

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

Angela Mathee<sup>1,2\*</sup>, Joy Oba<sup>1</sup> and Andre Rose<sup>2</sup>

<sup>1</sup>South African Medical Research Council, Johannesburg, South Africa; <sup>2</sup>School of Public Health, University of the Witwatersrand, Johannesburg, South Africa

**Background:** It is now widely accepted that climate change is occurring as a result of the accumulation of greenhouse gases (GHG) in the atmosphere. With the prospect of a warmer world, increased attention is being devoted to the implications for worker well-being and work performance.

**Objectives:** The 'high occupational temperature health and productivity suppression' (HOTHAPS) programme is a multi-centre health research and prevention programme aimed at characterising and quantifying the extent to which working people are affected by, or adapt to, heat exposure while working. The main aim of the current South African pilot study was to look at the perceptions of outdoor workers regarding their work environment in hot weather and how this affected their health and productivity levels.

**Design:** A qualitative study utilising focus group discussions was employed in two sites, Johannesburg (which has a temperate climate) and Upington (located in the hottest part of South Africa).

**Results:** In summary, the pilot study demonstrated that especially in Upington, where daily maximum temperatures may reach +40°C, workers reported a wide range of heat-related effects, including sunburn, sleeplessness, irritability, and exhaustion leading to difficulty in maintaining work levels and output during very hot weather. Few, if any, measures were being undertaken by employers to protect health or improve worker comfort.

**Conclusion:** This pilot study has demonstrated that people working in sun-exposed conditions in hot parts of South Africa currently experience heat-related health effects, with implications for their well-being and ability to work and that further research is warranted. In this regard, the pilot study has proved valuable in informing the design, site, sample selection, and logistical planning for a proposed main study on the health and performance aspects of work in hot weather in South Africa.

Keywords: *climate change; HOTHAPS; global warming; worker; health; productivity; South Africa*

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It is now widely accepted that climate change is occurring as a result of the accumulation of greenhouse gases (GHG) in the atmosphere (1). It is also stipulated that current trends in energy use, development, and population growth will lead to continuing – and more severe – climate change (2). A majority of climate change scientists agree that a degree of climate change is inevitable, even with the best emissions mitigation efforts of the international community (3). It is thought that changes in climate systems have already contributed to increased heat wave frequency (4). The IPCC (5) projections suggest that in sub-Saharan Africa warming is expected to be greater than the global average and in parts of the region, rainfall could decline. Detrimental

health effects are likely and the poorest population groups are expected to be the most vulnerable (1).

With the prospect of a warmer world, increased attention is being devoted to the implications for worker well-being and work performance (5–8). Heavy labour and constant exposure to hot working conditions increases the work load and heat stress that workers are exposed to (9). Under normal circumstances, the human body is able to maintain its core body temperature at 37°C. Excessive heat may result in this thermoregulatory process being compromised, leading to detrimental consequences such as heat exhaustion and heat stroke (10). Heat and radiation from the sun can cause a range of biological effects such as lethargy, dizziness, headaches,

dehydration, heat stress, heat stroke, and even death (11). In a study by Hübler et al. (12), which aimed to quantify the climate induced health and economic risks for Germany based on the high resolution climate scenarios forecast for the period 2071–2100, heat was found to increase the number of related casualties by a factor of more than three. Heat related hospitalisation costs increased sixfold. Heat was found to also reduce work performance, resulting in an estimated output loss of between 0.1% and 0.5% of the gross domestic product (GDP).

The South African Occupational Health and Safety Act no 85 of 1993 states that workers have the right to a work environment that is safe and healthy (13). In general, however, this protection refers to machinery and the indoor occupational environment, rather than exposure to the outdoor environment (14). There is no specific legislation or safety limits regarding temperature and UV radiation exposure for sun-exposed workers in South Africa.

‘Too hot’ working environments are not just a question of comfort, but a concern for health protection and the ability to perform work tasks (15, 16). In a study by Tawatsupa et al. (17), 18% of a large national cohort of more than 40,000 subjects working under heat stress conditions was associated with the worst overall health as well as psychological distress (adjusted odds ratio ranging from 1.49 to 1.84). Thus not only are chronic disease risks likely to increase with climate change and related increase in malnutrition and extreme weather events, but in addition to this, the increasing heat exposure due to local climate changes is likely to create occupational health risks and to have a significant impact on the productivity of workers, unless effective preventive measures and/or adaptation reducing the occupational heat stress are implemented (18–20).

This may be practically and economically possible for indoor environments, but it is much more difficult for outdoor environments. However, unless appropriate preventive measures are taken in the planning processes for workplaces and urban development, economic and social development in affected countries will eventually be hampered (19). Careful and scientific communication of the health risks of climate change and the co-benefits of climate policies may therefore be an important approach for convincing both lawmakers and the general public of the urgency of climate policy (21).

## Background: the HOTHAPS study

The ‘high occupational temperature health and productivity suppression’ (HOTHAPS) programme is a multi-centre health research and prevention programme aimed at quantifying the extent to which working people are affected by, or adapt to, heat exposure while working.

The study also aims to identify and evaluate preventive interventions in different social and economic settings. The study was initiated by Professor Tord Kjellstrom, Visiting Fellow, National Centre for Epidemiology and Occupational Health, Australian National University, Canberra, Australia. In addition to South Africa, other potential participating countries include Costa Rica, Nicaragua, Panama, Thailand, India, Australia, and New Zealand. Prior to the commencement of potential, larger-scale main Hothaps studies in the selected settings, pilot investigations are recommended. This report outlines the main findings of such a pilot study conducted in South Africa.

## Purpose of the pilot study

The objectives of the South African pilot Hothaps study were to:

1. Identify and describe potential population groups (workers who perform work in sun-exposed settings for substantial parts of the day).
2. Identify potential South African study sites (sites with temperatures that frequently exceed 30°C during the summer months).
3. Outline the study to potential stakeholders and gain their support for a potential main study.
4. Obtain information about the perceptions of workers in relation to working in hot weather in sun-exposed conditions.
5. Identify measures currently adopted by workers to cope with hot weather.

## Methods

### Place and time of study

The study was undertaken in the cities of Johannesburg and Upington in March 2009 (at the end of the South African summer). Johannesburg is a large metropolitan area with a population of around 3.5 million, but is part of a larger urban agglomeration (including the municipalities of Mogale City, Ekurhuleni, and Tshwane) with a population exceeding 10 million people. Johannesburg has a moderate climate. Average maximum summer temperatures range from 24 to 30°C.

Upington has a population of around 75,000 people and is located in the hottest part of the country, in the Northern Cape province. Average maximum daily temperatures in the summer in Upington range from 28 to 40°C.

### Focus group discussions and interviews

Information was obtained from workers through focus group discussions. Purposive sampling was used in selecting the focus group participants. Municipalities were contacted and provided assistance in identifying

suitable groups of workers involved in sun-exposed occupations. Workers were eligible for inclusion in focus groups discussions if they had worked in the current job for at least 1 year in a sun-exposed environment. Those who had worked in their current job for less than 1 year, but who had worked in a similar job and setting immediately before, were also considered eligible. The range of jobs included grave diggers, street sweepers, roadside construction workers, sewage and sanitary workers and horticultural workers. Each focus group consisted of 8–10 workers.

Interviews were undertaken by the researcher and a research assistant. The Johannesburg interviews were conducted in the local languages of Zulu and Sesotho. Audio recorded interviews were translated verbatim into English and transcribed by the research assistant. The Upington interviews were conducted and transcribed in Afrikaans.

The study was explained to participants prior to commencement, and their right of refusal without negative consequences emphasised. Two people (one from each study site) elected not to participate in the study. Separate informed consent forms were signed for participation in focus group discussions and to permit audio recording. Demographic data were recorded on a data capture sheet that did not have any participant identifiers.

A total of 151 workers participated in the focus group discussions; 122 and 29 in Upington and Johannesburg, respectively (see Table 1). One-on-one interviews were undertaken with the supervisors of the workers who participated in the focus group discussions. A semi-structured interview schedule was used to guide focus group discussions and one-on-one interviews.

### Telephonic discussions with farm managers

Telephonic interviews were conducted with the representative of several large farms located near Upington, along the banks of the Orange River. The purpose of the discussions was to obtain additional information about working conditions for farm labourers in the area.

**Table 1.** Characteristics of workers interviewed at Johannesburg and Upington

	Upington	Johannesburg
Number of focus groups	14	3
Number of workers participating in focus groups	122	29
Number of female participants	8	14
Mean age of workers	41.5 years	40.6 years

### Temperature and climate

Quantitative data on weather elements were obtained from the South African Weather Service. Figs. 1 and 2 give information on hourly humidity and temperature readings during March 2009, the period of the pilot study. During the study period, humidity measurements were generally higher in Johannesburg than in Upington (see Fig. 1) and hourly maximum temperature ranged from 23–36°C in Upington and 21–27°C in Johannesburg (see Fig. 2).

### Data analyses

Analyses of quantitative data were carried out using STATA version 10. Thematic analyses of qualitative data were carried out using MAXQDA 2007. A grounded theory approach was used. The process involved reading through the data several times to get a good sense of the content. The text segments from all the transcripts were then labelled and coded. The initial codes were further explored according to the attributes of the focus groups and differences and similarities between the study sites.

The codes from the supervisors' interviews were compared with those of the focus groups. The second phase of the analysis involved developing concepts and categorising the codes in themes, which were cross-referenced with the raw data to check for consistency. Linkages between themes (e.g. co-occurring themes) and codes were explored. The results of the analysis were an empirically derived theoretical model of the individuals' perspectives.

### Ethics

Approval for the study was obtained from the Human Research Ethics Committee of the University of the Witwatersrand, Johannesburg. The ethics approval number is M090228.

### Findings from focus group discussions and interviews

The focus group discussion explored issues around the nature of the work done, the perception of weather patterns, heat effects of heat on work performance, heat effects on health and well-being, coping strategies, women's perception of issues specific to them, and awareness of climate change. The perceptions of supervisors regarding how heat affected workers and the strategies employed to protect workers from the effects of sun exposure are also presented.

### Nature of work performed

Participants undertook work related to grave digging, street sweeping, road construction, horticulture, sewage construction, and maintenance of electrical cables. Workers described the work they performed as manual, labour

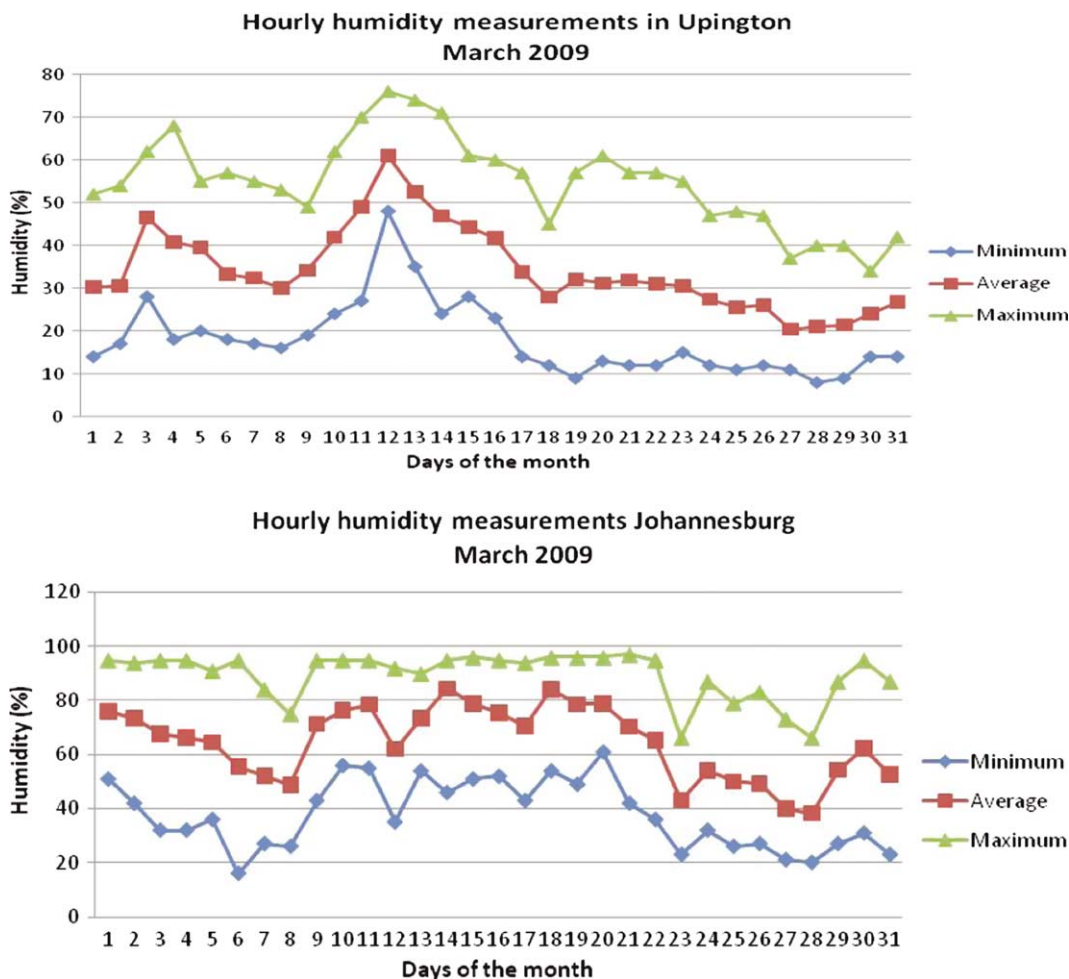


Fig. 1. Hourly humidity measurements in Upington and Johannesburg during March 2009. Source: South African Weather Service.

intensive, and physically demanding. They spent large parts of the workday outdoors, exposed to the elements. Many workers said that they did not enjoy their work, describing their jobs as ‘tough.’ They said they only did it because it was their only available source of income.

We [do] work [that is] strenuous, only thing is we are used to this work.

Johannesburg participant

**General perceptions of weather patterns**

Views on trends in weather patterns varied widely. Several people in Upington were of the view that weather patterns were changing. For example, some felt that in the current summer rainfall as well as humidity levels had been higher but that temperatures had been lower, while others reported having observed an increase in very hot days over the years especially in the frequency of occurrence. Many others had not perceived any changes

in weather patterns or thought that temperatures were declining.

Last year’s summer was much hotter. This year is much better.

Upington participant

[This] Year for me is hotter than the other summers, is very hot, and is getting hotter and hotter.

Johannesburg participant

**Knowledge of climate change**

Overall worker knowledge of climate change and the associated implications was weak or inaccurate. Some made an association between climate change and mining practices as well as vehicular pollution. A few others spoke of the built environment contributing to towns and cities feeling warmer, recent heat waves in Europe, the melting of icebergs, lowered productivity, and the implications for food production and food quality. Many reported having heard about climate change, but did not

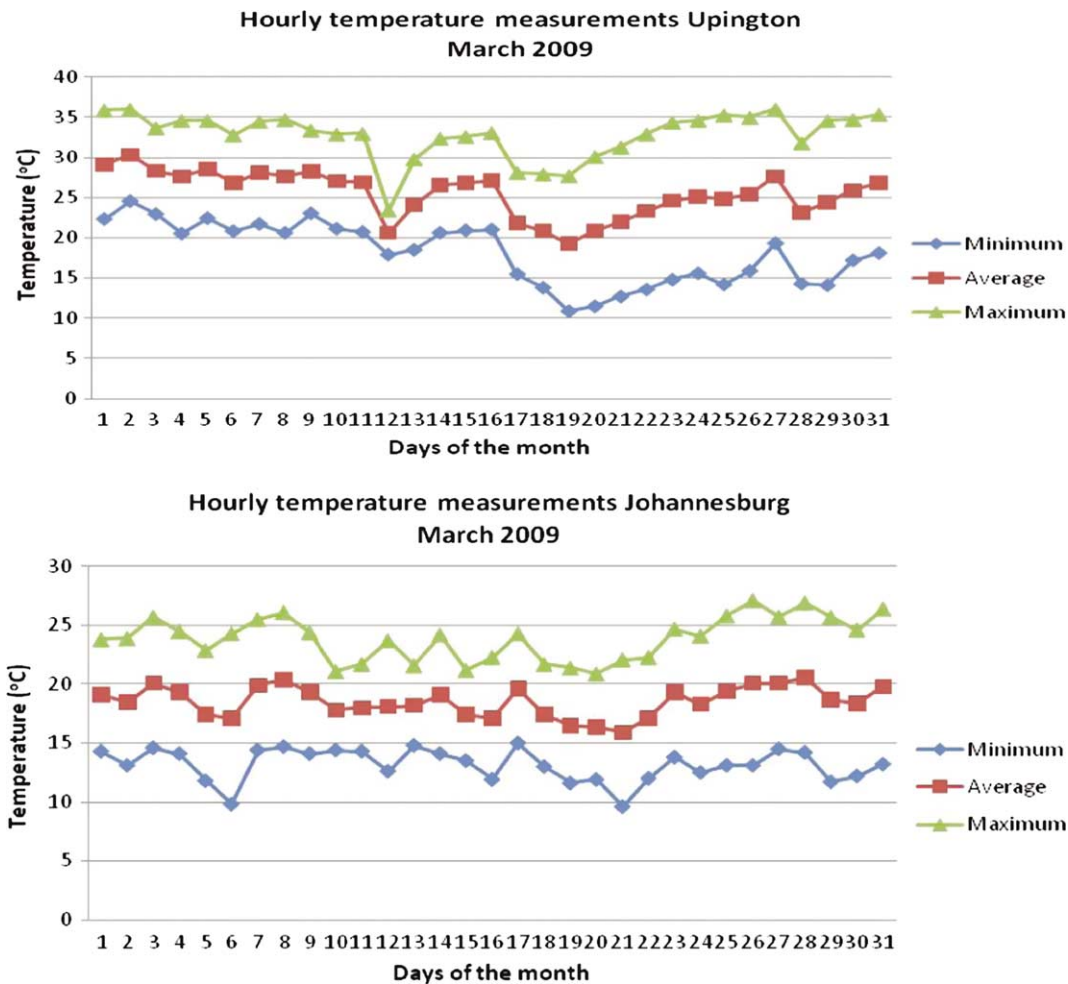


Fig. 2. Hourly temperature measurements in Uppington and Johannesburg during March 2009. Source: South African Weather Service.

understand the phenomenon. For example, one person thought climate change was due to space travel. In the Johannesburg focus groups none of the participants had ever heard of climate change.

I hear they say about climate change like sometimes it is raining, sometimes it is hot and sometimes it is windy [on] the radio.'

Johannesburg participant

#### Effect of heat on work performance

As expected, workers reported that very hot weather makes their work more difficult and uncomfortable.

The clothes end up being wet from perspiration, and they smell due to working in the sun.

Johannesburg participant

When the weather is hot it is exhausting – you can't take it.

Uppington participant

Some workers reported having to work at a slower pace during hot weather.

When it is hot [we] work very slowly, even in the morning.

Johannesburg participant

In Uppington, where workers have been raised in the hot climate, something akin to 'heat resistance' was reported, with workers saying the heat did not affect them greatly.

#### Effect of heat on health and well-being

Most participants felt that working in very hot weather could have varied impacts on health. The health effects mentioned during the focus group discussions included increased thirst, excessive perspiration, itchy skin, tiredness, dry nose, blister formation, sinus problems, teary or burning eyes, exhaustion, malaise, dehydration, headaches, backache, leg pains, nose bleeds, premature baldness, and dizziness. Some workers complained of

difficulty in falling asleep at night and then waking up feeling tired and irritable.

There are days that the heat makes you feverish, it makes you sick'

Upington participant

When it is very hot, sometimes, when you wake up in the morning, you still feel exhausted.

Upington participant

Sometimes in very hot weather I fall asleep well before my usual bedtime.

Upington participant

In Upington there was some agreement that pre-existing chronic ill health conditions could exacerbate the effects of working in hot weather. As examples of people who had increased difficulty coping in hot weather, participants mentioned people with conditions such as hypertension and diabetes. Participants also felt that working in hot weather could aggravate chronic ill health conditions such as hypertension.

I know someone with high blood pressure and the guy cannot really cope with it in this heat'

Upington participant

A minority of workers felt that hot weather did not affect health. In one case a participant acknowledged a potential association between hot weather and health, but was confident that his health was unaffected by heat.

It is what we hear the sun can cause you to have a cancer problem, sun dizziness but I have never experienced it. Maybe I have not been working long [enough] in the sun.

Johannesburg participant

In both Upington and Johannesburg, participants thought that working in sun-exposed conditions could affect skin conditions. Participants thought that working in the sun caused dry skin, skin rashes, and permanent skin changes. Some participants also reported a mild to severe sunburn.

My skin becomes[s] dry and sore [from working in the sun].

Johannesburg participant

Several participants knew of outdoor workers who had developed skin cancer. They were convinced of a causal relationship between sun exposure and skin cancer. One participant commented that previously it had mainly been white farmers in the Upington area who had developed skin cancer, but that in recent years an increasing number of black people were also suffering from skin cancer.

We know that [white] farmers use[d] to get skin cancer but now black people are also getting [skin] cancer.

Upington participant

Workers reported the impacts of sun exposure on their eyes. They said that working in the sun caused eye strain and this sometimes resulted in pain. They also felt that in the long-term, exposure to the sun resulted in blurring of their vision. The Upington participants felt strongly that eye problems in the community were a result of sun exposure.

My eyes become blurred and painful.

Johannesburg participant

The sun affects your eyes; you will see that the majority of people here in Upington have eye problems.

Upington participant

Upington participants felt strongly that working in very hot conditions affected their sleep, which in turn affected their mental well-being. Working in very hot conditions meant that they were exhausted on returning home after a day's work. At night summer temperatures were usually still very high. During hot nights exhausted workers were seldom able to get a good night's sleep. Workers felt that the consequences included irritability and a short temper, as well as aggression toward their family members.

This heat works on you psychologically.

Upington participant

In this heat you get angry [with family members] for no apparent reason.

Upington participant

### Women's perceptions

Women were asked to comment on how they felt hot weather affected them in specific relation to issues such as pregnancy and menstruation.

[When the weather is hot,] during [my] menstrual cycle I experience a heavy flow and have cramps and pains [in] my legs.

Johannesburg participant

Women felt that they could not cope with hot weather as well as men did, especially when they had to do labour intensive work. They thought that women experienced higher levels of discomfort and minor ill health symptoms during hot weather. Several women felt strongly about the need for toilet facilities, especially when they were working in distant fields and parks while menstruating.

### Perceptions of supervisors

Supervisors were asked about their perceptions regarding the difficulties experienced by sun-exposed workers in very hot weather. The majority of supervisors agreed that the work was strenuous and that environmental conditions made it difficult for workers to perform optimally. Some supervisors felt that the heat caused workers to be

exhausted easily and, in some instances, significantly affected work productivity.

Many supervisors agreed that there was a need to implement measures to protect workers against the effects of sun exposure, and shared ideas on how this might be achieved. For example, supervisors suggested job rotations, an earlier start to the work day (to avoid work in the hottest part of the day), the use of sunscreen, the provision of dark sunglasses, providing painkillers to those with headaches, ensuring that lunch breaks are taken under shelter, and that cold water is provided.

I would say that people [workers] need to protect themselves from the sun by using sunscreen and that would have to be at least a number 80 sunscreen and we need to wear long sleeved jackets to protect our arms. But it is also possible to protect your face. Here we buy the men hats and here in Upington you have to permanently wear sunglasses to protect your eyes from the heat.

Upington supervisor

However, there was little evidence that supervisors had been able to implement, to a significant degree, measures to protect workers against heat exposure. Though sympathetic to the plight and needs of the workers, many were of the attitude that at the end of the day the priority is to ensure that the work gets done.

I understand that the sun is hopelessly too hot to work in continuously so I let them work turns in the sun ... but mmm mmm at the end of the day the work must carry on.

Upington supervisor

Supervisors felt that employers were unlikely to be willing to bear the costs of measures such as the provision of sunglasses. Some supervisors made arrangements with workers to start working earlier so that the midday rest period could be longer. Others allowed intermittent short rest breaks throughout the day.

I would prefer that they started early; the sun rises early here [Upington], and then they can finish early as well.

Upington supervisor

### *Coping strategies*

Workers reported adopting various strategies to cope with working outdoors, such as drinking large amounts of water, wearing hats and long sleeved clothing, and applying calamine lotion to the skin. In general, workers did not think their clothing was an important factor in coping with heat. In Johannesburg, mention was only made of the fact that at times they may need to pull off their long sleeved shirts because of the heat in order to feel cooler.

That day I was wearing long sleeve overall but I wanted to remove them to get some air. I felt better after.

Johannesburg participant

In Upington, many workers complained about having to wear long-sleeved overalls. Some workers said that in very hot weather, they suffered sunburn and skin peeling, even while wearing the long-sleeved clothing.

Water was widely mentioned as an important element for coping with hot weather, with several workers reporting that they needed to consume as many as five litres of water daily. Many workers lamented the failure of employers to provide ample quantities of safe water, especially when work was undertaken at a distance from water supplies. In public parks water drawn from boreholes was sometimes unsafe to drink, leading to gastrointestinal symptoms. Several workers were bringing their own water supplies from home.

Workers felt that the use of sunglasses would protect their eyesight. While some workers had purchased their own sunglasses, others could not afford to do so. Instead they felt that employers should provide them with sunglasses. At the same time however, workers were pessimistic about the prospect of employers providing them with sunglasses. Upington workers also thought employers should provide them with broad-brimmed sun hats to help keep the sun out of their eyes.

When work was undertaken in teams, workers would sometimes arrange their workday so that individuals could take breaks while their fellow teammates continued working. In some instances, supervisors would allow for short rest periods on very hot days.

When asked about knowledge of indigenous methods of coping with hot weather, most participants were aware of a stone and the bark of a particular tree that could be ground and mixed with animal fat and then applied to the face and arms as a sunscreen. These methods were not employed much anymore as they were considered to be outdated and that moderns sunscreen lotions were more readily and conveniently available.

### *Discussion with farm managers*

To further inform the main study, telephonic discussions were held with a representative of seven large fruit farms along the Orange river, near Upington. These discussions revealed that on some farms, practices have already been put in place to reduce worker exposure to very high temperatures. Such measures include changes to the work day, for example, commencing work at 06:00 in the morning; by 10:00, when temperatures are starting to peak, work in sun-exposed areas is concluded and shifted to cooler, protected settings such as in air-conditioned packing sheds. Thus farm workers are not exposed to the highest temperatures of the day in exposed settings.

## Discussion

### *The study settings*

This pilot study has shown that in both Johannesburg and Upington, sun-exposed workers report discomfort and ill health effects that are associated with working in hot weather. However, in Upington where summer temperatures are considerably higher than in Johannesburg and where there is a greater frequency of very hot days, a broader range of difficulties and ill health effects was reported. While it is clear that Upington and surrounding areas will constitute a more appropriate site for the proposed hothaps main study, the final study site selection process will need to take account of existing heat exposure reduction practices and their implications for meeting the requirements for the main study.

### *The study populations*

In the occupational groups studied, it is apparent that the selected workers spent at least a proportion of their work days in exposed settings and found their jobs strenuous and physically demanding. In hot weather they endured particular discomfort. Many suffered ill health effects or discomfort that they attributed to their levels of sun exposure. There were direct reports of lowered productivity on very hot days ('When it is hot [we] work very slowly, even in the morning').

A greater number of workers were interviewed in Upington than in Johannesburg because more workers consented to participate in the study in Upington than in Johannesburg. In general, the maximum temperature in Upington is much higher compared to that of Johannesburg.

In some pilot study groups – such as the grave diggers – work was conducted in an unsystematic or sporadic manner, which has implications for measuring work output in the main study. This aspect needs consideration in the design of the main study.

### *Protection against sun exposure: policy and practice in South Africa*

The South African legislation requires that workers be provided with a safe work environment, but there is no specific provision made for outdoor workers in terms of minimising exposure to the hazards. While a detailed overview of legislation and policy with regard to the protection of workers against sun exposure was not undertaken as part of this pilot study, it is apparent that implementation of existing legislation to protect workers against the health effects of heat exposure is lax. Even in settings where it is apparently warranted, basic measures to improve the comfort and decrease the health risks of workers in exposure settings, such as the provision of safe water, are not always implemented. The supervisors interviewed recognised the hazards to health posed to

outdoor workers but felt disempowered to address the situation effectively.

### *Stakeholder interest*

There was a high level of interest among prospective stakeholders in participating in the study, and securing support and participation in a possible main study is not expected to hold major challenges.

### *Limitations*

The study was locally undertaken in two settings and the findings are not representative of outdoor workers in general. Employers selected the participants and this may have introduced bias. The researcher did not speak the home language of the Johannesburg focus groups and the reliance on an interpreter may have resulted in loss of detail and impacted on interpretation. Focus groups involving both men and women may have inhibited women's willingness to discuss issues pertinent to them.

### *Conclusions*

This pilot study has illustrated that outdoor workers in the selected study settings have difficulty coping with work in very hot conditions, and have difficulty maintaining work levels and output during very hot weather. Ill health effects were reported and in some instances associated with heat exposure. Upington and surrounding areas were indicated to be an appropriate setting for the conduct of the future larger Hothaps study, but care will need to be taken to ensure the inclusion of highly technical farms with air-conditioning facilities for workers as well as farms or settings with more basic infrastructure. Careful consideration with respect to the particular job groups selected for inclusion in the main study will also be required, with particular emphasis on the measurement of work output. Employers and managers identify with the objectives of the Hothaps study and it is likely to receive high levels of support.

With the prospect of increasing temperatures associated with climate change, there is a growing need to address the detrimental experiences and risks of ill health among those working in sun-exposed settings, especially in the warmer regions of South Africa.

The study highlighted the public health importance of outdoor exposure and a further study to quantify the effects of outdoor work on workers is recommended. There needs to be increased focus on improving the knowledge of workers and supervisors on the effects of heat on health and on the development of health promotion strategies to avert these effects. Occupational legislation in South Africa needs to be assessed with regard to the adequacy of protection for workers in exposed, outdoor environments.



The qualitative information obtained from the pilot study modified the design of the quantitative aspects of the intended main HOTHAPS study. In order to measure worker productivity, it is required that the study participants achieve measurable outputs at the end of each day. The pilot study indicated that the previously selected worker groups (road construction workers and grave diggers) were not suitable for the main study, due to non-measurable work outputs. In addition to this, the study identified the different coping strategies employed by outdoor workers in this region.

### Conflict of interest and funding

The authors have not received any funding or benefits from industry or elsewhere to conduct this study.

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#### \*Angela Mathee

South African Medical Research Council  
PO Box 87373  
Houghton 2041  
Johannesburg, South Africa  
Email: [amathee@mrc.ac.za](mailto:amathee@mrc.ac.za)