Temperature

ISSN: 2332-8940 (Print) 2332-8959 (Online) Journal homepage: http://www.tandfonline.com/loi/ktmp20

Electric fan use during heat waves: Turn off for the elderly?

Daniel Gagnon & Craig G. Crandall

To cite this article: Daniel Gagnon & Craig G. Crandall (2017): Electric fan use during heat waves: Turn off for the elderly?, Temperature, DOI: 10.1080/23328940.2017.1295833

To link to this article: http://dx.doi.org/10.1080/23328940.2017.1295833

Accepted author version posted online: 16 Feb 2017.
Published online: 16 Feb 2017.

TEMPERATURE
2017, VOL. 4, NO. 2, 1–3
http://dx.doi.org/10.1080/23328940.2017.1295833

FRONT MATTER: COMMENT

Electric fan use during heat waves: Turn off for the elderly?

Comment on: Ravanelli NM, Jay O. Electric fan use in heat waves: Turn on or turn off? Temperature. 2016;3:358–360. doi:10.1080/23328940.2016.1211073.

In their Discovery article, Ravanelli & Jay[1] make a compelling argument that should change our perception of electric fan use during heat waves. Public health agencies generally discourage fan use above air temperatures of ~35°C (95°F), due to the concern that increased air velocity will only serve to accelerate dry heat gain and dehydration. However, as Ravanelli & Jay[1] discuss, greater heat gain during fan use is far outweighed by increased sweat evaporation, the latter of which can be offset by drinking less than one cup of water per hour. Consequently, fan use delayed the increase in heart rate and internal body temperature of young adults exposed to a humidity ramp protocol performed at 36°C (97°F) and 42°C (108°F)[2]. These findings are particularly important given a general lack of knowledge regarding the effectiveness of fan use during heat waves.

Identifying simple, cost-effective, and sustainable cooling interventions has perhaps never been more important. The world's climate is changing, the effects of which are already being felt. According to the National Oceanic and Atmospheric Administration, 2016 was the hottest year on record and the third year in a row that this record was set. One consequence of climate change is an increase in frequency, intensity, and duration of heat waves. For example, Kuwait endured a heat wave during July 2016 that saw temperature peak at 54°C (129°F). In the United States, a June heat wave brought temperatures in excess of 46°C (115°F) across parts of the Southwest. Such periods of extreme heat are consistently associated with excess morbidity and mortality[3]. Therefore, the finding that electric fans can alleviate cardiovascular and thermoregulatory strain at temperatures as high as 42°C (108°F) is promising for their implementation as a cooling intervention during heat waves. Electric fans represent a relatively more sustainable intervention than widespread air-conditioning use, which places significant burden on the electrical grid and adds a substantial thermal load to the environment. Furthermore, access to air-conditioning is not universal and for those who do have access to air-conditioning, economical concerns may limit its use.

Heat-related morbidity and mortality disproportionately affect the elderly[3]. This is important because aging, even in the absence of overt disease, compromises cardiovascular and thermoregulatory responses during heat exposure[3]. It remains unclear if the beneficial effects of fan use, as identified in young adults, can be transferred to a vulnerable population such as the elderly. As a first step toward addressing this question, we followed up on the Ravanelli et al.[2] study by exposing healthy older adults (61–71 years) to extreme heat and humidity[4]. Following an initial baseline period at a relative humidity of 30%, relative humidity was increased in a step-wise fashion by 2% every 5 min until 70%. Throughout the protocol, air temperature remained constant at 42°C (108°F). On separate days, the participants performed the protocol with or without an electric fan turned on to provide an air velocity of ~4 m/s. In contrast to what Ravanelli et al.[2] observed in young adults, fan use did not delay the increase in heart rate and internal body temperature of older adults. Rather, fan use resulted in greater heart rate and internal body temperature during the protocol[4]. Taken at face value, these findings suggest that fan use may be detrimental for the elderly during heat waves.

An important consideration of our study is the air temperature used (42°C; 108°F). Although such temperatures are sometimes encountered, they are rarely accompanied with the levels of humidity we examined. Therefore, our findings cannot be generalized to most heat wave conditions. Rather, our findings provide the first

CONTACT Daniel Gagnon daniel.gagnon.3@umontreal.ca Cardiovascular Prevention and Rehabilitation Centre, Montreal Heart Institute, 5055 rue St-Zotique Est, Montréal, QC, H1T 1N6, Canada.
Color versions of one or more of the figures in the article can be found online at www.tandfonline.com/ktmp.

validation of a model proposed by Jay et al.[5] that predicts the environmental limits at which fan use is either beneficial, or of marginal benefit, or detrimental. This model is reproduced in Figure 1. It can first be appreciated that, for a given relative humidity, the "marginal benefit" and "detrimental" zones are shifted to lower air temperatures in the elderly. For example, at a relative humidity of 20%, fan use would remain beneficial until an air temperature of ∼45°C in young adults, whereas it would only remain beneficial until an air temperature of ∼42°C for the elderly. It is also evident that, before beginning the step-wise increases in humidity, the environmental conditions of our protocol (42°C, 30% humidity, green dashed line) exceeded the peak conditions of all but 2 of the most severe heat waves of the past 20 y (see circled numbers). Furthermore, these baseline conditions were already within the zone of marginal benefit of fan use predicted for the elderly. Finally, the environmental conditions at which an increase in heart rate (42°C, ∼55% humidity) and internal body temperature (42°C, ∼65% humidity) occurred were well within the zone where fan use was modeled to be detrimental (red dashed lines). Therefore, we cannot rule out the possibility that fan use would be beneficial for older adults exposed to less extreme environmental conditions.

Overall, the results of our study raise 2 considerations for future research. First, the effectiveness of fan use during heat exposure is likely influenced by factors which compromise thermoregulatory responses, such as age and health status. When air temperature is greater than skin temperature, fan use will only be beneficial *if* it is accompanied by greater sweat evaporation. In older adults, a reduced sweating capacity may explain why fan use was not beneficial under the conditions we examined. In fact, whole-body sweat loss was similar between conditions in our study[4], whereas sweat loss was elevated by fan use in young adults[2]. Second, the effects of fan use will differ according to the environmental conditions used. As the model proposed by Jay et al.[5] clearly highlights, there is a finite range of environmental conditions within which electric fans will be beneficial. However, the benefits of fan use (as predicted by this model) might be overestimated for very hot and dry environments. In such conditions, evaporative efficiency is high even without additional air flow provided by an electric fan. If evaporative efficiency is not further improved by fan use, the fan will only serve to increase skin temperature leading to greater cutaneous vasodilation. This may result in greater cardiovascular strain that is not considered by the model. Therefore, an important task moving forward will be to experimentally quantify the range of air temperatures and relative humidities within which electric fans are beneficial, particularly for populations vulnerable to heat-related morbidity and mortality. Doing so will allow public health agencies to establish guidelines for fan use based on empirical evidence, rather than the (as of yet) unsubstantiated belief that fan use is detrimental for all when air temperature reaches ∼35°C (95°F).

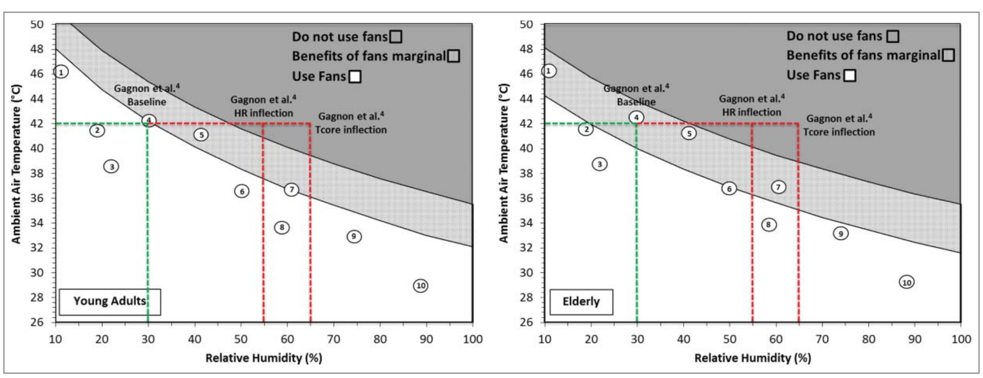

Figure 1. Predicted environmental limits at which fan use is either beneficial (white area), or of marginal benefit (light gray area), or detrimental (dark gray area) for young adults (left panel) and the elderly (right panel). The green dashed lines represent the baseline environmental conditions of our protocol (42°C, 30% humidity). The red dashed lines represent the environmental conditions at which an increase in heart rate (HR; 42°C, ∼55% humidity) and internal body temperature (Tcore; 42°C, ∼65% humidity) occurred during a step-wise increase in relative humidity. The circled numbers indicate the peak outdoor conditions for 10 of the most severe heat waves in the past 20 years: (1) Washington, DC, 2012 (day); (2) Paris, France, 2003 (day); (3) Newark, NJ, 2011; (4) Chicago, IL, 1995; (5) New York, NY, 2006; (6) Chicago, IL, 1999 (day); (7) Washington, DC, 2012 (night); (8) Chicago, IL, 1999 (night); (10) Paris, France, 2003 (night). Modified with permission from Jay et al.[5]

References

[1] Ravanelli NM, Jay O. Electric fan use in heat waves: Turn on or turn off? Temperature. 2016;3(3):358-360. doi:10.1080/23328940.2016.1211073
[2] Ravanelli NM, Hodder SG, Havenith G, Jay O. Heart rate and body temperature responses to extreme heat and humidity with and without electric fans. JAMA 2015;313(7):724-725. PMID:25688786; doi:10.1001/jama.2015.153.
[3] Kenney WL, Craighead DH, Alexander LM. Heat waves, aging, and human cardiovascular health. Med Sci Sports Exerc. 2014;46(10):1891-1899. PMID:24598696; doi:10.1249/MSS.0000000000000325.
[4] Gagnon D, Romero SA, Cramer MN, Jay O, Crandall CG. Cardiac and thermal strain of elderly adults exposed to extreme heat and humidity with and without electric fan use. JAMA 2016;316(9):989-991. PMID:27599335; doi:10.1001/jama.2016.10550.
[5] Jay O, Cramer MN, Ravanelli NM, Hodder SG. Should electric fans be used during a heat wave? Appl Ergon. 2015;46(Pt A):137-143. PMID:25134988; doi:10.1016/j.apergo.2014.07.013.

Daniel Gagnon
Cardiovascular Prevention and Rehabilitation Centre
Montreal Heart Institute Research Centre, Montréal, QC, Canada
Département de pharmacologie et physiologie, Faculté de Médecine
Université de Montréal, Montréal, QC, Canada

Craig G. Crandall
Institute for Exercise and Environmental Medicine
Texas Health Presbyterian Hospital Dallas and
University of Texas Southwestern Medical Center, Dallas, TX, USA