

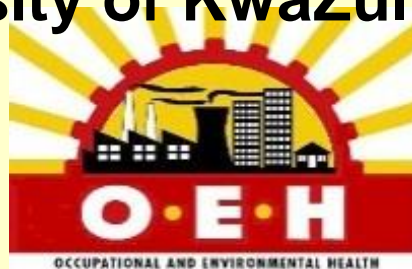


UNIVERSITY OF  
KWAZULU-NATAL  
INYUVESI  
YAKWAZULU-NATALI

# **Occupational Heat Stress: Protecting workers, exploring policy frameworks**

**Rajen Naidoo  
Professor**

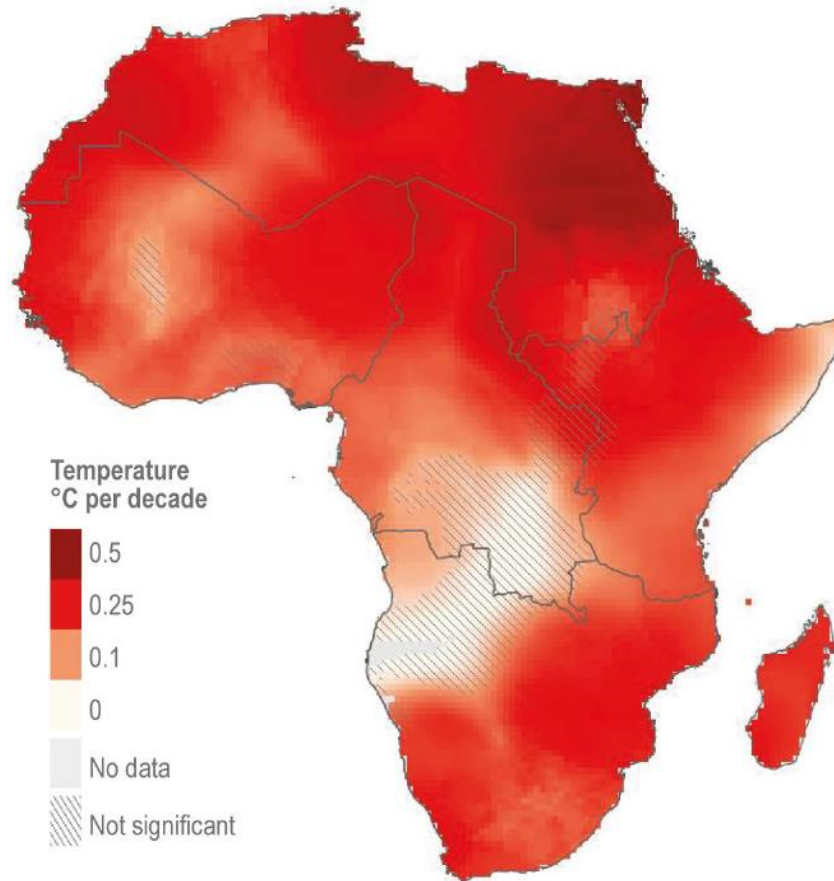
**Occupational and Environmental Health  
University of KwaZulu-Natal**



# Africa – carrying the costs and health burden

Observed climate trends calculated for 1980–2015

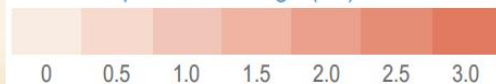
(a) Temperature trend



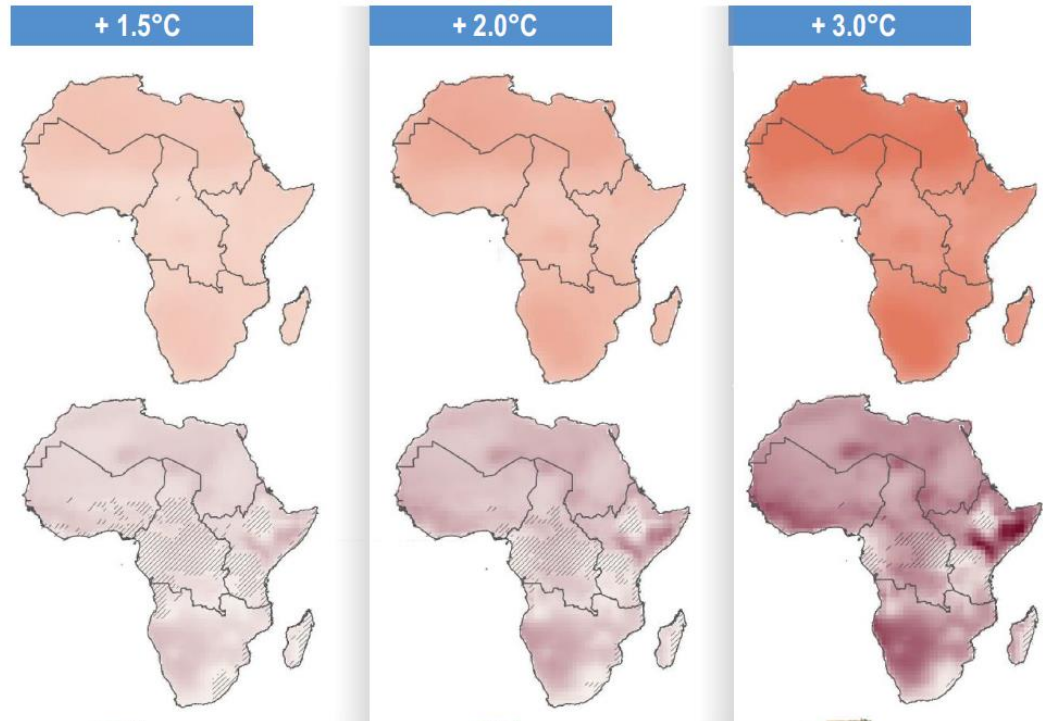
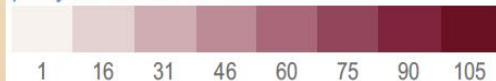
## Projected changes of climate variables and hazards

(relative to 1995–2014 average)  
at 1.5°C, 2°C and 3°C of global warming  
above pre-industrial (1850–1900)

(a)  
Mean temperature change (°C)



(b)  
Change in the number of days  
per year above 35°C



“At 1.5°C, 2°C and 3°C of global warming above pre-industrial levels, mean annual temperatures in southern Africa are projected to be on average, 1.2°C, 2.3°C and 3.3°C warmer than the 1994–2005 average respectively”

“Children born in 2020, under a 1.5°C-compatible scenario will be exposed to 3–4 times more heatwaves in their lifetimes compared to people born in 1960, although in Angola this is 7–8 times....”

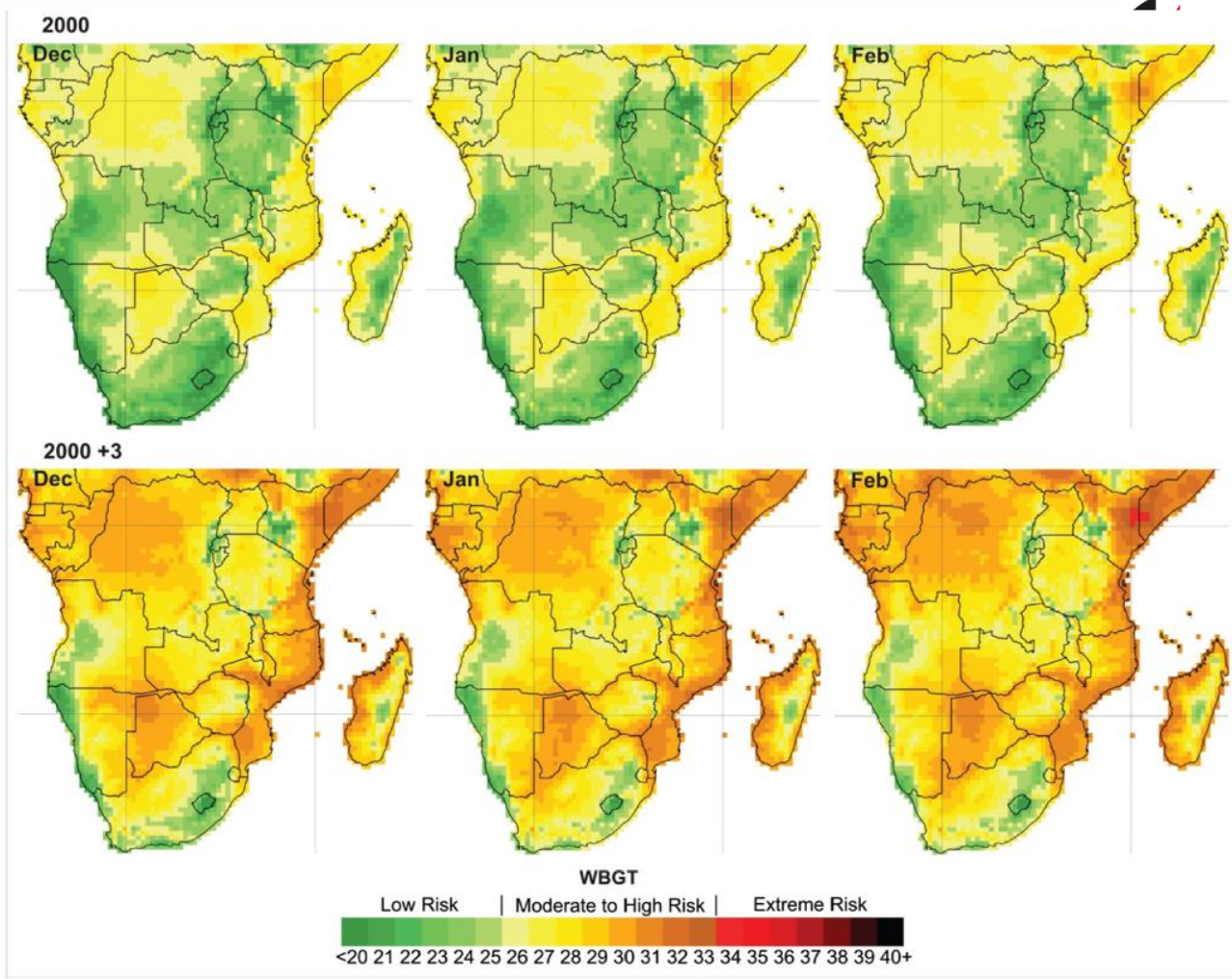


Fig 3. WBGT (indoors and outside in the shade) for Southern Africa in 1975, 2000, and a scenario where WBGT is increased by 3° from the year 2000.

(Hyatt et al., 2010)

# Data Scarcity

- Although extreme responses may be reported – death or prolonged hospital admission, acute work-related heat stress responses are poorly documented
- Chronic outcomes, eg kidney disease are generally not even considered

# Data Scarcity



The image shows a screenshot of the africanews.com website. The header features the site name 'africanews.' in white on a yellow background, with 'EN' and a dropdown arrow. To the right, 'NEWS' is written in white on a black background. Below this, a yellow navigation bar contains links for 'NEWS', 'BUSINESS', 'SPORT', 'CULTURE', 'SCIENCE & TECHNOLOGY', 'NO COMMENT', and 'PROGRAMM'. The main content area has a dark image with a 'NEWS' label on the left. The headline reads 'Heatwave kills eight in South Africa - Govt'. The text below states: 'A stifling heatwave that has swept parts of South Africa in recent weeks has killed eight people over several days, the government said Tuesday (Jan. 24). The dead were mostly farm workers in the sparsely populated and largely semi-arid Northern Cape province which borders Namibia and Botswana, according to the labour ministry.'

**africanews.** EN NEWS

NEWS BUSINESS SPORT CULTURE SCIENCE & TECHNOLOGY NO COMMENT PROGRAMM


**Heatwave kills eight in South Africa - Govt**

A stifling heatwave that has swept parts of South Africa in recent weeks has killed eight people over several days, the government said Tuesday (Jan. 24).

The dead were mostly farm workers in the sparsely populated and largely semi-arid Northern Cape province which borders Namibia and Botswana, according to the labour ministry.

- “In 2008 382 cases of heat related illnesses were reported at a major gold mining group in South Africa. Of the 382 cases, 380 were heat cramps and two were heat exhaustion.”
- (Claasen et al., 2009, SIMRAC Report)

# Recent Research



HERALD

HSOA JOURNAL OF  
COMMUNITY MEDICINE & PUBLIC HEALTH CARE

ISSN: 2381-1978

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

Bigboy Ngwenya<sup>1\*</sup>, Jacques Oosthuizen<sup>1</sup>, Martyn Cross<sup>1</sup> and  
Kwasi Frimpong<sup>1</sup> (Ngwenya et al., 2018)

Annals of  
Global Health

Meshi EB, et al. Thermal Exposure and Heat Illness among  
Workers in Mara Gold Mine, Tanzania. *Annals of Global Health*  
84(3), pp. 360–368. DOI: <https://doi.org/10.1016/j.anngh.2018.05.001>

## ORIGINAL RESEARCH

### Thermal Exposure and Heat Illness Symptoms among Workers in Mara Gold Mine, Tanzania

E.B. Meshi\*, S.S. Kishinhi†, S.H. Mamuya† and M.G. Rusibamayila†



ELSEVIER

Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: [www.elsevier.com/locate/scitotenv](http://www.elsevier.com/locate/scitotenv)

### Heat exposure effect on Ghanaian mining workers: A mediated-moderation approach

Victor Fannam Nunfam<sup>a,b,\*</sup>, Ebenezer Afrifa-Yamoah<sup>c</sup>

### Climate change impacts on working people (the HOTHAPS initiative): findings of the South African pilot study


Angela Mathee, Joy Oba & Andre Rose



International Journal of  
*Environmental Research  
and Public Health*

## Article

### Sun Exposure, Sun-Related Symptoms, and Sun Protection Practices in an African Informal Traditional Medicines Market

Caradee Y. Wright<sup>1,2,\*</sup> , Tarylee Reddy<sup>3</sup>, Angela Mathee<sup>4,5,6</sup> and Renée A. Street<sup>7,8</sup>

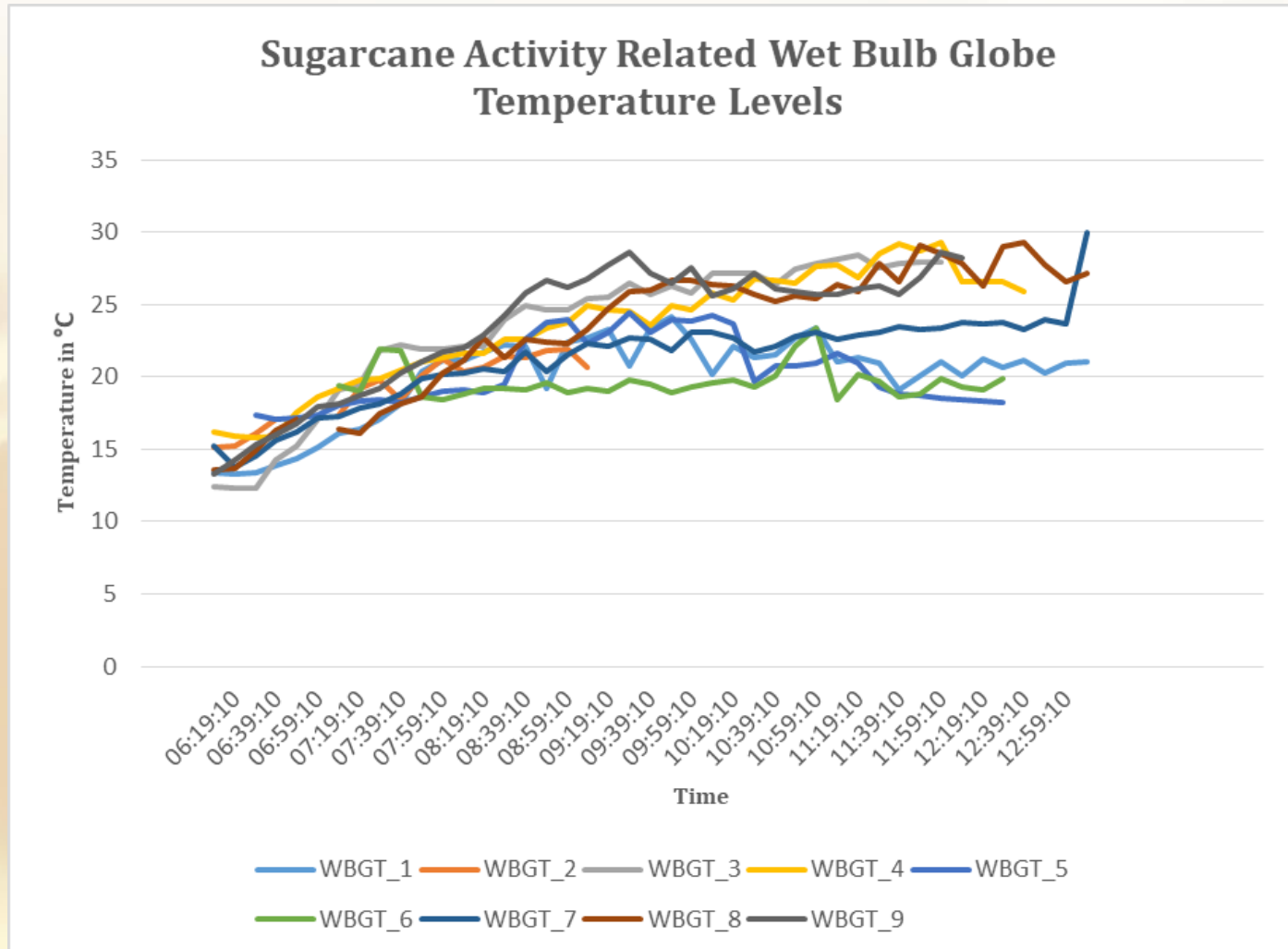
### Environmental heat stress on maternal physiology and fetal blood flow in pregnant subsistence farmers in The Gambia, west Africa: an observational cohort study

Ana Bonell, Bakary Sonko, Jainaba Badjie, Tida Samateh, Tida Saïdy, Fatou Sosseh, Yahya Sallah, Kebba Bajo, Kris A Murray, Jane Hirst, Ana Vicedo-Cabrera, Andrew M Prentice, Neil S Maxwell, Andy Haines

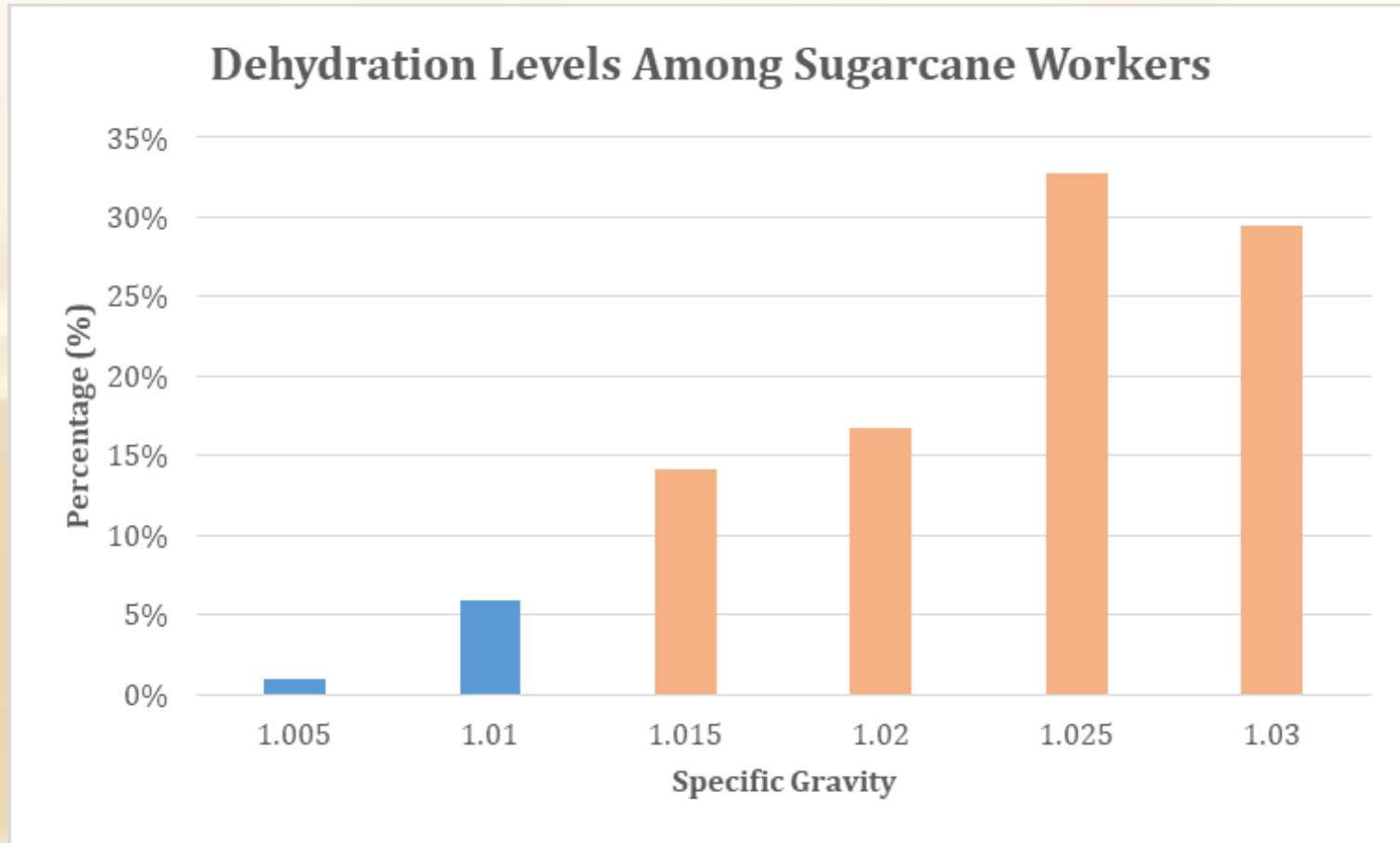
(The Lancet Planetary Health, 2022)



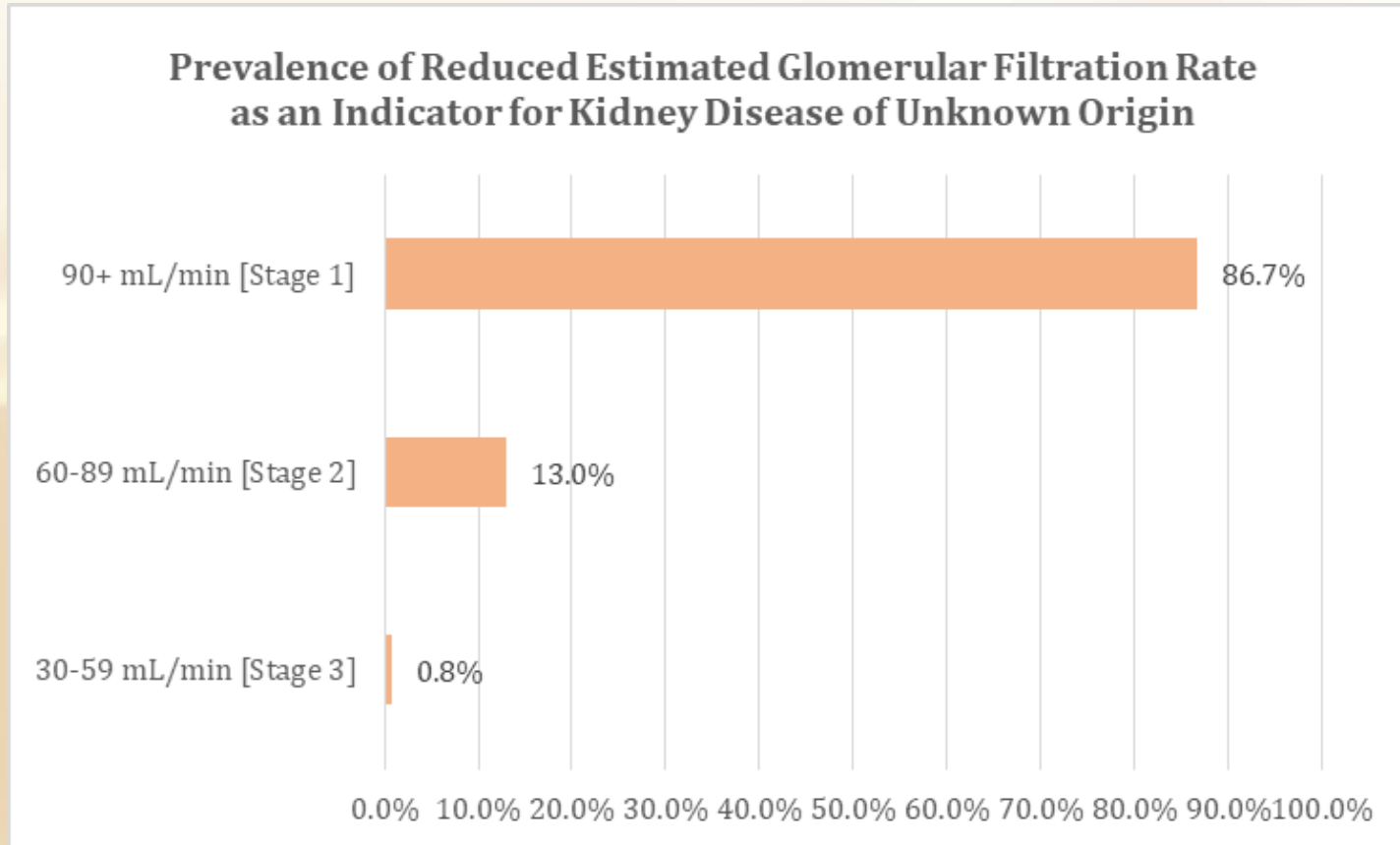
# Sugarcane Workers and Heat Exposure



# Levels of Dehydration



# Indicators of CKD



Msibi et al., 2023, unpublished



UNIVERSITY OF  
KWAZULU-NATAL  
INYUVESI  
YAKWAZULU-NATALI





# Heat and Work: South African Mines

- Acclimatization chambers for indigenous miners

102 *Journal of the Chemical, Metallurgical and Mining Society of South Africa.* Nov., 1935.  
*Symposium—Problems arising out of Temperature and Humidity in Deep Mining.*

---

SYMPOSIUM—PROBLEMS ARISING OUT OF TEMPERATURE AND HUMIDITY  
IN DEEP MINING ON THE WITWATERSRAND.

---

THE RESULTS OF SOME INVESTIGATIONS INTO THE MEDICAL ASPECT OF DEEP MINING  
ON THE WITWATERSRAND.

---

By DR. ALDO O. DREOSTI.

mining experience. The instructions were to the effect that new natives were to be engaged in light work in specially selected working places for the following periods:—

Natives without previous experience	.. ..	10 days
Natives with previous underground experience		5 days

efficiency. Bearing in mind that relatively few of the natives working in bad underground conditions showed any marked effects of such exposure, it seemed reasonable to assume that the natives who developed heat-stroke were “abnormally” susceptible to this condition. The immediate concerns

## (1) *The Experimental Chambers :*

The experimental chambers were designed for the purpose of studying the effects of muscular work in an environment more severe, but comparable, in the form of humidity and stagnation of air, with that obtained in hot underground places. These

- (1) Would it be possible to detect new natives who were abnormally susceptible to heat-stroke and to prevent them from going to their death underground ?
- (2) At the same time would it be possible to reduce this long and wasteful period of acclimatisation without in any way affecting the native's health ?



## THE EFFECTS OF HEATSTROKE ON THE FUNCTION AND STRUCTURE OF THE KIDNEY<sup>1</sup>

BY M. C. KEW, C. ABRAHAMS, N. W. LEVIN,  
H. C. SEFTEL, A. H. RUBENSTEIN, AND I. BERSOHN

(From Department of Medicine and Renal Unit, Johannesburg Hospital and  
University of the Witwatersrand, and South African Institute for Medical  
Research, Johannesburg)

Regulation 10.6.2 of the regulations promulgated in terms of the Mines and Works Act 27/1956 provides that “The workings of every part of a mine where persons are required to travel or work shall be properly ventilated to maintain safe and healthy environmental conditions for the workmen...”, and regulation 10.12.1 provides that no Black miner shall work in any part of a mine “where the environmental conditions are conducive to heat stroke” unless he has been acclimatized to such conditions; there is however no upper limit to which acclimatized Black workers (or unacclimatized Whites) may be exposed.

HEAT STRESS IN WITWATERSRAND GOLD MINES

*Journal of Occupational Accidents*, 1 (1976/1977) 171–193

M.J. MARTINSON



- **Mponeng** is a gold mine in South Africa's Gauteng province. The underground and surface works were commissioned in 1987. It extends over 4 kilometres (2.5 mi) below the surface,
- The temperature of the rock reaches 66 °C and the mine pumps slurry ice underground to cool the tunnel air to below 30 °C



# Legislative Framework in SA

## DEPARTMENT OF LABOUR

Government Notice. R: 2281

16 October 1987

### Environmental Regulations for Workplaces, 1987

The Minister of Manpower has, in terms of section 35 of the Machinery and Occupational Safety Act, 1983 (Act 6 of 1983) made the regulations contained in the Schedule hereto.

#### Thermal requirements

(4) Where the time-weighted average WBGT index, determined over a period of one hour, exceeds 30 in the environment in which an employee works, the employer of such employee shall -

(a) if practicable, take steps to reduce the said index to below 30; or

(b) where it is not practicable to reduce the said index to below 30 and where hard manual labour is performed-

(i) have every such employee beforehand and thereafter, at intervals not exceeding one year, certified fit to work in such environment by a registered medical practitioner or a registered nurse according to a protocol prescribed by such practitioner, and every such employee shall, if found fit to work in such environment, be issued with a certificate to that effect by such practitioner or nurse;

(ii) ensure that every such employee is acclimatised to such working environment before he is required or permitted to work in such environment;

(iii) inform every such employee of the need to partake of at least 600 millilitres of water every hour;

(iv) train every such employee in the precautions to be taken to avoid heatstroke; and

(v) provide the means whereby every such employee can receive prompt first-aid treatment in the event of heatstroke:

Provided that, where the question arises as to whether any particular type of work does in fact constitute hard manual labour, the decision of an inspector shall be decisive.

# The mining industry

## System of Occupational Hygiene Measurements

(2) The *employer* must establish and maintain a system of occupational hygiene measurements, as contemplated in section 12, of all working places where the following hazard limits prevail:

(b) thermal stress	-	heat >25,0°C wet bulb and/or >32,0°C dry bulb and/or >32,0°C mean radiant temperature;
--------------------	---	--

Guideline for the Compilation of a  
Mandatory Code of Practice or  
an Occupational Health Programme on  
Occupational Hygiene and Medical Surveillance

## T h e r m a l S t r e s s

MINE HEALTH AND SAFETY INSPECTORATE



mineral resources  
Department  
Mineral Resources  
REPUBLIC OF SOUTH AFRICA



# Code of Practice: Thermal Stress

- A legal requirement for each mining operation
- Stipulates the need for a clear risk assessment, risk control and management
- Sets out the approach for medical surveillance for exposed workers
- Provides guidelines for Heat Stress Management, acclimatization, heat tolerance testing and heat tolerance screening

# Policy in Other African Countries

- Approximately 25 African countries have some form of legislation that includes exposure to extreme temperatures
- Most are basic, and only address indoor work
- Some countries have detailed legislation:
  - Gabon
  - Namibia
  - Mozambique
  - Malawi

# Mozambique

- workers exposed to high temperatures must use personal protective equipment. Mining activities suspended when the temperature exceeds 33°C (Legislative Decree No. 48/73 of 5 July 1973; General Safety Rules at Work in Industrial Units 1973-07-05 (Art. 135))
- in industries where workers are exposed to extremely high or low temperatures, there must be transition chambers so that they can heat up or cool down gradually until they reach the outside temperature
- Heating systems that could corrupt the ambient air must not be used
- Steam and hot water piping or any other source of heat must be insulated in order to avoid thermal radiation on personnel
- fixed or removable guards, preferably fireproof, must be placed to protect workers against intense heat radiation

# Gabon

- (Decree No. 01494/PR/MTEPS, Art. 40).
- The Decree contains detailed provisions related to thermal environment, in particular:
  - rest periods granted to workers exposed to extreme temperatures;
  - means to protect workers from heat and
  - personal protective equipment for workers who perform their work outside to protect them from bad weather.

# Risk Assessment

- All workplaces at which workers are likely to be at risk for heat stress should undertake a risk assessment
  - Considers environmental heat exposure (WBGT)
  - Considers workplace conditions such as:
    - Humidity
    - Air movement and air circulation.
    - Radiant heat.
  - Considers work intensity
  - Determines scheduling of at risk work over the work day
  - Determines control of hazard/risk based on hierarchy of controls

# Engineering Controls

- Cool zones: controlled air conditioned environment within the workspace for resting
- Increase air movement through use of fans
- Insulating hot surfaces that generate heat
- providing an air-cooling system;
- shading windows;
- siting workstations away from areas subject to radiant heat.



# Workplace Organisation

- Acclimatization
- Change work patterns/time schedules
- Reduce work intensity
- Plan appropriate work-rest schedule
- task rotation and increased frequency of breaks
- training and education

# Protective Equipment

- Gel packs in a hard hat
- Use clothing that reflects radiant heat
- Wetted clothing and ice vest

# Important Issues

- Ensuring medical surveillance for all workers exposed to hot working conditions
- Carefully define the focus on such surveillance to ensure specific health outcomes are monitored, including acute and chronic kidney disease
- Legislation and policy frameworks must be implemented about controlling exposure in the changing context
- Responsibility to protect health of workers must rest with employer, and not shifted to worker: redesigning work, not the worker
- Currently focus in African legislation is on indoor workers, but needs to consider outdoor workers urgently

# Thank you!

Rajen Naidoo

Occupational and Environmental Health

School of Nursing and Public Health

University of KwaZulu-Natal

[naidoo@ukzn.ac.za](mailto:naidoo@ukzn.ac.za)

doeh.ukzn.ac.za

031-260 4385/4070