Comparing a Weather App and On-Site Measurement for High School Sports Safety

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Background

Our study was constructed with the purpose of preventing heat related illnesses in high school sports, a staggering problem present across the US. WBGT (Wet Bulb Globe Temperature) is a calculation often used to measure heat stress and to determine the necessary modifications for outside activities. WBGT is a calculation "of the heat stress in direct sunlight, which takes into account: temperature, humidity, sun angle, and cloud cover" (NWS). A common problem faced when measuring WBGT is the cost of equipment and ease of measurement. To combat this, phone applications are being advertised as convenient alternatives to on-site measurement. This has led to questions of accuracy of these products, which we sought to answer: our study utilized a phone application known as Zelus and compared its readings to a commonly used on-site measuring device (Kestrel 5400). The secondary purpose of our research was to determine if these different measurements impacted activity modification categories: it is important for categories to be properly measured, as inaccuracies can lead to more heat related illnesses.

WBGT (Wet Bulb Globe Temperature) Equation

$$WBGT = .7NWB + .2GT + .1DB$$

DB (Dry Bulb) temperature is the actual temperature of the air.

GT (Globe Temperature) is the temperature of a black globe, which is used to measure solar radiation.

NWB (Natural Wet Bulb) temperature is the temperature of a thermometer covered with a piece of wet cloth. It helps to emulate how the human body would cool itself with sweat.

Measurement Tools

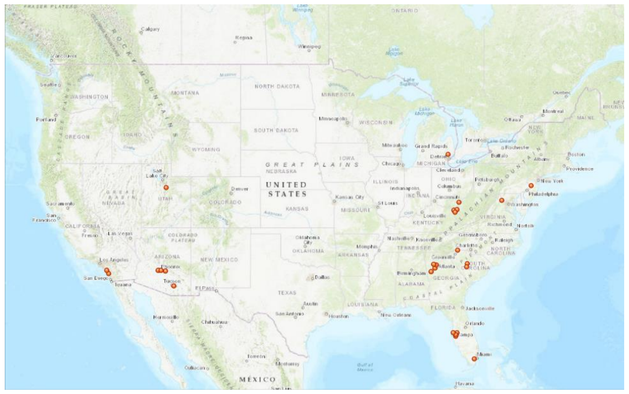


Above is the layout for the Zelus PA (phone application) used in our data

Below is the Kestrel 5400, a common device used by sports trained for on-site measurement of WBGT

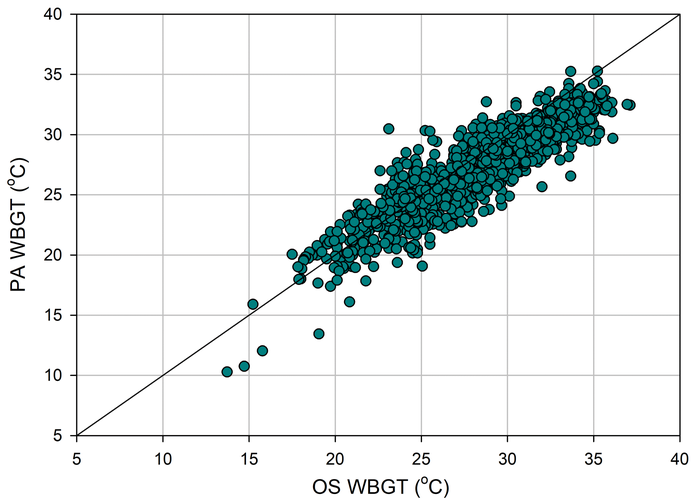


Data Locations



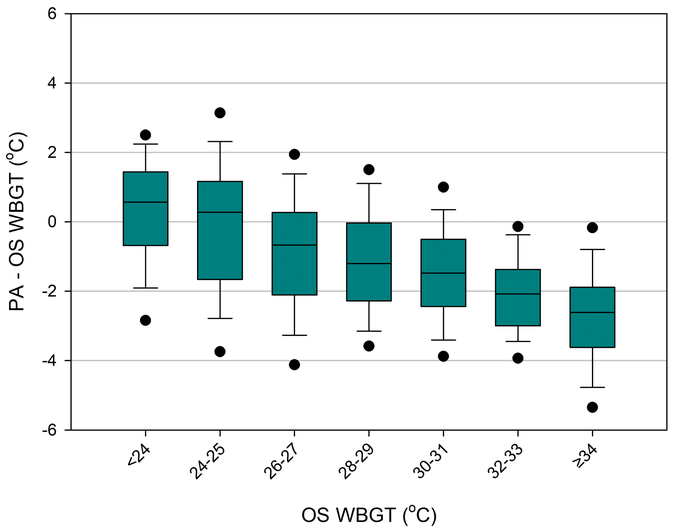
The map above utilizes red points to show the locations of the schools surveyed in our study, totaling to 27 throughout the country.

Graph Depicting PA (Phone Application) WBGT measurement vs OS (On-site) Measurement



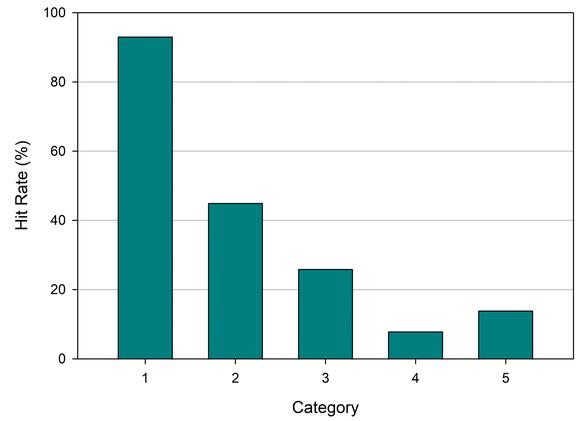
The plot above depicts readings taken at the same time for on-site (OS) measurement vs off-site (Phone Application). The scatter plot shows that as temperatures get increasingly higher, the OS WBGT measures higher values than that of the PA. This can pose a significant problem when selecting activity modification categories, especially with the tendency to underestimate higher levels of heat stress.

PA vs OS WBGT Measurement Differences



The above graph depicts the measured difference of WBGT utilizing box plots. This graph shows how as the temperatures increase, the PA application continuously underestimates the OS measurement. This is especially critical because of the increased heat illness risk at hotter temperatures if proper activity modification is not taken,

Hit Rate Graph Comparing Activity Modification Levels



The above graph depicts the hit rate of activity modification that the off-site measurement device (Zelus) attained during our data collection. Hit rate is defined as how often the variable "hits" the category that is necessary. We observed considerable misclassifications in activity modification category, particularly as the categories increased. The hit rates were high for category 1 (no activity modification needed) but decreased progressively with higher activity modification categories, from less than 50% "hit" at category 2 to 10-13% for categories 4-5

Activity Modification Levels:

Category	Guidelines
1	Normal Activities
2	At least 3 breaks every hour, each 4 minutes
3	Restricted equipment/pads worn, 4 breaks of 4 minutes every hour, maximum practice time is 2 hours
4	No equipment/pads worn, maximum practice time 1 hour, at least 20 minutes of break every hour
5	No outdoor workouts

Conclusions

We found that on-site measurements typically were hotter than off-site values by about 1 degree Celsius. Disparities such as this have the potential to signal incorrect activity modification categories to athletic trainers, leading to an increase in heat related illnesses. Additionally, the on-site measurements more frequently indicated the need for some sort of activity modification than the off-site measurement: the Zelus application did better matching these categories at cooler temperature, but progressively worse at hotter temperatures, which poses a large health threat. We conclude that caution should be used when using off-site measurement in hotter conditions.

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