Toward Assessing Heat Stress Risk: Comparing Wet Bulb Globe Temperature Index Versus Corrected Air Temperature

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Background

- Corrected Air Temperature (CAT) is a tool that intends to estimate the thermal stress level aiming at preventing heat stress (IRSST, 2019).
- To calculate CAT, two methods are used: 1) Local temperature and relative humidity and (2) “regional weather service” by using regional temperature and relative humidity from weather service (IRSST, 2019).
- CAT is essential in monitoring employee health in an outdoor setting such as agriculture. This tool is a potential alternative monitoring tool when Wet Bulb Globe Temperature (WBGT) is not available, especially in outdoor setting such as agriculture.

Purpose of the Study

- To determine the feasibility of calculating the CAT using secondary data comprised of weather parameters (air, temperature, and relative humidity) from local heat stress monitors and regional weather stations.
- To compare the calculated CAT using (a) local temperature and relative humidity, and (b) regional temperature and relative humidity from weather service.
- Compare the heat stress risks derived from instrument-measured WBGT index, CAT method using local instrument-measured weather data, and CAT method using regional weather station-derived data.

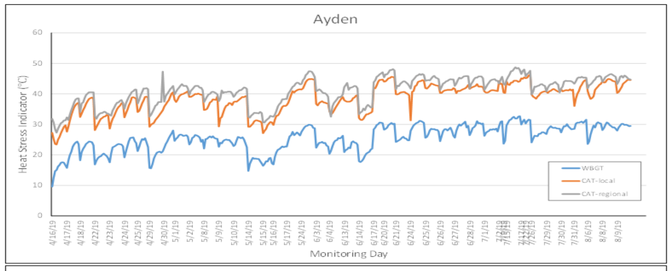
Significance of the Study

- There is currently no peer-reviewed literature published on CAT on how it can substitute WBGT in outdoor setting (e.g., agriculture).
- WBGT is not always available in workplace, especially in outdoor workplace such as agriculture.
- Studying the potential of CAT as an alternative to WBGT is essential.

Materials and Methods

- Secondary data collected from agriculture sites in eastern North Carolina were used to calculate the CAT by utilizing local (CAT-local) and regional (CAT-regional) weather data.
- CAT was calculated using an online calculator by the Institut de Recherche Robert-Sauve en Sante et en Securite du Travail (IRSST).
- The data were analyzed using one-way ANOVA.
- Statistical analysis were determined at $p \leq 0.05$.

A



B

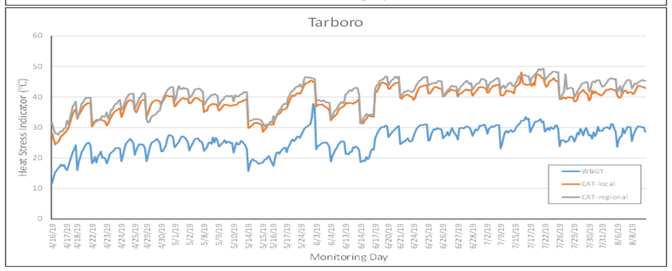


Figure 1. Hourly means heat stress indicators for the entire study period by monitoring location Ayden (A) and Tarboro (B).

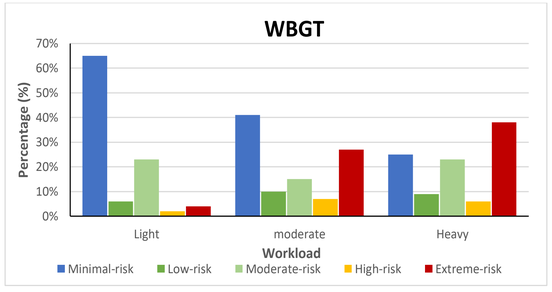


Figure 2. Percentage of hourly heat stress risk level assignments by workload (light, moderate, heavy) and heat stress indicator (WBGT).

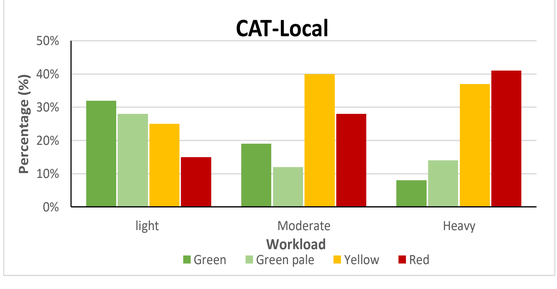


Figure 3. Percentage of hourly heat stress risk level assignments by workload (light, moderate, heavy) and heat stress indicator (CAT-local).

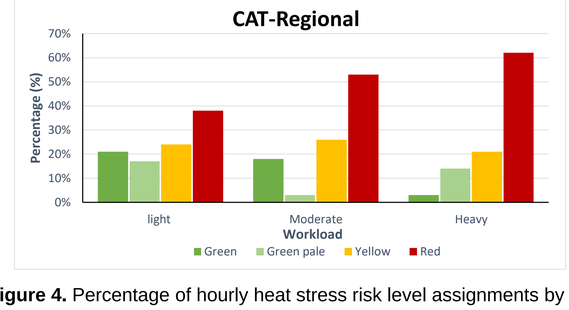


Figure 4. Percentage of hourly heat stress risk level assignments by workload (light, moderate, heavy) and heat stress indicator (CAT-regional).

Results

- CAT-regional has the highest mean (41.02 ± 4.75 ℃) followed by CAT-local (38.70 ± 4.65 ℃), with WBGT having the lowest mean (25.60 ± 4.21℃).
- WBGT and CAT-regional are statically significant ($F=4764.15$, $p<0.01$)
- WBGT has the lowest standard deviation 4.21℃, followed by CAT-local 4.65℃ and CAT-regional 4.75℃.
- WBGT vs CAT-local, WBGT vs CAT-regional, and CAT-local vs CAT-regional are all statistically significant ($F=3519.66$, $p<0.01$), ($F=4764.15$, $p<0.01$), and ($F=98.0$, $p<0.01$), respectively.
- Correlations between the pairs WBGT, CAT-local, and CAT-regional are statistically significant ($p<0.01$).
- WBGT vs CAT-local, WBGT vs CAT-regional, and CAT-local vs CAT-regional have shown a strong and positive correlation ($r=0.94$, 0.92, and 0.94), respectively (Figure 1).
- Heat stress risks were compared 65% of workers experience a low risk followed by 41% (moderate risk), and 25% (high risk). When workload is light, the percentage of workers experiencing low risk is higher. This is true for all heat indicator used.
- When workload is heavy, lower percentage of workers experience low risk decreases regardless of the heat stress indicator used and the percentage or workers experiencing high risk increases 3% (low risk) followed by 28% (moderate risk), and 38% (high risk).

Discussion Highlights

- Findings of this study have shown that risk is less when workload is light whether CAT or WBGT is used. Therefore, those results support that CAT can be used when WGBT is not available.
- Other studies have been conducted to determine other alternative tools to use when WGBT is not available (Dillane & Balanay, 2020; Dillane & Balanay, 2021).
- Thus, considering the strong correlations between the CAT and WGBT, it is likely that CAT can be used as an alternative to WBGT in the outdoor environment such as agriculture (Figures 2,3 & 4).

Conclusion

- CAT is found to be a valuable tool for outdoor workplaces with limited financial resources, such as agriculture or landscaping. The study also showed that CAT is as dependable as WBGT in identifying risk conditions under heavy workload conditions.
- Although further studies are still required, it is recommended to use CAT in outdoor workplaces where WBGT is not available.

References

- Dillane, D., & Balanay, J. G. (2020). Comparison between OSHA-NIOSH Heat Safety Toll App and WGBT Monitor to assess heat stress risk in agriculture. *Journal of Occupational and Environmental Hygiene, 17(4), 181-192*. doi:10.1080/15459624.2020.1721512
- Dillane, D., & Balanay, J. G. (2021). Comparison between EPA UV monitor to assess risk for solar ultraviolet radiation exposure in agriculture setting in Eastern North Carolina. *Journal of Occupational and Environmental Hygiene, 18*(1), 16-27. doi: 10.1080/15459624.2020.1842880
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