

EXTREME ENVIRONMENTAL HEAT STRESS IN COSTA RICA

by
Cecilia González
&
Luis F. Aragón-Vargas
University of Costa Rica

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Five years of meteorological records were manually tabulated and analyzed for the estimation of the maximum WBGT (an environmental heat stress index) values that could be expected at different times of the day in three regions of Costa Rica. The results were presented at an international conference in the U.S.A. in 1989. The original paper presented at the conference is included, together with improved graphs reproduced from the undergraduate thesis by Mario Fco. Calderón Navarro and Cecilia González Álvarez. This information should help with the planning of long distance running and triathlon events in Costa Rica. Comparison with recent five-year records is encouraged; **current, on-site WBGT readings should always be used at endurance events.**



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Abstract

Increasing popularity of long-distance running has led to a higher incidence of injuries, especially heat-related injuries. The latter can be reduced by scheduling races under appropriate weather conditions. Extreme WBGT values for each month and for the 8:00, 10:00, 12:00 and 14:00 hours, as a useful index of maximum possible environmental heat stress, were calculated for three regions of Costa Rica from 1984 to 1988. The Valle Central region showed WBGT values under 28°C at all times, but only a few 8 o'clock values were under 23°C. The other two regions showed maximal WBGT values exceeding 28°C year round; except for two months at 8:00 hours. It was concluded that long-distance running events should not be scheduled in the Región Atlántica nor in the Pacífico Norte, unless current readings of WBGT showed safe conditions. In Valle Central, it is recommended to take readings of WBGT prior to scheduled events; these events should be programmed for December and January. The earlier hours show the most favorable conditions. Further studies to determine the applicability of the ACSM criteria to tropical countries' runners are suggested.

Long-distance running events have more and more followers everyday but, as their popularity increases, so does the amount of risks during competitions. Heat illnesses are among these, especially the heat stroke which could lead to death (1, 2,3,4,5). Conditions for competition have been the subject of numerous studies, in an attempt to ensure a higher performance as well as to provide safer competitions for the athletes (6,7,8,9).

Considering that heat illnesses depend to a large degree on prevailing environmental conditions, it is very important to know what those conditions are. Studies have dealt with establishing indexes for the safe practice of exercise and work in a variety of environments (10,11,12). An important parameter has been the "Wet Bulb-Globe Temperature index"(WBGT), used by the American College of Sports Medicine as a guideline for programming long-distance running events (13). The ACSM establishes that this type of event should be postponed or re-scheduled whenever WBGT exceeds 28°C; if it is below, but close to this value, participants should be warned about the heat stress (14).

Costa Rica is a tropical country characterized by warm temperatures (15). Nevertheless, there are no guidelines or policies regarding prevention of heat illnesses during sports events of any sort; moreover, other criteria tend to promote scheduling events at the warmer times of the day and during the warmer months. This study attempts to provide some information about maximal environmental heat stress conditions in three areas of the country, in order to suggest those times of the day and times of the year when long-distance running events would be more safely programmed.

PROCEDURE

Weather history data were obtained from the National Meteorology Institute, namely, maximum temperatures and their corresponding relative humidity values.

Three different regions of the Country were selected: Valle Central, Región Atlántica, and Pacífico Norte. Maximal monthly temperatures and their corresponding relative humidities were obtained for 8:00, 10:00, 12:00 and 14:00 hours, for a representative weather station from each region, from 1984 to 1988.

Maximal WBGT values were calculated with the formula

$$\text{WBGT} = 0.567 (\text{DBT}) + 0.288 (\text{VP}) + 3.38 \quad (16)$$

where DBT (dry bulb temperature) was the maximum monthly temperature and VP (vapor pressure) was calculated from the temperature and its relative humidity, according to the formula:

$$E + 10^L \text{LGT} = \log_{10}$$

$$\begin{aligned} L = & (7.90298 * ((373.16/T) - 1)) \\ & + (5.02808 * \text{LGT} (373.16/T)) \\ & - (1.3816 * (10^4(-7)) * ((10^4(11.344 * (-1(T/375.16))))-1)) \\ & + (8.1328 * (10^4(-3)) * ((10^4(-3.49149 * ((373.16/T)-1)))-1)) \\ & + \text{LGT} (373.16) \end{aligned}$$

$$L = -7.90298X \left(\frac{373.16}{T} \right) - 1 + 5.02808 X \log_{10} \left(\frac{373.16}{T} \right)$$

$$-1.3816 * 10^{-7} * (10^{11.344} X (1 - \frac{T}{373.16}) - 1)$$

$$+ 8.1328 * 10^{-3} + 10^{-3.49149X [(\frac{373.16}{T}) - 1] - 1}$$

$$+ \log_{10} (373.16)$$

Smithsonian Meteorological Tables
List, Robert VI Edition, Washington
Smithsonian Institution, 1966 (17)

Five-year average WBGT values were obtained for each month and time of the day.

Results were compared with the ACSM standard mentioned above. Programming was contraindicated during those months and times of the day when extreme WBGT values were equal to or higher than 28°C. On the other hand, programming of long-distance running events was recommended during these months and times of the day when WBGT values were equal to or below 23°C.

RESULTS

Figure #1 shows average WBGT values for Valle Central at 8:00, 10:00, 12:00 and 14:00 hours. At 8 o'clock, maximum WBGT goes from 22.1°C to 24.3°C; at 10 o'clock between 23.9°C and 25.5°C. At noon time ranges from 24.6°C to 26.7°C. Finally, at 2 p.m. stays between 24.6 and 27.2°C.

December and January have the lowest WBGT values, while August and September show the highest.

Values for the Región Atlántica are shown in figure #2. At the earliest time studied, maximum WBGT ranges from 25.6 to 28.3°C; at 10 o'clock from 27.3 to 29.1°C; at 12 noon from 27.9 to 30.0°C, and by the 14:00 hours reaches values between 28.0 and 30.3°C.

For the Región Atlántica, lowest maximal WBGT values are in December, January and February; highest values take place in April and June.

Figure #3 shows maximal WBGT values take for Región del Pacífico Norte. WBGT goes up to 29.0° at 8:00 hours; ranges from 28.4 to 30.3 at 10 o'clock and from 28.7 to 31.2°C at noon. In the afternoon (2 o'clock) values range from 29.0 to 30.8°C.

Months with the lowest maximal WBGT are November, December and January. The highest values happen during April, May and August.

DISCUSSION

First of all, care must be applied in interpreting the preceding data, because the study was conceived as a guideline of maximal possible WBGT values throughout the year. Only when WBGT does not exceed 23°C, scheduling can be safely recommended; at all other times, it will be necessary to obtain current WBGT values, as they may have increased.

Considering this criterion of 23°C, only the Valle Central, in December and January at the 8:00 hours, can be recommended. WBGT values for this region do not exceed 28°C, but adverse conditions are especially likely in June, August and September at the 12:00 and 14:00 hours.

In the Pacífico Norte and Atlántica regions, values get as high as 31.2°C. These are low altitude regions, close to or by the ocean, where environmental heat stress tends to be high.

According to the results, the possibilities for dangerous WBGT values are high; it follows that on-site WBGT readings should be mandatory for long-distance running. Other precautions should be taken such as giving good medical assistance and having enough water available for the runners at reasonable intervals.

Costa Rican runners could be expected to be well acclimated, because of the relatively stable weather conditions year-round. This situation would reduce the risk of heat injuries, although many runners practice at times of the day differing with the race schedules, and many of them are not in optimal conditions for the race, and it is for these runners that the safety guidelines have been devised.

In any case, further study is recommended to investigate the applicability of the ACSM standards to tropical countries runners.

Finally, although rainfall was not considered in this study, Costa Rica has heavy rainfall during a large part of the year, especially during the "warmer" months (18); this is a very important variable to consider for scheduling running events.

SOURCE:

González, C. & L.F. Aragón-Vargas (1989): "Extreme Environmental Heat Stress in Costa Rica" in *Proceedings of the 32nd ICHPER Anniversary World Congress*, pp. 319-322. Sullivan-Haberlein, S. & H.J. Cordts (editors). Frostburg State University, Frostburg, Maryland, U.S.A.

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Figure #1.

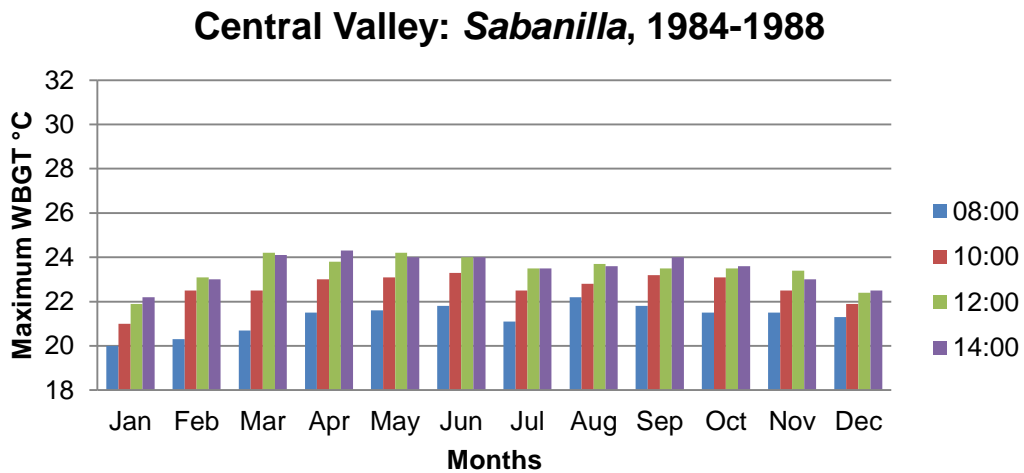


Figure #2.

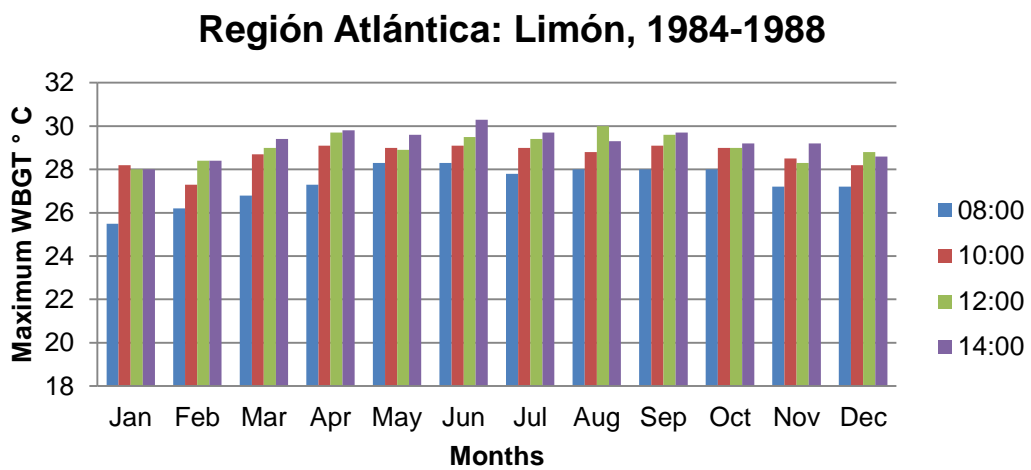


Figure #3

