Comparison of heat stress exposure of outdoor workers between concrete and grass surfaces

KiHyira Jones, Bridget Angol, Jo Anne G. Balanay

BACKGROUND

- Extreme heat exposure can cause heat-related illnesses (HRIs) such as heat exhaustion, heat cramps, heat rashes and heat stroke (CDC, 2019; OSHA, 2017).
- Heat stroke is the most dangerous HRI and may occur when the body loses the ability to regulate its temperature and result to death (CDC, 2019).
- The heat stress of exposure of outdoor workers may be affected by several environmental factors, including the type of surface on which workers perform their tasks. Asphalt has significantly greater surface temperature, heat storage and subsequent emission to the atmosphere were for asphalt than for concrete or bare soil (Asaeda et al., 1996).

PURPOSE OF THE STUDY

The purpose of this study is to assess the heat stress exposure of outdoor workers in a university setting. The specific aims of this study are to:

1. Compare the heat stress exposures between concrete and grass surfaces
2. Compare the heat stress exposure of outdoor workers to the ACGIH Threshold Limit Value (TLV)

HYPOTHESIS

- The heat stress exposure of outdoor workers on a concrete surface is higher than those on a soil surface.

MATERIALS & METHODS

DATA COLLECTION

- Heat monitoring was conducted simultaneously using 2 heat stress monitors (Figure 1) in 2 monitoring locations (Figure 2).
  - 1st location (grass surface): close to the front of the ECU Carol Belk building on a grassy area near a small parking lot
  - 2nd location (concrete surface): at a big student parking lot across the street from the Belk building
- Wet bulb globe temperature (WBGT) indices (°C) were recorded from 8am-5pm.
- Monitoring period: June 8 – July 12, 2023 (15 days)

Figure 1: *Heat stress monitoring set-up on the parking lot (concrete surface; location 2)*

DATA ANALYSIS

- The WBGT was compared to the TLV, depending on the workload and work allocation.
- Hourly mean, daily mean and daily maximum WBGT were compared between grass and concrete surfaces using ANOVA.

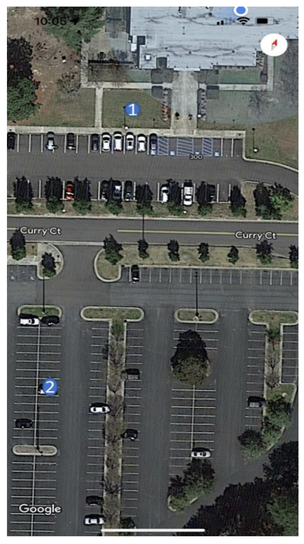

Figure 2: *Google map showing the 2 monitoring locations: 1) grassy area and 2) parking lot*

RESULTS

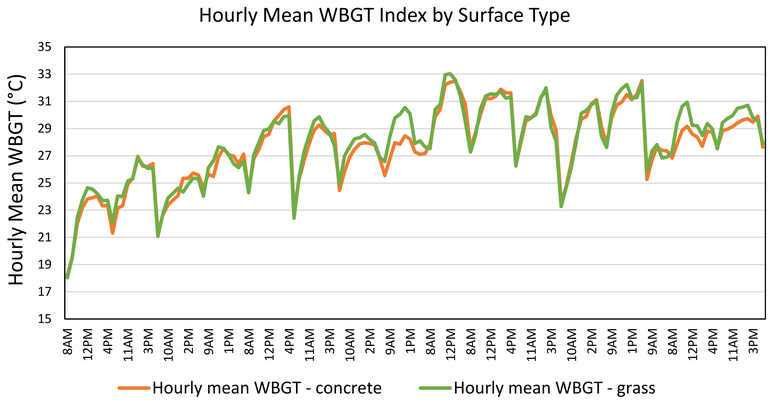

Figure 3: *Hourly Mean WBGT Index by Surface Type*

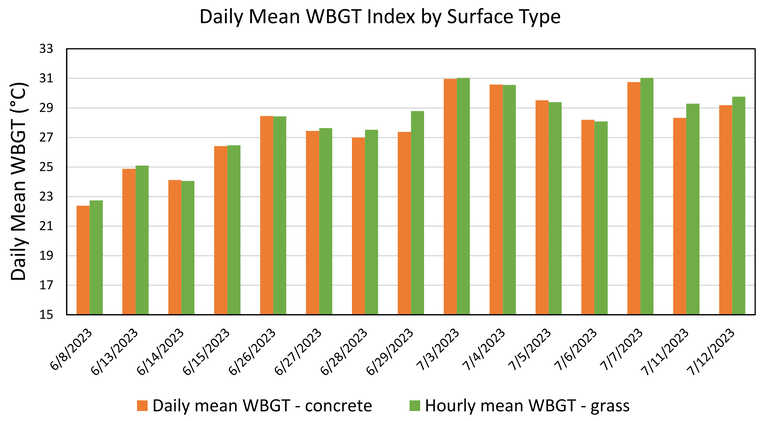

Figure 4: *Daily Mean WGBT Index by Surface Type*

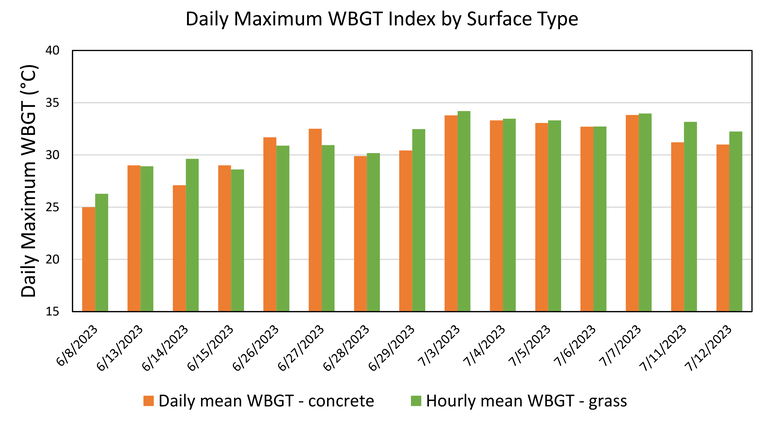

Figure 5: *Daily Maximum WBGT Index by Surface Type*

RESULTS (cont'd)

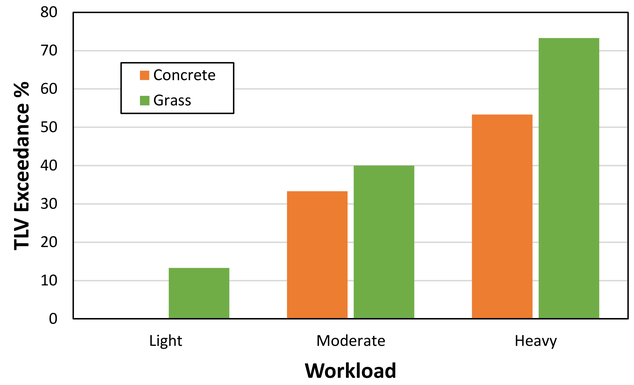

Figure 5: *Percentage of Daily Mean WBGT Indices Exceeding ACGIH TLV for Heat Stress Exposure by Surface Type Based on Workload Assumptions*

DISCUSSION

- Study findings showed that WBGT indices were similar on both grass and concrete surfaces, which did not support the hypothesis.
- Such similarity in heat exposure between surfaces may be due to:
  - Presence of certain heat sources that may have added to the heat around the monitored grass surface
  - Ability of concrete to retain heat inside the concrete material, instead of releasing the heat to the surrounding air outside the concrete surface
- The area of the concrete surface is not comparable to the area of the grass surface, which may have attributed to the additional heat sources for the grass surface.

CONCLUSION

- The grass surface has the highest hourly mean, daily mean, and the daily maximum WBGT index measured.
- Heat stress exposure on the grass surface is not significantly different from that on the concrete surface.
- For future studies, surfaces used for comparison are recommended to be comparable in terms of size, area and presence of nearly structures.

REFERENCES

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