to excrete heat through sweat is impaired; hence the body fails to maintain a cooler body (Sobolewski, 2021).

2.3.3 CLOTHING

According to ACGIH (2016), the mechanism of personal protective clothing (PPC) can increase the metabolic rate especially if it is thick and heavy, thus restricts air movement. In hot areas, light, loose clothing is recommended as it assists in thermal insulation and dynamic air movement, preventing heat rash and other heat related complications (Aziah *et al.*, 2012). Also, cool vests can be used as they provide 1-2 hours of cooling, and maintain a constant temperature of 27°C (EHS, 2016).

2.3 EFFECTS OF EXPOSURE TO EXTREME HEAT CONDITIONS

Several consequences arise as a result of prolonged exposure to extreme heat, and these include heat stress, exhaustion, heat cramps, heat rash, poor human performance and productivity (EHS, 2016; OSHA, 2016; Zander *et al*, 2018). These effects are described below.

Heat stroke arises when the body is unable to regulate its core temperature, resulting in failure to dissipate heat out of the body (OSHA, 2016) thus the sweating mechanism fails, and the body is unable to cool down. This usually occurs when body temperature rises to 41^{o}C within 10 to 15 minutes. The arising symptoms include impaired planning, perceptions and poor sense of danger leading to errors which can affect their performance and workplace accidents (EHS, 2016). Heat exhaustion usually occurs prior to heat stroke arising from sharp increase in body temperature above 39^{o}C (OSHA, 2016), and is exacerbated by the failure of the body's thermoregulatory system due to lack of rehydration and salt imbalance.

Excessive dehydration due to heat triggers fatigue, which in turn disturbs skilled sensorimotor functioning, thinking capacity, and impairs decision making (OSHA, 2016). Ultimately the likelihood of making errors increases thus affecting overall work performance. On the other hand, heat strain occurs when the body fails to maintain its core temperature (EHS, 2016), especially due to workplace heat and manual physical. According to OSHA (2016), high ambient temperatures (> 38^{o}C) contribute to increased dehydration, internal body temperature and pulse rate, which ultimately yields heat strain. Also, heat Syncope occurs when the body loses much water through sweating and is also linked to prolonged standing and awkward seating (EHS, 2016). Consequently, heat syncope is associated with decreased blood flow in the cerebral hemisphere, due to excessive water loss, venous blood clotting, and low blood pressure (EHS, 2016).

Human performance refers to the ability in which an individual is able to meet the requirements of undertaking particular tasks (Zander *et al*, 2018). As opined by Kjellstrom *et al.* (2016) decline in human performance usually occurs after long time of work in hot environments. This is mainly a result of the increased exhaustion emanating from high temperatures and physically demanding tasks which in turn reduces work concentration (ILO, 2019). At an organisational scale, a decline in employee concentration results in incomplete tasks, targets are not met and ultimately production is affected. In addition, employee absence due to heat related illnesses further reduces the productivity and work capacity (Zander *et al*, 2018).

High temperatures also cause heat rash, which appears as itchy skin pimples, or skin lesions in areas mostly covered by clothing (EHS, 2016). These mainly arise as a result of sweat which fails to be evaporated from the skin. Heat cramps, which are sharp pains in the muscles may occur alone or with one of the other heat stress disorders (Kjellstrom *et al.,* 2016). These cramps occur as a result of strenuous physical work in hot workplaces. In addition, heat stress and long hours of physical exertion, may trigger Rhabdomylosis, a condition in which muscle fibres are torn, myolysis occurs, and eventually electrolytes and proteins are released into the blood stream (Zutt *et al.,* 2014). If untreated, it may result in kidney damage, seizures, cardiovascular problems, and death (Trujillo and Fragachan, 2011). Table 2.1 summarises some of the symptoms and effects of exposure to excessive heat.

Table 2.1: Summary of the effects of prolonged heat exposure and their management: adopted from EHS (2016)

Condition	Signs/symptoms	Management
Heat cramps	• Painful muscle spasms • Heavy sweating	
Heat syncope	• Brief fainting	Increase water intake

	• Blurred vision	• Rest in shade/cool environment
Dehydration	• Fatigue • Reduced movement	
Heat exhaustion	• Pale and sweaty skin	• Lie down in cool environment
	• Weakness, fatigue and fainting • Nausea and dizziness • Heavy sweating and blurred vision • Elevated body temperature	• Water intake • Loosen clothing • Call emergency services if symptoms continue once in cool environment.
Heat stroke	• Cessation of sweating • Hot and dry skin • High body temperature • Unconsciousness, collapse • Convulsions and confusion	• Medical Emergency • Summon ambulance • Move victim to shade, immerse in water

2.4 STRATEGIES OF MANAGING HEAT AT THE WORKPLACE

Vega-Arroyo *et al.* (2019) asserted that occupational practices can be altered improved in different ways in order to reduce heat levels and the associated adverse health consequences. According to Lucas *et al.* (2014) employees should be trained to identify the signs of heat illness, thus enabling them to be aware of the risks associated with heat exposure and dehydration (OSHA, 2016). In addition, Lundgren *et al.* (2013) reported that the most important intervention to heat stress management is regular hydration. For example, Hunt (2014) deduced that employees working in hot environments should rehydrate with at least 250ml every 20 minutes. However, such frequent drinking breaks are regarded to reduce worker productivity (Kenefick *et al.*, 2007) hence most employees tend to relinquish (Cramer and Jay, 2016).

Use of appropriate clothing to reduce heat levels have also been proposed (Cheung *et al.*, 2016), for example, lightweight, loose-fitting clothing, wide-brimmed hats made from synthetic fabric (polyester or acrylic) (Magyar and Revai, 2014). Also, constant environmental monitoring through periodic temperature measurements to establish work/rest cycles, appropriate work conditions and interventions to lessen heat strain should be implemented (ILO, 2019). Furthermore, surveillance, warning systems and communicating hazards, can be useful tools for avoiding heat stress (Bodin *et al.,* 2016). Long work shifts should be avoided as they increase exposure; however, most employees work overtime to secure higher income (Santos *et al.*, 2015). As such workers should be appropriately remunerated as income and livelihood are prevalent motivating factors that drive workers to ignore psychophysiological indicators of heat strain (Lucas *et al.*, 2014).

2.5 HEAT EXPOSURE LEVELS IN DIFFERENT WORKPLACES

In a study of heat stress by Beheshti *et al.* (2015), it was deduced that WBGT heat levels ranged from 27.9^{o}C to 29.7^{o}C in three different bakeries. Furthermore, they observed that there was performance loss among workers due to high temperatures in the kitchen (31.8^{o}C), refractory brick (32.0^{o}C) manufacturing and porcelain (32.4^{o}C) manufacturing industry respectively. In another study, Matsuzuki *et al.* (2011) reported WBGT values of gas kitchens (24.3^{o}C to 27.4^{o}C) being higher than electrical kitchens (19.3^{o}C to 24.5^{o}C) in a hospital and elementary school, whereas in the family restaurant it ranged from 22.5^{o}C to 23.7^{o}C for the electrical kitchen and 22.8^{o}C to 26.2^{o}C for the gas kitchen. However, the gas kitchen had lower WGBT values than the electrical kitchen in the pub. In addition, all values were within the Japanese and American heat exposure limits for light and moderate work. Logeswari and Mrunalini (2017) determined that five out of the six sampled work areas in hostel kitchens had temperatures above the ACGIH limits resulting in the workers affected by heat stress.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 DESCRIPTION OF STUDY AREA

The study was carried out in fast food outlets in Bindura (17º18’32.92” S and 31º19’57.45” E) central business district (CBD). Bindura town is a small mining and agricultural community situated approximately 88km due North East of Harare and is easily accessed by road and rail. The study sites are within the CBD and are involved in the business of selling fried chicken, chips and pizza. The fast food outlets include:

i) Outlet A (17°18'30.71"S and 31°19'51.79"E) is situated in the western part of the town.

ii) Outlet B (17°18'34.68"S and 31°20'3.60"E) situated in the central part of the CBD.

iii) Outlet C (17°18'37.23"S and 31°20'10.46"E) located in the eastern section of the CBD.

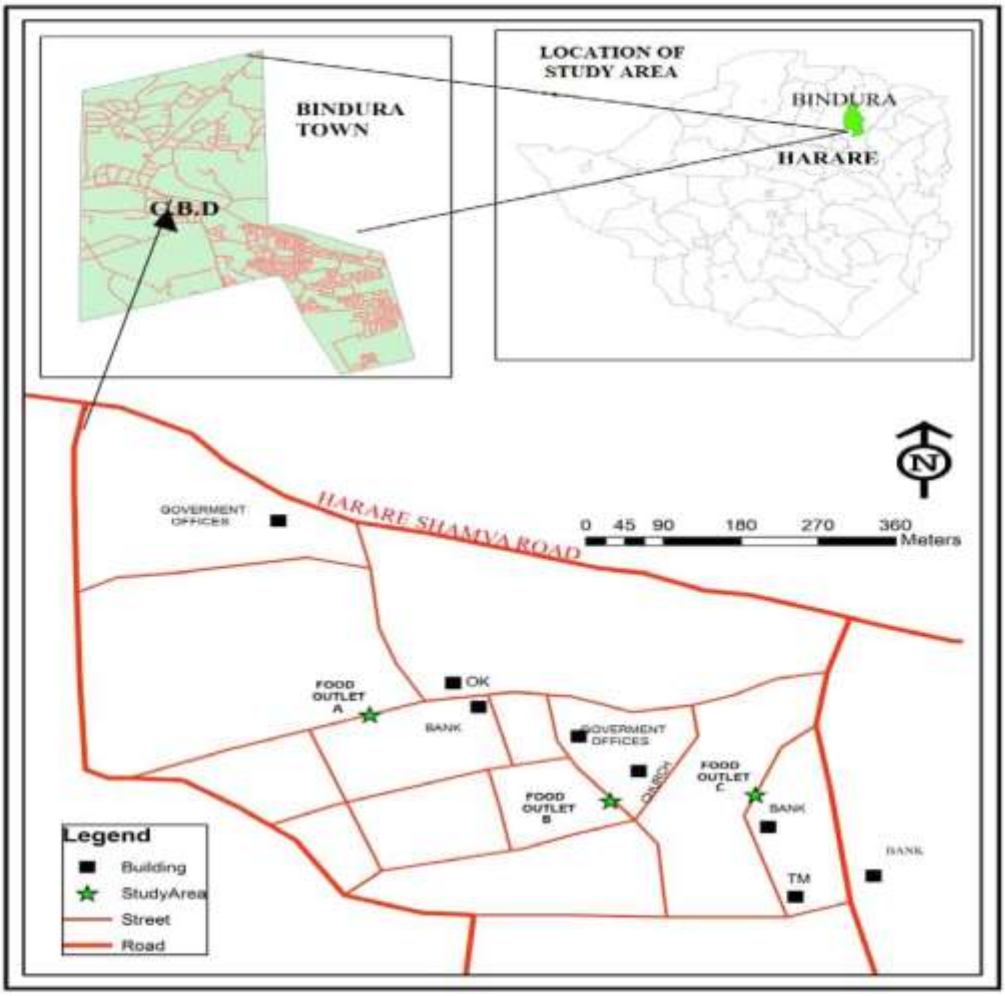


Figure 3.1: Location of study sites in Bindura CBD

3.2 RESEARCH DESIGN

The study employed a cross-sectional design with the aid of a questionnaire to collect both qualitative and quantitative data. A cross-sectional study involves looking at data from a population at one specific point in time (Cresswell, 2014). In addition, random sampling was employed to select the study participants at each fast food outlet.

3.3 STUDY POPULATION AND SAMPLE SIZE

The study population consisted of random employees working in different sections of the different fast food outlets. These sections included baking, peeling, chips and meat frying, and food serving sections. In total the fast food outlets have a total of 53 employees, with each section having at least three workers. As such the sample size was determined using

Cochran's formula (Israel, 2009). Each employee at each work station was assigned a number, and a random number generator used to select participants. The number of employees selected at each work section in the three food outlets is shown in Table 3.1.

$$n = \frac{N}{1+N(e)^2} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{[1]}$$

Where *n* is the sample size; *N* is target population and *e* is the level of precision.

$$n = \frac{53}{1+53(0.05)^2} \rightarrow \frac{53}{1+53(0.0025)} \rightarrow \frac{53}{1+0.1325} \rightarrow \frac{53}{1.1325} \approx 46.7991$$

Therefore, the sample size was approximately 47 respondents

Table 3.1: Number of respondents sampled at each fast food outlet

Work station	Food Outlet A		Food Outlet B		Food Outlet C	
	Total	Selected	Total	Selected	Total	Selected
Baking section	5	4	4	4	4	4
Peeling section	4	3	4	4	3	3
Fryer section	5	5	5	4	4	4
Food serving	6	5	5	4	4	3
Total	20	17	18	16	15	14

3.4 DATA COLLECTION

This section gives a detailed description of instruments and methods used during data collection which includes experimental measurements, questionnaires and interviews. In addition, the section enlightens on how these instruments and methods were applied to collect critical information for the research.

3.4.1 MEASURING HEAT EXPOSURE LEVELS

Heat exposure levels were determined through randomly recording indoor ambient temperature and relative humidity using the Ex-tech digital heat stress monitor certified by NSSA. The heat exposure levels were measured in four sections of each fast food outlet (oven area, chip fryer, meat fryer and food serving section). Three random sampling points (per each section) were selected, totalling 12 sampling points per fast food outlet. Overall, a total of 36 sampling points were established for the whole study. Measurements of parameters (globe temperature; natural wet bulb temperature and humidity) were distributed equally across all 4 sections and these were taken in the morning, afternoon and evening

Temperature and humidity recordings were entered into Wet Bulb-Globe Temperature (WBGT) formula (equation 2) for calculating heat stress levels. The WBGT is an effective and simple temperature scale, which at the same time measures dry and wet bulb temperatures, radiation, and air movement into single heat index (EHS, 2016).

$$WBGT = 0.7tnw + 0.3tg \quad \text{[2]}$$

Where: *tnw* is the natural wet bulb temperature; *tg* is the temperature of 150 mm diameter black globe.

The exposure limits (Action Limit for un-acclimatized and Threshold Limit Value for acclimatized) set by American Conference of Governmental Industrial Hygienists (ACGIH, 2016) can maintain one normal body temperature (37^{o}C) for most workers. In addition, it helps to provide guidance and raise alarm when heat exposure is getting higher than Action Limit or Threshold Limit Value as highlighted in Table 3.2.

Table 3.2: Threshold Limit Values based on WBGT for acclimatised workers

Workload	ACGIH (^{o}C)	OSHA (^{o}C)	ISO (^{o}C)	NIOSH (^{o}C)
Resting	–	–	33	–
Light	30	30	30	30
Moderate	26.7	27.8 – 30.6	28	28
Heavy	–	26.1 – 28.9	25 – 26	26

Very heavy	25	_	23 – 25	25

3.4.2 QUESTIONNAIRE

Data was collected using a questionnaire with both close-ended and open-ended questions to collect qualitative and quantitative data (Appendix I). The questionnaire was divided into four sections, namely A) socio-demographic information; B) exposure to heat and heat stress effects; and C) managing heat stress. The questionnaire was disseminated to a total of 47 random respondents from the three fast food outlets taking cognizance to cover all shifts including those that were off-duty. Cresswell (2014) asserted that a questionnaire interview is very effective method of gathering data as it is flexible and adaptable. Questionnaires maximises efficient use of time, anonymity (for the respondent) and the possibility of a high return rate (Gilham, 2008).

3.4.3 KEY INFORMANT INTERVIEW

Individual in-depth interviews (Appendix II) were done with key informants at each fast food outlet. These included managers and section supervisors. Consent for interviewing the key informants was sought via telephone and the interviews conducted through face-to-face interviews seeking information on heat stress and working conditions at each fast food outlet. According to Cohen and Morrison (2011) interviews collect in-depth information. However, questionnaires may be strained by time arrangements with the target group (Gilham (2008).

3.5 ETHICAL CONSIDERATIONS

Ethical issues were observed as guided by key codes of ethics described by the American Psychological Association (APA, 2017). These include informed consent, privacy and confidentiality, and respecting the rights and dignity of the respondents. As such, permission to carry out the study was granted by management of each respective fast food outlet. The participants were debriefed about the nature of the research prior to taking part. Thus, participation in the study by respondents was voluntary. Information on personal identifiers of respondents was not captured. Respondents had the right to stop or withdraw from the interview if they felt so and the researcher was non-judgmental during data collection and respected opinions of the respondents. The collected data was treated strictly private and confidential as it was only used for academic purposes (APA, 2017).

3.6 RELIABILITY AND VALIDITY

The questionnaire reliability check yielded a Cronbach alpha result above 0.7. To ensure validity of the data and reduce bias, respondent validation (or member check) was done to 15 respondents. This entailed returning to respondents and asking them to carefully read through their questionnaire and/or interview transcripts for them to validate or refute the researcher's interpretation of the data. This was done relatively soon after data collection to minimize participants' change of perceptions and views due to temporal effects and potential changes in their situation or health. Questionnaire transcripts were independently reviewed and explored by Lecturers from Bindura University. Data analysis was done by an external tutor to ensure reliability of the data thereby eliminating the potential for lone researcher bias.

3.7 STATISTICAL ANALYSIS

Data collected through the questionnaire was coded, and entered in the Statistical Package for Social Sciences (SPSS) version 22.0 for analysis using descriptive statistical techniques. A multivariate analysis of variance (MANOVA) at $p < 0.05$ level of significance was used to test for significant differences in heat stress levels in work sections, and between fast food outlets. Also, a chi-square test was used to determine the association between sociodemographic characteristics of respondents with knowledge on heat stress. A confidence level of 95% was used with $p < 0.05$ considered statistically significant.

CHAPTER 4: RESULTS

4.1 HEAT EXPOSURE LEVELS AT DIFFERENT FAST FOOD OUTLETS

Table 4.1 shows the mean humidity and WBGT values for three fast food outlets and their respective work sections. Humidity was significantly highest in the baking section of Outlet A (45.9±3.2%), and significantly lowest in the food serving section of outlet B (33.8±1.6 %). Overall, humidity ranged from 33.8% – 50.4% for all the fast food outlets. The baking and frying sections attained WBGT values above 30^{o}C in all the food outlets, with Outlet B recording the highest values in both the baking (31.7±1.6^{o}C) and frying sections (33.0±0.7^{o}C). On the other hand, Outlet C had the lowest value in the baking section (30.3±1.8^{o}C) whereas Outlet A had the lowest value in the frying section (30.4±0.8^{o}C). The minimum and maximum WBGT values recorded for each fast food outlet were outlet A (25.2 to 32.2^{o}C), outlet B (26.9 to 34.0^{o}C), and outlet C (27.2 to 31.4^{o}C). Compared with ACGIH threshold limits for heat stress, all sections of Outlet A were within the ACGIH limits, whereas the baking and frying sections of Outlet B were above the maximum threshold value by 0.7^{o}C and 3^{o}C respectively. In Outlet C, the frying section exceeded the ACGIH limit by

1.1^{o}C whereas the food serving section was 0.3^{o}C below the limit.

Table 4.1: WBGT values for three different fast food outlets (mean ± standard dev.)

Location	Work section	Humidity (%)	Temperature values (^{o}C) WBGT	Min.	Max.	ACGIH Limit
Outlet A	Baking	45.9±3.2^{ac}	30.6±0.9^{a}	28.9	32.2	27.5 - 31
	Peeling	36.8±1.8^{b}	27.9±1.8^{bc}	25.2	29.9	
	Frying	50.4±1.8^{a}	30.4±0.8^{ab}	29.3	31.5	
	Food serving	44.0±2.3^{c}	27.5±1.0^{b}	26.0	29.2	
Outlet B	Baking	42.9±1.3^{ac}	31.7±1.6^{acd}	29.2	33.7	27.5 - 31
	Peeling	34.1±1.3^{b}	29.8±0.8^{ac}	28.4	31.4	
	Frying	48.6±2.3^{a}	33.0±0.7^{d}	31.9	34.0	
	Food serving	33.8±1.6^{b}	28.6±0.9^{abc}	26.9	29.7	
Outlet C	Baking	43.9±2.1^{ac}	30.3±1.8^{abc}	27.7	33.1	27.5 - 31
	Peeling	34.9±1.7^{b}	29.9±0.9^{ac}	28.5	31.4	
	Frying	44.8±2.5^{ac}	32.1±0.6^{ad}	31.4	33.3	

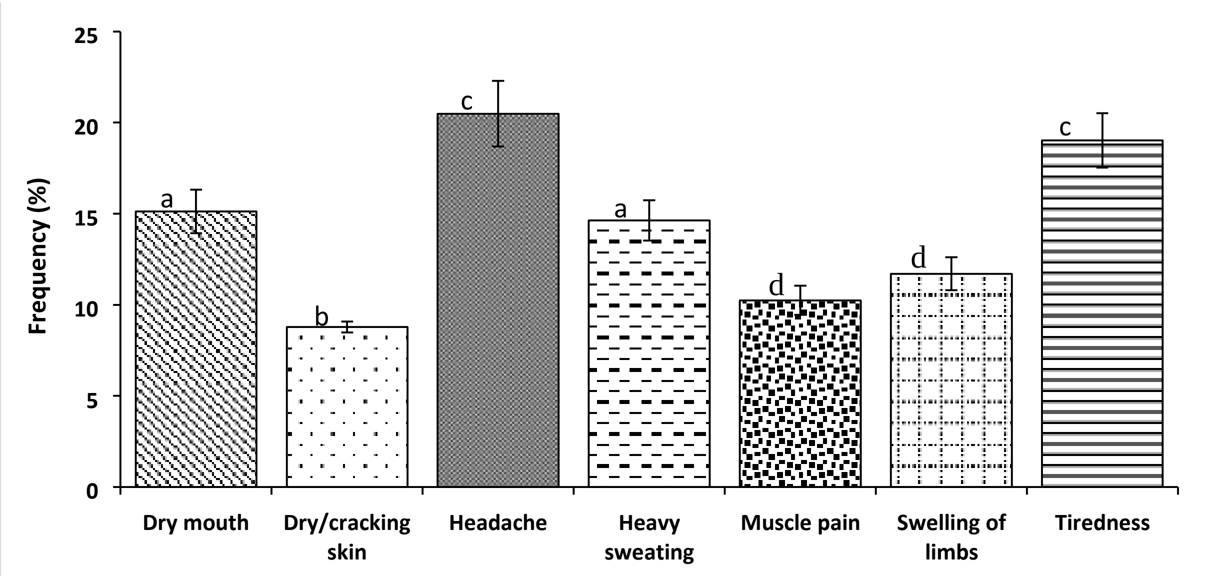
Food serving	34.7 ± 2.1^{b}	27.2 ± 1.6^{ab}	25.2	30.6

Different superscripts $^{a, b, c, d}$ down a given column denotes significantly different means ($p < 0.05$).

4.2 PERCEIVED EFFECTS OF HEAT STRESS ON FAST FOOD EMPLOYEES

The perceived symptoms and related effects of heat stress on employees working in fast food outlet are shown in Fig. 4.1 and Fig 4.2 respectively. Headaches (20.5%) and tiredness (19.0%) were the most recognized symptoms of heat stress, whereas dry/cracking skin (8.8%) was the least recognized symptom (Fig. 4.1). On the other hand, most respondents recognized fatigue and heat stroke as the major impacts of heat stress, attaining values of 25.7% and

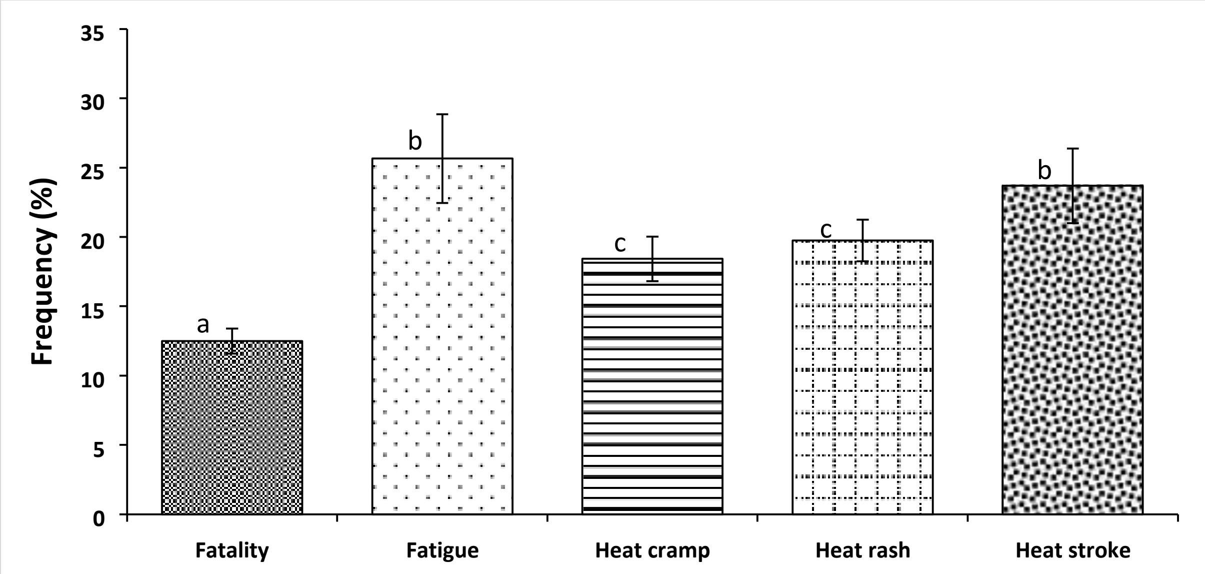
23.7% respectively, whereas fatality (12.50) was the least mentioned impact.



Superscripts $^{a, b, c, d}$ denotes significantly different ($p < 0.05$).

Figure 4.1: The heat stress symptoms perceived by respondents working in three fast food

outlets of Bindura



Superscripts [a, b, c, d] denotes significantly different ($p < 0.05$).

Figure 4.2: The most perceived heat-related effects that might occur within a hot workplace

4.3 ASSOCIATION OF SOCIO-DEMOGRAPHIC ATTRIBUTES WITH KNOWLEDGE ON HEAT STRESS AND ITS MANAGEMENT

Knowledge on heat stress and its management is shown in Table 4.2 and Fig. 4.3. The majority of respondents had received awareness on heat stress (70.2%), and nearly 60% acknowledged that their work station was a source of extreme heat. Also, 66.0% felt fatigued at work, whereas 57.4% were always thirsty at work. Fewer respondents (27.7%) had suffered from heat related stress though 72.3% had experienced heat related symptoms. Over 60% had not missed work due to heat related illness (Table 4.2). As shown in Fig. 4.3, the most proposed ways of reducing heat exposure in included providing cooling breaks (34.2%) and frequent rehydration (26.3%).

Table 4.2: Knowledge on heat stress

Variable	Frequency (%)	
	Yes	No
1. Received awareness on heat stress	33 (70.2)	14 (29.8)
2. Is your work station a source of extreme heat?	28 (59.6)	19 (40.4)
3. Do you feel fatigued at work?	31 (66.0)	16 (34.0)
4. Are you always thirsty at work?	27 (57.4)	20 (42.6)
5. Have you suffered from heat related stress?	13 (27.7)	34 (72.3)
6. Do you experience heat related symptoms?	34 (72.3)	13 (27.7)
7. Have you missed work due to heat related illness?	18 (38.3)	29 (61.7)
8. Do you have cooling breaks?	23 (48.9)	24 (51.1)
9. Is drinking water readily available?	21 (44.7)	26 (55.3)
10. Are employees encouraged to drink water?	47 (100)	0 (0)

11. Do you wear any heat resistant clothing?	11 (23.4)	36 (76.6)

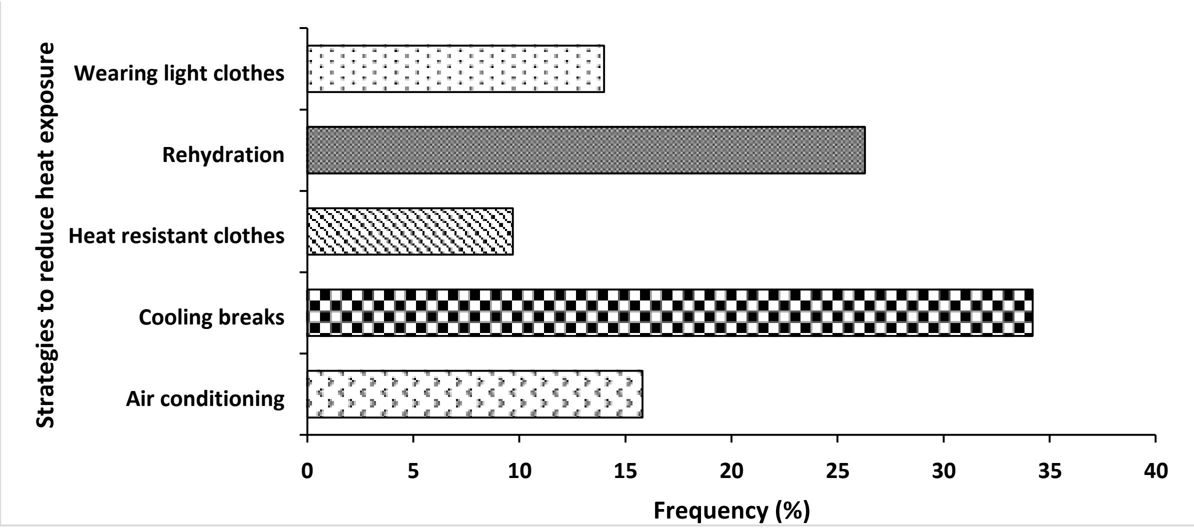


Figure 4.3: The proposed strategies of reducing heat exposure in fast food outlets

The association of socio-demographic characteristics of the respondents with knowledge on heat stress and its management is shown in Table 4.3. Most of the respondents were female (55.3%), married (59.6%), and were within the 21 - 40 years' age group (57.5%). In addition, the majority of respondents attained ordinary level education (68.1%) and had 1 - 5 years working experience (55.3%). For the association of socio-demographic attributes with knowledge on heat stress effects and its management, it was determined that work section (X^2=16.5; p=0.02), age class (X^2=19.2; p=0.04) and work experience (X^2=20.6; p=0.03), significantly influenced knowledge on heat stress and its management among workers of three selected fast food outlets in Bindura.

Table 4.3: Association of socio-demographic characteristics with knowledge on heat stress in three fast food outlets

Variable	Category	Freq.	%	Pearson's X^2-Test	
				X^2-Test Value	p-Value
1. Food outlet	Outlet A	17	36.2	32.667	0.1634
	Outlet B	16	34.0		
	Outlet C	14	29.8		
2. Work section	Baking	11	23.4	16.547	0.0297*
	Peeling	10	21.3		
	Frying	14	29.8		
	Food serving	12	25.5		
3. Gender	Male	21	44.7	9.286	0.2865
	Female	26	55.3		

4. Marital status	Married	28	59.6	24.497	0.4169
	Divorced	4	8.5		
	Single	13	27.7		
	Widowed	2	4.3		
5. Age class	< 20 years	12	25.5	19.153	0.0418*
	21 – 40 years	27	57.4		
	41 – 60 years	8	17		
6. Educational level	Ordinary	32	68.1	14.339	0.7982
	Advanced	9	19.1		
	Tertiary	6	12.8		
7. Work experience	< 1 year	6	12.8	20.689	0.0371*
	1 – 5 years	26	55.3		
	6 – 10 years	8	17.0		
	> 10 years	7	14.9		

*represent significantly different ($p < 0.05$)

CHAPTER 5: DISCUSSION

5.1 HEAT EXPOSURE LEVELS AT DIFFERENT FAST FOOD OUTLETS

The WGBT values for Outlet A were within the ACGIH threshold in all sections. These values were comparable with the findings of Matsuzuki *et al.* (2011) who reported WBGT values of gas kitchens (24.3 - 27.4°C) and electrical kitchens (19.3 - 24.5°C) within the Japanese and American heat exposure limits. Observations in these outlets revealed that the work sections were well ventilated with sound air-conditioning systems.

The baking (31.7°C) and frying sections (33°C) of Outlet B were above the ACGIH limit. This was mainly a result of the elevated humidity level in these sections. Similarly, Beheshti *et al.* (2015) determined high temperatures in the kitchen (31.9°C), brick manufacturing (32.0°C) and porcelain manufacturing (32.4°C) above set limits which resulted in poor employee performance in Iran. Likewise, Logeswari and Mrunalini (2017) reported that hostel kitchens had temperatures above the ACGIH limits leading to heat stress among employees in India. The heat shocks increase accident risk as opined by Page and Sheppard (2019), who determined that temperature between 18°C and 30°C can elevate accident rates by 4.5 % in restaurants. However, the accidents are also influenced by work volume or lack of protective measures, for example, insufficient or lack of a cooling system. On the other hand, the WGBT for food serving section of Outlet C was below the ACGIH limit mainly because it was situated under a shade outside the main building where there was adequate ventilation.

5.2 PERCEIVED EFFECTS OF HEAT STRESS ON EMPLOYEES

The most recognized symptoms of heat stress by respondents were headaches, tiredness and dry mouth. These symptoms emanate from dehydration which leads to dizziness and fatigue, coupled with long working hours these symptoms could become fatal. Similarly, OSHA, (2016) and Zander *et al*, (2018) reported that the consequences of prolonged exposure to extreme heat, include exhaustion, heavy sweating and heat cramps. Overtime, these symptoms may lead to serious health effects. As such, fatigue, heat cramp, heat rash, heat stroke and fatality were acknowledged as some of the impacts of heat stress. These effects tally with those mentioned by Environmental Health and Safety (2016), Kjellstrom (2016) and Zander *et al.,* (2018 who stated that exposure to extreme heat leads to heat exhaustion, heat strain and heat stroke.
According to National Safety Council (2003) heat stress promotes anger and even comparative behaviour as well as thinking skills and cause increasing numbers of accidents. Similarly, EHS (2016) asserted that the effects of heat stress will negatively impact employee performance causing less concentration, and more mistakes resulting in accidents. Moreover, it results in low production due to employee absence due to illness, as well as increased expenditure on medical expenses and lost time (Kjellstrom *et al.,* 2014; ILO, 2019). The organisation's image is tarnished due to high number of heat stress incidences (OSHA, 2016).

5.3 ASSOCIATION OF SOCIODEMOGRAPHIC ATTRIBUTES WITH KNOWLEDGE ON HEAT STRESS AND ITS MANAGEMENT

There was no difference in heat stress knowledge with respect to food outlet, gender, marital status and educational level. However, it was shown that work section, age class and work experience were closely associated with knowledge on heat stress and its management. Employees in the baking and frying sections were more knowledgeable on heat stress compared with those working in the peeling and food serving sections. This could be a result of the consistent exposure to heat emanating from the ovens and fryers in these work areas. Thus, employees become aware on how to manage heat due to prolonged heat experience.

With respect to age class, the 21-40 years' age group was more knowledgeable on heat stress than other age groups and had the majority number of respondents. This is usually the age group engaged in livelihood activities and as such increases their awareness due to the daily work experiences. These tallies with the findings of Pradyuma *et al.* (2018) who reported that those involved in livelihood activities are constantly exposed to the threat of heat as such become more aware of it and devise ways of avoiding and reducing its effects. Similarly, Marinaccio *et al.* (2019) deduced that the 15-34 years' age group is better knowledgeable on heat stress as they are at a higher risk of injury when temperature increases.

Work experience showed that those with more than five years' work were aware of heat stress management compared with those that had lower than five years working experience. This could be attributed to the knowledge gained over the years in dealing with heat stress. In addition, most of the respondents had 1-5 years' work experience in the fast food industry hence their awareness on heat stress was low. As reported by Pradyuma *et al.* (2018) with work experience one gains knowledge overtime, on the need to acquire adequate rest and recovery time, and how to avoid heat stress.

CHAPTER 6: CONCLUSION AND RECOMMENDATIONS

6.1 SUMMARY

This study investigated the effects of heat stress on employee health in three fast food outlets in Bindura. A heat stress monitor was used to measure humidity and temperature in the food outlets, whereas questionnaires, and interviews were used to determine awareness on heat stress and possible effects of heat stress to the employees. It was determined that some sections of the food outlets exceeded heat stress exposure levels, whereas the employees had varying awareness on heat stress effects.

6.2 CONCLUSION

The study determined that WGBT of all the work stations of Outlet A were within the ACGIH threshold of 27.5^{o}C to 31^{o}C, whereas the baking and frying sections of Outlet B recorded WBGT values above 42^{o}C, which surpassed the set limits. For Outlet C, the frying section exceeded the ACGIH limit but the food serving section was below the limit. The most recognized symptoms of heat stress were headaches and tiredness whereas fatigue and heat stroke were the major known impacts of heat stress. Work section, age class and work experience were closely associated with knowledge on heat stress and its management.

6.3 RECOMMENDATIONS

From the study findings it can be recommended that the fast food outlets should:

- Improve ventilation and install air-conditioning systems so as to reduce heat in the various work stations.

- Provide heat resistant clothing to protect the workers from direct heat and, provide flexible work shifts to reduce exposure to extreme temperatures among the employees.
- Exercise periodic training to its employees to increase awareness on working in areas with extreme heat.
- Further research efforts should focus on ways of improving employee safety in heat related working areas.

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APPENDICES

APPENDIX I: RESEARCH QUESTIONNAIRE

Good morning/afternoon. My name is **JOHN MASONA**. I am a student in the department of Environmental Science (Reg. number: B192731) at Bindura University of Science Education. I am undertaking research on *"The effects of heat stress on employee's health and work capacity at in fast food outlets, in Bindura, Zimbabwe"*. I am inviting you to participate in the study by answering a few questions on the topic. Your participation in this study is voluntary. I guarantee you that information shared will be treated as confidential and your identity will not be disclosed. The study findings will be used to make recommendations on food safety and hygiene in Zimbabwe. Answering the questions takes about 15 minutes of your time.

Questionnaire No: ....   Section: …………………………………………… Date: ....

SECTION A: DEMOGRAPHIC INFORMATION *(please TICK appropriate)*

1) Gender: male ☐ female ☐

2) Marital status: married ☐ divorced ☐ ☐ single ☐ widowed

3) Age: <20yrs ☐ 21-40yrs ☐ 41-60yrs ☐ >60years ☐

4) Level of education: none ☐ primary ☐ ordinary level ☐ advanced ☐ ☐ tertiary

☐ ☐ ☐ ☐

5) Years working at fast food outlet: <1yr 1-5yrs 6-10yrs >10yrs

SECTION B: EXPOSURE TO HEAT AND HEAT STRESS EFFECTS *(please TICK or fill in empty space)*

6) Have you received awareness on heat and its related effects? yes ☐ no ☐

7) What is your usual work station? ………………………………………………………….

8) Do you think your work station is a source of unacceptable levels of heat? yes ☐ no ☐

9) Do you feel fatigued/tired at work? ☐ no ☐ yes

10) Are you always thirsty at work? ☐ no ☐ yes

11) Have you suffered from any heat ☐ no ☐ related illness? yes

☐ no ☐

12) If no, do you experience any heat ☐ no ☐ related symptoms? yes

13) Have you ever missed work due to 1-3mnths ☐ 3-6mnths ☐ >6mnths heat related illness? yes

14) If yes, when was that? <1mnth ☐ ☐

15) If yes, what do you think caused the heat related illness you suffered from. *Please specify*

………

………

16) Which of the following do you think are heat stress symptoms? *(please Tick your response)*

a) Headache: ☐ no ☐ yes

b) Heavy ☐ no ☐ sweating: yes

c) Tiredness/ ☐ no ☐ fatigue: yes

d) Dry mouth: ☐ no ☐ yes

e) Swelling of ☐ hands and legs: yes no ☐

f) Muscle pain: ☐ no ☐ yes

g) Dry/ cracking ☐ no ☐ skin: yes

17) Which of the following heat related effect/s you think can occur within a hot workplace?

a) Heat cramp: yes ☐ ☐ no

b) Fatigue: yes ☐ no ☐

c) Heat rash: yes ☐ no ☐

d) Heat stroke: yes ☐ ☐ no

e) Fatality: yes ☐ no ☐

SECTION C: MANAGING HEAT STRESS

18) How long is your working shift (hours/ per day)? <3hrs ☐ ☐ 4- ☐ 6hrs 6-9hrs

☐ ☐

19) Do you have cooling breaks during work shifts? yes ☐ no ☐ ☐ ☐

20) If yes, how long are the cooling breaks? 5mins ☐ ☐ 10mins 15mins >15mins

☐ ☐

21) Is drinking water readily available? yes no

☐ ☐

22) If yes, are employees encouraged to drink water? yes no

☐ ☐

23) How many litres of water do you drink per shift? <1litre 1-2litres >2litres ☐

24) Do you wear any heat resistant clothing when working? yes no **25)** What strategies can you suggest to reduce heat exposure at your workstation?

………

no

no

no

Meat fryer

………

………

………

………

END OF QUESTIONNAIRE ………………………. **THANK YOU**

APPENDIX II: INTERVIEW GUIDE FOR KEY INFORMANTS

1) How long have you been employed at this fast food outlet? …………………………… **2)** Do you perform pre-shift safety talks with employees? yes

3) If yes, provide evidence you have ………………………………………………………….

4) Have you ever received any heat related complaints, or illnesses from employees? yes

5) Have you recorded lost time illness concerning heat from employees? yes

6) If yes, how often ………………………………………………………………………

7) Which section/s of the outlet have most of these lost time illnesses? Chips fryer

Baking section Food serving section

8) Have you ever noticed loss in job attention and poor work results among employees as a result of heat discomfort? yes no

9) If yes, state the section/s where such a situation is mostly identified ....

10) What do you think are the main leading factors to heat related illnesses within your workplace?

………

………

………

………

11) Does the company provide work rest cycles or cooling breaks to employees during shifts? yes no

12) If yes, state length of each work rest or cooling break and its frequency. ……………………………………

13) How do you handle a situation/ incident concerning heat related injury or illness? …………………………..

………

……….

14) Are there existing protective and control measures to curb the effects of heat? yes ☐ no ☐

15) If yes, please state them in detail ………………………………………………………………….....................

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16) What additional preventative and control measures do you think must be put in place or practiced to reduce the effects of heat within your workplace? …………………………………………………………………

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END OF Questionneire ……………………………… THANK YOU

APPENDIX III: HEAT STRESS MONITORING INSTRUMENT