Self-reported and biometrically measured hot flashes in relation to ambient temperature and humidity

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Objective: Warm ambient temperatures provoke hot flashes in the laboratory, but outside the laboratory the temperature to hot flash relationship is less consistent. A study in Bangladesh and London found that temperature and humidity at 12:00 and 18:00 were not associated with self-reported or biometrically measured hot flashes. However, in Spain and three South American countries, higher temperatures and humidities were associated with more frequent and problematic hot flashes. The study reported here differs from previous work in that we asked women to carry an ambulatory temperature and humidity monitor while wearing an ambulatory hot flash monitor. The purpose of this study was to examine the relationship between concurrent temperature, humidity, and hot flash experience. We hypothesized more frequent hot flashes with higher ambient temperatures.

Design: Women aged 45 to 55 years were drawn from western Massachusetts for an ongoing cross-sectional study (n=195) from October through April (2019-2023). Exclusion criteria included use of medications that dampen hot flashes. Hot flashes were queried with a semi-structured questionnaire: During the past two weeks, have you been bothered by hot flashes (not at all, a little, somewhat, a lot)? Currently, how often do they occur (from less than 1/month to 5+ times/day, scored 0-8)? Hot flashes were also assessed by sternal skin conductance using a Biolog ambulatory hot flash monitor (3991x/1-SCL, UFI, Morro Bay, CA). Subjective hot flashes during the 24-hour study period were recorded with buttons on the hot flash monitor. Ambient temperature and humidity were continuously recorded with the GSP-6 Temperature and Humidity Data Logger Recorder (Elitech Technology, San Jose, CA). Menopausal status was categorized as pre-, peri- (change in cycle length >6 days) and post- (absence of menses for 12 months). Univariate relationships between temperature (maximum, minimum, mean), humidity (maximum, minimum, mean), and hot flashes (yes/no) were examined by t-tests. Temperature, humidity, and hot flash bothersomeness were examined by ANOVA. Pearson correlations were used to evaluate temperature, humidity, and hot flash frequencies (from the questionnaire and Biolog monitor). Logistic regression was also applied to examine temperature and humidity measures in relation to hot flashes while adjusting for menopausal status.

Results: Mean ambient temperatures ranged from 16.3 to 30.1°C (mean 24.5°C, s.d. 2.8); mean humidities ranged from 18.9 to 68.6% (mean 40.8%, s.d. 9.2). Minimum temperature was positively associated with minimum ($r=0.508$, $p<0.001$) and mean ($r=0.316$, $p<0.001$) measures of humidity. Hot flash bothersomeness was described as not at all (31%), a little (23%), somewhat (23%), and a lot (24%). In univariate analyses, maximum, minimum, and mean temperatures and humidity levels were not associated with hot flashes (yes/no) or with the bothersomeness of hot flashes. Temperature measures were not correlated with current frequency of hot flashes or with the frequency of objective or subjective hot flashes during the study period. However, the current frequency of hot flashes was negatively correlated with minimum ($r=-0.205$, $p<0.01$) and mean ($r=-0.196$, $p<0.01$) levels of humidity, so that as humidity levels increased, the likelihood of hot flashes decreased.

Although participants were keen to wear the monitor for 24-hours, the Biolog monitor quit during 38% of the studies. In the majority of cases, participants restarted the monitor. Compared to monitors that

continued to function, monitors that quit were more likely to be worn when minimum temperatures were lower (mean 6.8°C vs. 8.9 °C, $p=0.03$), minimum humidity levels were lower (mean 17.2% vs. 22.6%, $p<0.001$), and mean humidity levels were lower (mean 37.2% vs. 43.0%, $p<0.001$).

Conclusion: The hypothesized positive relationship between temperature and hot flashes was not supported. Instead, as humidity levels increased, the likelihood of hot flashes decreased. This preliminary study will be followed by syncing of the temperature, humidity, and hot flash data in order to study how changes in temperature and/or humidity may provoke hot flashes.

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