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Policy Brief
Heat and health impacts in Gauteng, South Africa – Towards an Early Warning System

Headline issues

- Most deaths occur at lower heat thresholds than expected, and exceed the number of deaths during extreme heat events.
- A tiered approach to heat health warnings using heat indicator percentiles (95th, 97th, 99th, 99.5th and 99.99th) could lead to "alert fatigue."
- A possible trade-off could be to only issue lower percentile warnings to disaster risk management, health authorities (i.e., clinics and hospitals), early childhood centres, schools and older adult facilities for enhanced preparedness.
- A comprehensive plan should be developed to raise awareness for the public to understand the proposed heat alerts
- This needs to include clear messages for appropriate 'action steps' when a heat alert is issued based on a threshold, knowing that heat alerts are linked to increased risk of death.

Summary

Human exposure to high temperatures over short and long periods can have serious implications for health, productivity and infrastructure. Many of these impacts are already being felt in places around the world, including in South Africa. For example, in Gauteng, Pretoria has about an average of 10 days per year which can contribute to a heat wave (maximum temperature 35 °C or higher) while for Johannesburg it is about four days per year (maximum temperature 32 °C or higher) (SAWS, 2021). Given the current context of global warming, the number of hot days are likely to increase, hence the need for a Heat Action Plan and early warning system for the province of Gauteng.

Here, we assessed the impact of heat on mortality in Gauteng province to identify thresholds at which potential warnings could be issued to reduce the risk of heat-related deaths. We found that maximum temperature had the strongest associations with mortality therefore we recommend this metric for use in an early warning system. Our results showed that children younger than 5 years and older adults (>65 years) are at greatest risk of mortality as maximum temperature increases beyond 30ºC. Lower temperature thresholds (31 °C and 32 °C) resulted in more deaths because they occurred more frequently and affected people more often.

How does mortality vary with temperature?

When considering maximum temperatures, the risk of death peaked at 38 °C, with mortality twice more likely at this temperature compared to the Minimum Mortality Temperature (MMT). During the study period, the highest number of deaths occurred for a maximum temperature threshold of 31 °C. The higher burden of death during this temperature threshold is linked to a greater occurrence of this lower threshold in Gauteng than extreme heat events.

Box 1. **What is Minimum Mortality Temperature MMT**? Optimum temperature, at which the risk of temperature-related deaths is empirically estimated to be the lowest, is defined as minimum mortality temperature - could also be considered the most comfortable temperature

The percent increase in deaths compared to deaths observed at MMT was 5% for the lowest threshold value of 31 °C (the 95th percentile) (see Table 1).

Table 1. All-cause mortality above percentile thresholds.

Indicator	Percentile	Value (°C)	Increase in expected deaths compared to expected deaths at MMT
Maximum Temperature	95th	31.4	5%
	97th	32.1	8%
	99th	33.4	16%

The optimal temperature most associated with minimum mortality for daily maximum temperature was 18 °C. This means that mortality was lowest at this temperature and begins to increase as the daily maximum temperature rises above 18 °C.

Comparison of excess deaths between an usually hot year and a "normal" year

From late 2015 into 2016, the world experienced one of the strongest El Niño events ever recorded. During this event, global temperatures reached record highs and anomalies of maximum temperature up to 6 °C higher than normal were reported in parts of South Africa. Figure 1 below shows that there were 585 excess deaths during summer (December, January, February) in 2016 while there were no excess deaths during summer in 2017. Maximum temperature for Gauteng in 2016 was 2 °C higher than 2017. Our study therefore suggests that hotter than normal conditions may be linked to an increase in excess deaths. Figure 2 shows a comparison of maximum temperatures and excess deaths during January 2016.

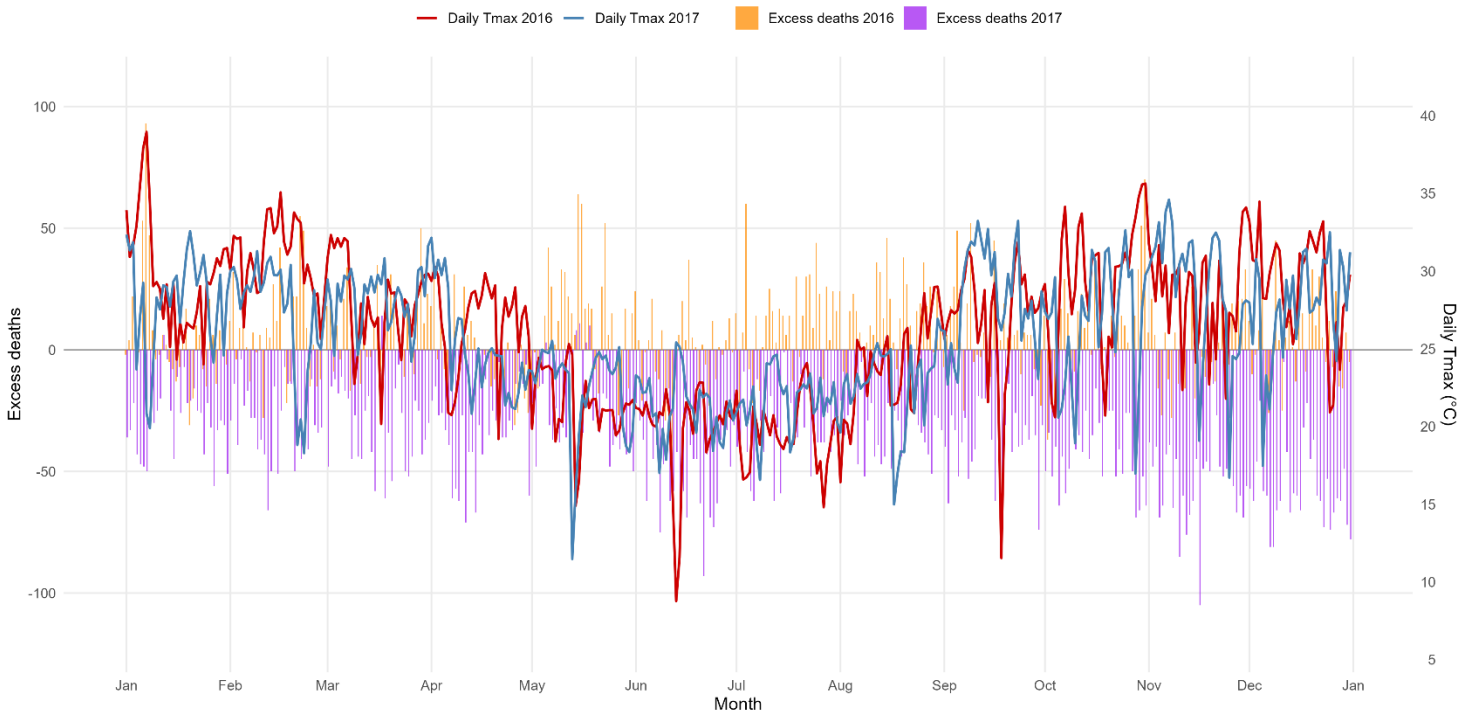

Figure 1: A comparison of maximum temperatures and excess deaths during 2016 and 2017.

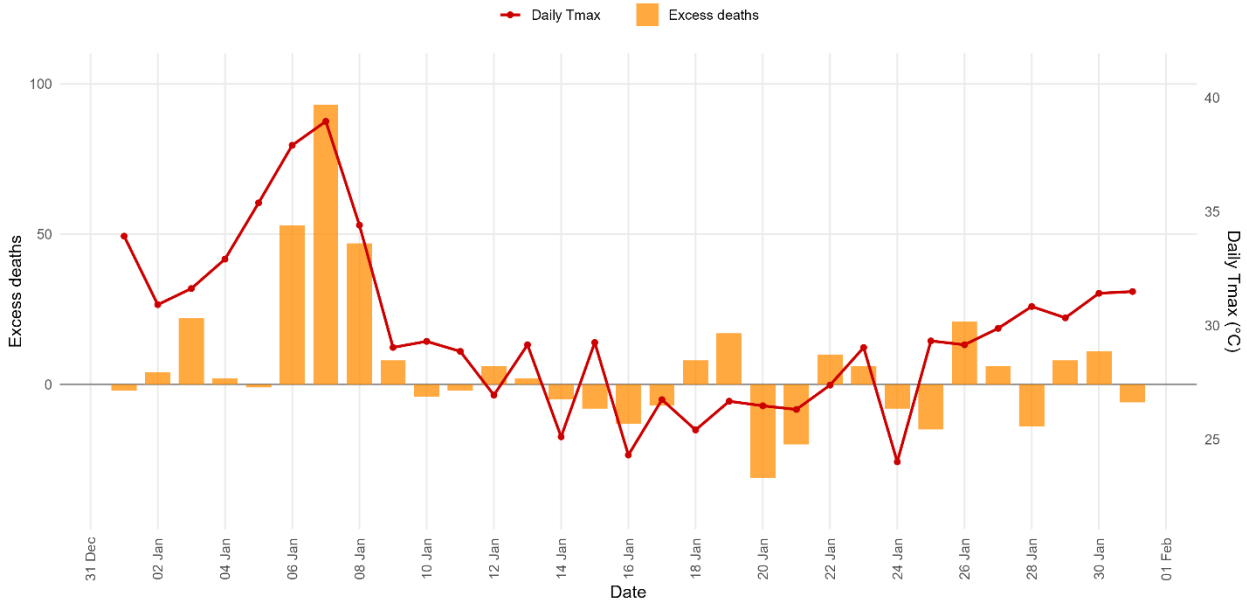

Figure 2: A comparison of maximum temperatures and excess deaths during January 2016 .

What is the temperature-mortality relationship in Gauteng province?

Deaths per day increase significantly when maximum temperatures are higher than 31 °C (heat risk: caution shown in yellow in Figure 3).

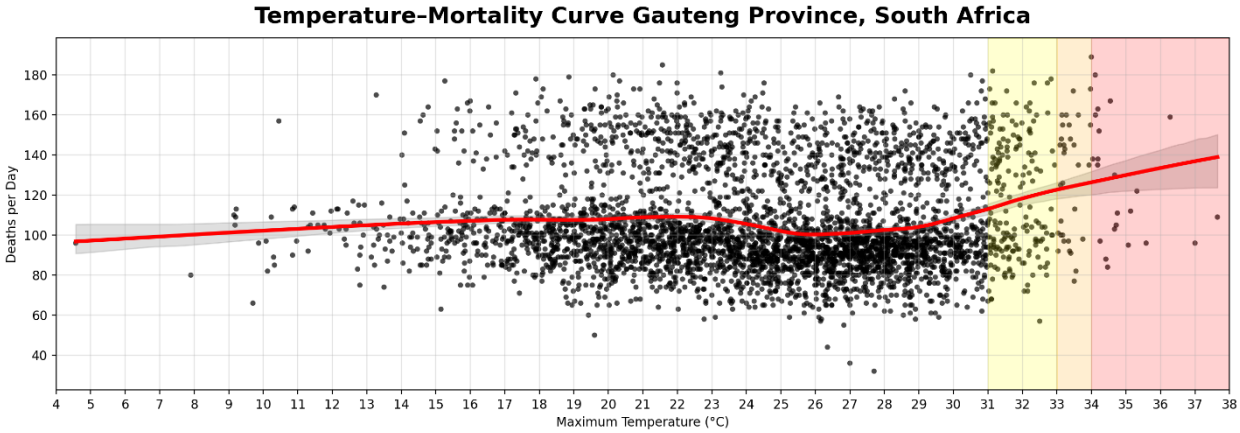

Figure 3. Temperature-Mortality Curve for Gauteng province, South Africa. Code: 31 °C – 33 °C (yellow - low risk); 33 °C – 34 °C (orange: moderate risk); and 34 °C – 38 °C (red: high risk).

Who is more vulnerable to heat, and by how much?

In general, several vulnerable groups require special consideration in a Heat Action Plan. Older adults with functional impairments or chronic conditions and socially-isolated individuals are at higher risk of death from extreme heat, as well as outdoor workers and agricultural labourers, and individuals with cardiovascular disease, diabetes, and mental health conditions (Wright at al., 2026). Children are also more vulnerable to severe heat-related illnesses because they are less able to control their body temperature (Rowland, 1985). People living in low-income communities and rural populations with limited healthcare access also face higher mortality risk.

From this project, we assessed the population characteristics of age and gender and found that 38 °C could be an appropriate threshold for daily maximum temperature across all age groups:

- For 0 – 4 years age group, the highest risk of mortality was at 38 °C where the risk of death was almost twice as high but not quite double
- For 5 – 64 years age group, the risk of death was about one third higher at 38 °C.
- The trend was similar for the older adults aged >65 years, the risk of death was highest at 38°C (3 times more likely)

In terms of gender, for females, maximum temperature had the highest mortality at 38 °C with an estimated one third higher risk of mortality, while for males, the risk of mortality was highest at 38 °C when there were two-thirds more deaths than would be expected, both relative to optimal-temperature days.

Recommended Health System Actions by Heat Alert Level

The health sector plays a pivotal role in safeguarding populations during periods of extreme heat. A Heat Early Warning System with graded alert levels—**green (normal – no concern - prepare), yellow (watch), orange (alert), and red (emergency)**—can guide pro-active and coordinated health system responses (see Table 3). This framework aligns with South Africa's National Climate Change and Health Adaptation Plan and aims to reduce morbidity and mortality associated with heat stress, particularly among vulnerable groups identified above.

Green Level (Preparedness and Routine Monitoring)

During normal temperature conditions, the focus is on preparedness and resilience building. The National Department of Health, local health authorities, and partners such as SAWS should ensure health facilities have up-to-date heat-health education materials, including clinic posters, public service announcements, and community outreach messages on hydration and sun safety. Training should be conducted for healthcare and emergency personnel on recognizing and managing heat-related illnesses. Surveillance systems should routinely capture temperature-related morbidity and mortality data, integrated into provincial health information systems. Ambulance services and clinics should ensure cooling equipment and hydration supplies (e.g., box containing rehydrate, cooling towels, battery-operated handheld fans) are stocked and functional.

Yellow Level (Heat Watch)

When temperatures are forecast to rise above seasonal averages (pending analysis results), health authorities should activate early communication mechanisms. Hospitals and clinics should review heat response protocols (put in place in advance), assess staff rosters, and confirm readiness for increased caseloads. The NDoH should disseminate targeted alerts to primary healthcare facilities, NGOs, and workplaces, advising on protective measures for high-risk groups. Community health workers should conduct risk awareness visits to elderly homes, informal settlements, and workplaces. Coordination between meteorological, health, and disaster management agencies should intensify to validate forecasts and align public messaging.

Orange Level (Heat Alert)

As heat conditions intensify and health impacts become common, emergency preparedness measures should be scaled up. Health facilities must ensure adequate water, power backup, and functioning ventilation systems. Ambulances should be equipped with ice packs, cold water, and cooling blankets. Emergency departments should implement triage protocols for heat stroke and dehydration, ensuring rapid treatment with IV fluids and cooling interventions. The provincial Department of Health should enhance heat-illness surveillance, collating data daily and sharing summaries with local disaster management centres. Communications teams should intensify media engagement and push alerts through SMS, radio, and social media, highlighting public cooling points and health advice.

Red Level (Heat Emergency)

At this level, extreme heat poses an immediate public health threat. The Provincial Command Centre (if we do not have this, we need something like this – would it go through Disaster Risk Management) should coordinate real-time response among health, emergency, and municipal stakeholders. Hospitals and health centres may activate surge capacity plans, including extended working hours, emergency staffing, and rapid supply chain activation for essential medicines, IV fluids, icepacks and cooling devices. Cooling centres and temporary shade shelters should be operational in high-risk areas. Health workers and first responders must prioritize vulnerable patients and ensure rapid case management. If possible, stop all outdoor hard labour work at construction sites, farms, mines etc. Alert all heat exposed workers like traffic police, street vendors, GIG workers etc not to go out during peak heat time or have short shifts with mandated breaks and increase water intake etc. Post-event evaluation, mortality audits, and psychosocial support for affected staff and communities should follow once conditions subside.

The implementation of this four-tier heat early warning system would support the Gauteng City-Region's ability to anticipate, prepare for, and respond to heat extremes thereby protecting health, saving lives, and strengthening climate resilience.

Table 3. Recommended health systems actions by stakeholder for inclusion in the Gauteng City Region Heat Action Plan.

Alert Level	Stakeholder	Key Actions
Green (Preparedness)	Provincial Department of Health	Develop and distribute heat-health education materials; integrate heat indicators into health surveillance; conduct staff training. Conduct mock drills or table-top exercises with various stakeholders.
	Hospitals, Clinics	Review and update heat-response plans; ensure water, fans, and cooling supplies are stocked; include heat safety in morning briefings. Check electrical systems and power back-up systems.
	EMS and Ambulance Services	Maintain hydration and cooling kits; train staff on heat-illness protocols; verify backup power and ventilation.
	NGOs, Community Health Workers	Conduct public education campaigns; identify vulnerable individuals. Prepare to provide hydration points/free drinking water supplies in the community
Yellow (Watch)	Provincial Department of Health	Issue early heat watch alerts; coordinate with SAWS and municipalities; activate communication channels.
	Clinics, Hospitals	Confirm staff readiness; increase surveillance for heat symptoms; verify backup power and ventilation.

Alert Level	Stakeholder	Key Actions
	EMS	Ensure ambulances have icepacks/cooling equipment; pre-position resources.
	Municipal Health	Inform community leaders and workplaces; support outreach activities.
Orange (Alert)	Provincial Department of Health	Implement daily monitoring and reporting of temperature, morbidity and mortality; convene coordination calls; issue risk-specific guidance (e.g., to schools, aged-care facilities).
	Hospitals, Clinics	Activate triage for heat-illness; increase staffing; ensure IV fluids and rehydration and cooling supplies are available.
	EMS	Equip with ice packs/cooling towels / blankets; prioritise vulnerable patients.
	NGOs, CHWs	Conduct public awareness in poor vulnerable communities and home visits to check on elderly and chronically ill.
Red (Emergency)	Provincial Department of Health & Disaster Management	Activate emergency command centre; coordinate intersectoral response; mobilize public cooling centres.
	Hospitals	Implement surge capacity plans; extend working hours; record and report heat-related admissions.
	EMS	Increase fleet availability; coordinate with hospitals for rapid transfers. Rapid cooling equipment such as icepacks in adequate quantities
	NGOs, Community Health Workers	Support emergency shelters; provide hydration and psychosocial support.

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