UNIVERSITI PUTRA MALAYSIA

KNOWLEDGE, PERCEPTION AND PRACTICE ON PROTECTION OF HEAT-RELATED STRESS AFFECTING HEALTH AND PRODUCTIVITY AMONG MAIZE FARMERS IN GOMBE, NIGERIA

LUKMAN SHIJI SADIQ

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By

LUKMAN SHIJI SADIQ

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfillment of the Requirements for the Degree of Master of Science

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DEDICATION

This piece of work is dedicated to the maize farmers of Gombe State.

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the Degree of Master of Science

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Chairman : Professor Zailina Bt Hashim, PhD
Faculty : Medicine and Health Sciences

Heat stress disorders and subsequent productivity reduction output have been a rising concern for agricultural workers, working under direct sunlight for an extended number of hours. The study was conducted to assess the knowledge, perception and practice on protection of heat-related stress affecting health and productivity among maize farmers in Gombe, Nigeria. A cross-sectional study was conducted among 396 maize farmers. Simple random sampling technique was used to determine the; knowledge, perception, and practice of heat stress, experience on impact of heat stress, self-reported heat stress related symptoms, the relationship between knowledge scores of workers and health practices, and the self-reported heat stress related symptoms. The validated self-administered questionnaire was used as the instrument for the data collection. The relationship between physiological body changes and exposed heat, and their difference was determined in the different time of the day during farming operation. The difference in productivity within the different time of the day was also determined. The relationship of temperature, BMI, age, and gender on the productivity were also determined. Anthropometric data was measured using a weighing scale and tape height instrument. Data on physiological body changes for blood pressure and heart rate were measured using digital blood pressure monitor, while body temperature was measured using a digital thermometer. The productivity of workers was determined using the productivity data sheet that keeps a record of the number of ridges tilled per hectare within the three different time of the farming operation. The wet bulb globe temperature monitor (WBGT) QuestTemp^{0}36 model was used in determining the heat index. The study showed that the majority of the respondents got high scores on knowledge of the basic factors that cause heat stress (87.9%), and moderate score on the early heat stress related illnesses or symptoms (68.4%). Heat stress is perceived by about 66% as a determining factor for causing health disorder and productivity decrease. Common safe working practices for protection against heat stress were embraced almost every day by about 90.0% of the farmers. Over 50% reported heat stress as a factor to the loss of productivity based on their experience. Heavy sweating (93.2%), tiredness (48.5%), dizziness (34.1) and headache (40.4)

were experienced by the respondents almost on daily basis. There was a significant positive correlation between knowledge and health practices of heat stress, as well as inverse relationship between knowledge and reported HRI and symptoms. There was a significant difference in practice score between knowledge groups. The total mean heat stress index of the farms was 30.26^0C exceeding the threshold level set by ACGIH. There was a direct significant correlations between respondents' body temperature before, during and after working hours and the environmental temperature, (p <0.001). Systolic blood pressure during work and the environmental temperature showed a direct significant correlations, (p <0.001). A direct significant correlation between respondents' heart rate and environmental temperature was seen during and after working hours (p < 0.001). Both systolic and diastolic blood pressure, heart rate and body temperature showed a significant difference before, during and after working hours (p <0.001). There was a significant regression for all the variables tested on productivity; temperature (p < 0.001), gender (p < 0.001), age (p = 0.033) and BMI (p = 0.008). The finding further showed significant differences in the productivity between the hours of 6am-9am, 9am-12pm, and 12-3pm (p <0.001). The farmers were frequently found experiencing heat exhaustion which decreased their productivity.

Keywords: Knowledge, Perception, Practice, Heat Stress, Health, and Productivity.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk Ijazah Master Sains

PENGETAHUAN, PERSEPSI DAN AMALAN PERLINDUNGAN TEKANAN HABA YANG MENYENTUH KESIHATAN DAN PRODUKTIVITI KALANGAN PELADANG JAGUNG DI GOMBE, NIGERIA

Oleh

LUKMAN SHIJI SADIQ

April 2017

Pengerusi : Profesor Zailina Bt Hashim, PhD
Faculty : Perubatan dan Sains Kesihatan

Masalah kesihatan berkaitan haba dan kesannya terhadap produktiviti pengeluaran merupakan isu yang semakin menular kalangan pekerja sektor pertanian yang bekerja di bawah panas terik matahari untuk jangka masa yang lama. Kajian ini dijalankan bagi melihat kesan haba ke atas kesihatan dan produktiviti petani ladang jagung di Gombe, Nigeria. Satu kajian keratan rentas telah dijalankan di kalangan 396 petani di Gombe, Nigeria. Subjek dipilih secara rawak bagi mengumpulkan maklumat tentang ciri-ciri sosio-demografi, pengetahuan, persepsi dan amalan terhadan tekanan haba, risiko tekanan haba dan kesan tekanan haba ke atas kesihatan dan produktiviti dengan menggunakan kaedah soal selidik yang dikendalikan oleh responden sendiri. Data antropometri diukur menggunakan skala pemberat dan pita pengukur tinggi. Data kesan fisiologi badan untuk tekanan darah dan kiraan nadi diukur menggunakan monitor tekana darah digital, manakala suhu badan disukat menggunakan termometer digital. Produktiviti petani dikenal pasti dengan menggunakan lembaran data produktiviti yang mempunyai rekod bilangan rabung yang berjaya disediakan dalam 3 jangka masa yang telah dikategorikan. Termometer WBGT QuesTemp36 digunakan bagi mengukur indeks haba. Statistik deskriptif menggunakan frekuensi, peratus dan markah purata komposit manakala statistik inferensi menggunakan Kolerasi Pearson, ANOVA sehala and pelbagai regresi linear digunakan dalam penganalisaan data. Kajian menunjukkan peratusan responden yang tinggi (>90%) mempunyai pengetahuan asas tentang faktor-faktor yang menyebabkan tekanan haba dan petunjuk-petunjuk atau simptom yang biasanya berhubung rapat dengan strok haba seperti banyak berpeluh (99.7%), keletihan/kelemahan (94.4%), suhu badan yang meningkat (96.4%), kekejangan otot (79.0%) dan pening (93.0%). Persepsi bahawa tekanan haba boleh menyebabkan masalah kesihatan dan pengurangan produktiviti dilihat kalangan 66.0% responden. Amalan bekerja secara selamat untuk mengatasi tekanan haba diamalkan setiap hari oleh 90.0% responden. Simptom seperti banyak berpeluh (93.2%), keletihan (48.5%), kepeningan (34.1%) dan sakit kepala (40.4%) dialami oleh responden hampir setiap hari bekerja. Lebih 50% responden melaporkan tekanan haba sebagai faktor pengurangan produktiviti berdasarkan pengalaman

mereka. Terdapat kolerasi positif yang lemah di antara suhu responden sebelum, semasa dan selepas bekerja dengan suhu persekitaran, yang menunjukkan hubungan yang signifikan (p=<0.001). Tekanan darah sistolik dan suhu perekitaran menunjukkan kolerasi positif lemah (p<0.001). Kolerasi positif yang signifikan juga dapat dilihat antara kadar denyutan nadi dengan suhu persekitaran sebelum dan selepas bekerja. Kesemua tekanan darah sistolik, diastolik, nadi dan suhu badan menunjukkan perbezaan yang signifikan sebelum, semasa dan selepas bekerja (p<0.001). Terdapat regresi yang signifikan untuk kesemua pengubah yang diuji; di mana suhu (p < 0.001), jantina (p <0.001), umur (p=0.033) dan BMI menunjukkan (p=0.008). Kajian juga menunjukkan perbezaan signifikan (p=<0.001) dalam produktiviti pekerja di antara masa 6-9 pagi, 9-12 tengah hari dan 12-3 petang. Petani sering kali berhadapan dengan tekanan haba yang boleh mengurangkan produktiviti.

Kata kunci: Pengetahuan, Persepsi, Amalan, Tekanan haba, Kesihatan, dan Produktiviti

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I certify that a Thesis Examination Committee has met on 11 April 2017 to conduct the final examination of Lukman Shiji Sadiq on his thesis entitled "Knowledge, Perception and Practice on Protection of Heat-Related Stress Affecting Health and Productivity among Maize Farmers in Gombe, Nigeria" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

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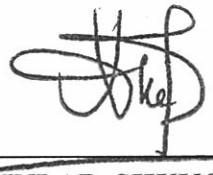

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This thesis was submitted to the Senate of the Universiti Putra Malaysia and has been accepted as fulfillment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

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This is to confirm that:

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Name of Chairman of Supervisory Committee: Professor Dr. Zailina Bt Hashim

Signature: _____
Name of Member of Supervisory Committee: Associate Professor Dr. Malina Osman

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LIST OF ABBREVIATIONS

ACGIH	American Conference of Governmental Industrial Hygienist
ANSI	American National Standard Institute
ASHRAE	American Society for Heating, Refrigerating and Air-Conditioning Engineers
BCT	Body core temperature
BMI	Body mass index
^{0}C	Degree centigrade
^{0}F	Degree Fahrenheit
CCOHS	Canadian Centre for Occupational Health and Safety
CDC	Centre for Disease Control and Prevention
GDP	Gross domestic product
GSADP	Gombe State Agricultural Development Programme
HRI	Heat stress related illnesses
HSE	Health and Safety Executive
IPCC	Intergovernmental Panel on Climate Change
NASA	National Aeronautics and Space Administration
NBS	National Bureau of statistics
NIOSH	National Institute for Occupational Health and Safety
NIMET	Nigerian Meteorological Agency
OSHA	Occupational Safety and Health Administration
PPE	Personal protective equipment
RH	Relative humidity
SPSS	Statistical package for social sciences
TLVs	Threshold limit levels

UNEP	United Nations Environment Programme
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
WBGT	Wet Bulb Globe Temperature
WHO	World Health Organization
WMO	World Meteorological Organization
WWF	World Wildlife Fund

CHAPTER 1

INTRODUCTION

1.1 Background of the Study

Climate change is one of the greatest threat facing the globe because it causes a rise in the ambient temperature of our environment (United Nations Environment Programme, 2014). The Intergovernmental Panel on Climate Change (IPCC) confirms that the global average surface temperature shows a warming of about 0.85^0C over the period of 1880 to 2012 (Intergovernmental Panel on Climate Change, 2013). Additionally, with the continued emission of greenhouse gases at the year 2000 levels, a further warming of about 1^0C per decade would be expected. The world Meteorological Organization (WMO), reported that 2011-2015 have been the warmest five-year period on record with many extreme weather events especially heat waves which are influenced by climate change (World Meteorological Organization, 2015). This phenomenon widely called global warming has been observed by the scientists of the nineteenth century to have cause rise in atmospheric and water temperatures (Rowland & Pittock, 2009). Furthermore, currently, each of the first six months of 2016 set a record as the warmest respective month globally in the modern temperature record, which dates to 1880 (National Aeronautics and Space Administration, 2016).

Africa which is the second largest continent situated on latitude and longitude of 7.1881^0N and 21.0936^0E respectively is one of the most vulnerable continent severely affected by climate change. Future warming across the continent due to climate change scenarios has been indicated ranging from 0.2^0C per decade (low scenario) to 0.5^0C per decade (high scenario) (Desanker, 2002). Tropical climatic zones with normal daytime air temperatures exceeding 30°C, consist about 40% developing countries (Costello et al., 2009). In the same vein, Nigeria which is in the tropics is one of the developing countries in Sub-Saharan Africa, has recorded an increase of 1.1^0C in its mean ambient air temperature from 1901 to 2005 (Odjugo, 2010). Nigeria has six geo-political zones, namely; South West, South East, South South, North Central, North West and North East. Several studies Eregha, Babatolu, and Akinnubi, 2014; Nwaiwu et al., (2014), have shown that climate parameters especially rainfall and temperature have been found to be significantly affecting agricultural productions and sustainability in Nigeria.

Gombe is one of the North-Eastern states of the country which lies within the coordinates of 10^019'N and 11^002'E. The state is characterized as a savannah region that experiences an average of 11hrs of sunshine daily with a temperature of 36 to 38^0C. The entire Northern part of the country recorded 0.5 to 2.2^0C warmer than normal. The comfort index anomaly level of Gombe state falls within the areas that experienced greater than normal level of discomfort during the 2011 hot season (Nigerian Meteorological Agency, 2011). According to National Bureau of Statistics, (2013), almost 70% of Nigerians are farmers that practice farming at subsistence level, that made about 41% of the country's Gross Domestic Product (GDP). Gombe State

farmers are accounting for about 60% of their population. Among the common crops cultivated in Gombe are millet, maize, guinea corn, rice, beans, etc. Heat stress is a serious problem among agricultural workers in Gombe because they spend quite a number of hours under a hot environment in almost all the farming practices throughout the farming season normally starting from the month of May to October.

Therefore, this study outlined the impact of heat on the health and productivity of farmers in Gombe, and provided possible recommendations that will limit the impact.

1.2 Problem Statement

Heat is an environmental and occupational hazard that people in the tropics are subjected to its vulnerability. Exposure to heat when WBGT exceeds 26 to 30^0C, can reduce work capacity and cause serious health problems such as; sun stroke, muscle cramps, heat exhaustion, heat stroke and even death, depending on the humidity, wind movement, and heat radiation. People within the group of low and middle-income countries are more vulnerable because many of them engage in heavy physical work, either outdoors under direct sunlight or indoors without effective cooling (Kjellstrom, Gabrysch, Lemke, & Dear, 2009). Agriculture has been the major industry in the developing world. Farming operations carried by farm workers are normally at high risk of heat stress, as they work under high pressure, perform extended hours of work under direct sunlight and high temperature, suffer dehydration and often do not have sufficient knowledge regarding prevention from heat exposure (Schenker, 2011). Farmers have been among the outdoor occupational workers faced with high physical load and are most at risk of severe heat exposure (Bernard, Dukes-Dobos, & Ramsey, 1994).

Accordingly, many studies were conducted on the environmental effect of global warming; however, less attention was given to its effect on environmental and occupational health, yet conditions for manual work in many types of industry and agriculture get worse with the anticipated effect of global warming, particularly in developing countries (Holmér, 2010). Nigerian Meteorological Agency (NIMET), reports that Gombe state is susceptible to the high amount of heat that can cause discomfort (NIMET, 2011). Approximately 60% of Gombe State populace are farmers that work in their farmland for an average of 8hrs per day mostly under the period of intense sunlight. Almost all farming operations starting from land clearance, planting, tilling, harvesting among others are done manually using local tools. According to Musari, Ajayi, and Abatan, (2014), the entire North-Eastern Nigeria is characterized by a high temperature that may cause heat stress due to hot and humid weather starting from May to October.

In view of the above, Gombe State farmers are vulnerable to heat stress related diseases and can possibly impact their productivity because they partake in hard labour under the effect of intense sunlight throughout their farming operations.

1.3 Research Questions

i. What are the levels of knowledge, perception and current health practices of farmers on the protection from heat stress, while working in the farm?
ii. What are the reported heat stress related symptoms among local farmers?
iii. What are the relationships between environmental parameters (temperature, humidity and wind movement) and farmers' physiological body changes?
iv. How do factors such as temperature, gender, age and BMI affect the productivity of local farmers?
v. What is the difference in productivity between the different time of the day in the farming operations?

1.4 Objectives of the study

1.4.1 General Objective

To assess the knowledge, perception, and practice of heat related stress affecting health and productivity among maize farmers in Gombe, Nigeria.

1.4.2 Specific objectives

i. To determine the socio-demographic factors of the respondents and their anthropometric measurement, as well as job characteristics (years of experience, hectares cultivated farming tools and operations).
ii. To determine farmers' levels of knowledge, perception, practices for protection from heat stress and experience on the impact of heat stress on productivity.
iii. To determine the self-reported heat stress related symptoms among farmers.
iv. To determine the association between the knowledge scores and health practices of heat stress among farmers.
v. To determine the relationship between the knowledge scores and self-reported heat stress related illnesses (HRI) and symptoms.
vi. To compare the practice score of heat stress based on knowledge groups.
vii. To determine the environmental temperature and its relationship with physiological body changes (body temperature, heart rate, and blood pressure) before, during and after working hours.
viii. To compare the difference between physiological body changes (heart rate, blood pressure, and body temperature) of the workers before, during and after working hours.
ix. To compare the difference in the productivity of farmers between the hours of 6-9am, 9-12pm, and 12-3pm.
x. To determine the predictors of farmers' productivity; temperature, gender, ag**e,** and **BMI**.

1.5 Null Hypotheses

The null hypotheses of the study are as follows:

H_0: There is no relationship between knowledge scores of workers and health practices of heat stress.
H_0; There is no relationship between knowledge scores and self-reported HRI and symptoms.
H_0: There is no difference in practice score between the knowledge groups.
H_0: There is no relationship between physiological body changes (heart rate, blood pressure, and body temperature) with the exposed heat in the worker.
H_0: There is no difference between physiological body changes (heart rate, blood pressure, and body temperature) before, during and after working hours.
H_0: There is no difference in the productivity of farmers between the hours of 6-9am, 9-12pm, and 12-3pm.
H_0: There is no influence between temperature, gender, age, and BMI on the productivity of local farmers.

1.6 Significance of the study

Humans are homeotherms, thus they try to maintain their internal body temperature near to about 37^0C; hence deviation of few degrees from this value can result in serious consequences (Parsons, 2013). Maize farmers were chosen because maize crop is the most widely cultivated by almost all the farmers of Gombe State. No research of this type was conducted in Gombe State in order to ascertain the knowledge, perception and practice of heat stress related illnesses and symptoms affecting farmers' health and productivity of these farmers, which work almost 8hrs per day under the action of intense sunshine. Gombe was chosen as the study area because it falls among the region experiencing higher temperature. Therefore, this study further contributed in creating more awareness among workers concerning heat stress and its effects on health and productivity, safe guard them from becoming victims of heat-related stress illnesses and symptoms and also makes them improve their productivity. The study will help farmers and government agencies or other non-governmental organisations in adopting any heat stress management plan among the Gombe maize farmers. The government can also use the study as a reference material for enacting laws and safety regulation on managing heat stress among occupational workers in Gombe State or the entire country.

This study provided information on the impact of heat on health and productivity of farmers, as it will serve as baseline information on heat exposure due to climate change among communities in Nigeria, and further served as a reference material for future researchers in this field of study.

1.7 Scope of the study

The scope of this study was limited to the maize farmers of Gombe state with respect to their knowledge, perception and practices of heat related stress affecting their health and work productivity.

1.8 Definition of Terms

1.8.1 Conceptual Definitions

I. Heat Stress

According to Ceballos, Ramsey, Musolin, Wiegand, and Mead, (2014), heat stress can be defined as; the sum of the heat generated in the body (metabolic heat) plus the heat gain from the environment (environmental heat) minus the heat loss from the body to the environment, primarily through evaporation.

II. Health

According to World Health Organization, health is defined as 'a state of complete physical, mental and social well- being and not merely the absence of disease and infirmity' (WHO, 1948 cited in WHO, 2006).

III. Productivity

Productivity can be defined as a ratio of output and input as well as efficiency per effectiveness (Ismail, Nizam, Haniff, & Deros, 2014). Productivity is also defined as the proportion of a working day that a worker can perform a job under different heat conditions (Costa, Floater, Hooyberghs, No, & No, 2016). It can be further described as the extent to which activities have provided performance in terms of system goals. Therefore, it is view differently in different organization. Productivity in a manufacturing industry may be measured in terms of how much of a product is produced, but it may also refer to quality. In a school, it may be measured in terms of number of examination successes, and in a restaurant or a welfare payments office how many customers or clients are served, how satisfied they are and whether their wants have been sufficiently satisfied for them to return (Parsons, 2013).

IV. Knowledge

A fluid mix of framed experience, contextual information, values and expert insight that provides a framework for evaluating and incorporating new experiences and information (Davenport & Prusak, 1998).

V. Perception

The process by which people recognize and interpret sensory impressions into a coherent and unified view of the world around them. Though necessarily based on incomplete and unverified (or unreliable) information. Perception is equated with reality for most practical purposes and guides human behavior (Business Dictionary, 2016).

VI. Practice

The act of performing a particular routinely activity, method or custom habitually or regularly (Business Dictionary, 2016).

VII. Heat Stress Related Symptoms

These are the most common sign and symptoms of heat exhaustion which include; dehydration, dizziness, fainting, fatigue, headache etc. (Occupational Safety and Health Administration, 2015).

VIII. Body Temperature

This is the degree of heat maintained by the body or it is the balance between heat produced in the tissues and heat lost to the environment (Karima, 2010).

IX. Heart Rate

The number of heartbeats per unit of time, usually per minute. The heart rate is based on the number of contractions of the ventricles (the lower chambers of the heart). The heart rate may be too fast (tachycardia) or too slow (bradycardia). The pulse is a bulge of an artery from waves of blood that course through the blood vessels each time the heart beats. The pulse is often taken at the wrist to estimate the heart rate (MedicineNet, 2016).

X. Blood Pressure

The blood pressure is the pressure of the blood within the arteries. It is produced primarily by the contraction of the heart muscle. Its measurement is recorded by two numbers. The first (systolic pressure) is measured after the heart contracts and is highest. The second (diastolic pressure) is measured before the heart contracts and lowest (MedicineNet, 2016).

1.8.2 Operational Definitions

I. Heat Stress

Heat stress was determined using the Wet Bulb Globe Temperature (WBGT). The heat stress index includes air temperature, humidity, radiant heat, and wind movement. The device sums up all the above variables and gives a single WBGT reading in ^{0}C based on the below formula;

WBGT = 0.7Tw + 0.2Tg + 0.1Td

Where;

- WBGT = Wet bulb globe temperature
- Tw = Natural wet-bulb temperature (combined with dry-bulb temperature indicates humidity.
- Tg = Globe thermometer temperature (measured with a globe thermometer, also called black globe thermometer.
- Td = Air temperature (Dry-bulb temperature)

II. Health

Health status of the respondents was determined by measuring their physiological body changes, which include; blood pressure, heart rate, and core body temperature. Moreover, other heat stress related symptoms was identified using the modified questions in the questionnaire.

III. Productivity

Productivity was measured using the productivity data sheet. The productivity data sheet keeps record of the rate of work done (number of

ridges tilled) been tilled and the outcome that was achieved within a specific time during the different sessions (6-9am, 9-12pm, and 12-3pm) of the farming operations each day.

IV. Knowledge

Knowledge was accessed based on twenty-one questions from Section B. The questions depicted the farmers' awareness of heat stress. Two forms of knowledge was accessed; knowledge of basic factors that contribute to heat stress and knowledge of heat stress related illnesses (HRI) and symptoms. This was further categorized based on scores into three groups of high (6-8), (9-11), moderate (3-5), (5-8), and low knowledge (1-2), (1-4) marks for knowledge on basic factors of heat and knowledge on HRI.

V. Perception

In this study, the perception was determined from the set of questions in Section B, where a set of eight questions were developed in order to test the farmers' perception. A five-point Likert-scale that ranged from strongly disagree to strongly agree (1-5), was used in determining the farmers' perception.

VI. Practice

The study determined farmers' practice as regard to heat stress based on ten questions from Section B. The question covers the range of possible preventive measures that farmers' should engage for protection against heat stress. The practice was assessed by using a five-point Likert-scale that ranged from never to very often (1-5).

VII. Heat Stress Related Symptoms

Heat stress related symptoms was captured in Section D of the questionnaire where symptoms starting from heavy sweating, weakness, headache, rapid pulse, nausea, elevated body temperature, muscle cramp and even unconsciousness was administered to the respondents.

VIII. Body temperature

The study observed the body temperature of the respondents in three different times using a digital thermometer. Measurement was made before, during and after working hours.

IX. Heart rate

Digital blood pressure monitor was used for this measurement. The heart rate of the respondents was measured before, during and after working hours.

X. Blood pressure

The respondents' blood pressure was measured using the digital blood pressure monitor. The readings was recorded before, during and after working hours.

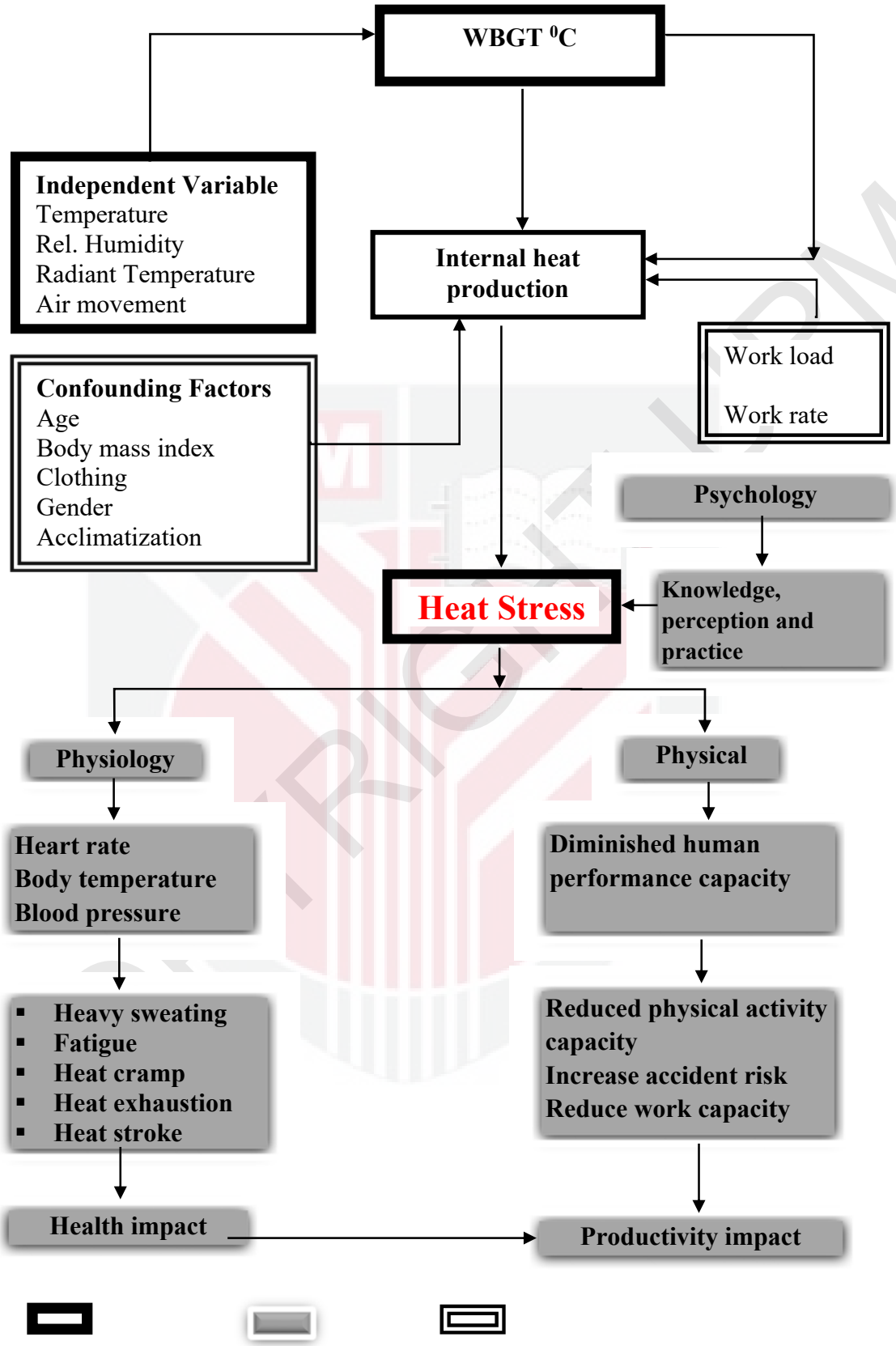

Figure 1.1 : Conceptual Frame Work of Heat Stress Assessment

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