Although plausible pathophysiological mechanisms link air pollution to arrhythmogenesis, among them altered autonomic tone, repolarization abnormalities, oxidative stress, myocardial ischemia, and increased intracardiac pressure (Link and Dockery 2010), definitive conclusions have not been reached as yet. Langrish et al. (2014) analyzed 13 double-blind randomized crossover studies and found no significant risk of arrhythmia attributable to acute controlled exposure to air pollutants. Three issues related to meteorological factors probably either confound or modify the short-term association between air pollution and cardiac arrhythmia.

First, several meteorological elements, including air temperature, atmospheric pressure, relative air moisture, and wind speed and direction, also are implicated in triggering ventricular (Čulic et al. 2004, 2005) and supraventricular (Čulic et al. 2012, 2013) arrhythmias independent of physical and emotional stress. In the short term, these meteorological factors may facilitate arrhythmias in susceptible patients by increasing circulatory load and thromboinflammatory processes (Čulic 2014).

Second, these same meteorological elements substantially influence concentrations of sulfur dioxide, carbon monoxide, nitrogen dioxide, ozone, and suspended particulate matter (Bertacini et al. 2012; Ilen and Selcic 2008; Ito et al. 2007). In addition, the greatest ozone production and pollution results from stable, dry, hot weather with high atmospheric pressure and low wind (Vanos et al. 2014).

Air pollution may increase human vulnerability to the effects of temperature, and temperature extremes, in turn, influence population vulnerability to air pollution (Burkart et al. 2013; Ren et al. 2006). Vanos et al. (2014) reported that cardiovascular and respiratory mortality due to short-term exposure to gaseous air pollutants was significantly modified by weather types and season. Alberdi et al. (1998) reported that both relative air moisture and air temperature are strongly related to daily mortality even after controlling for air pollution and influenza. Keatinge and Donaldson (2001) suggested that prolonged cold weather with less wind and rain may produce false associations between mortality and certain air pollutants.

Finally, strong mutual interrelations exist among the above-mentioned meteorological elements. Alberdi et al. (1998) pointed out the strong inverse association they observed between relative air moisture and air temperature as an important problem for regression analysis.

Langrish et al. (2014) caution against definitive acceptance of air pollution as an independent trigger of cardiac arrhythmias. However, the studies included in their analysis had no data on meteorological factors. It is likely that interactive effects among air pollutants and meteorological elements bias each other’s association with arrhythmias and other acute cardiac events. Therefore, further research of the health effects of atmospheric factors should continue in order to identify potentially harmful influences for the population as a whole as well as for its vulnerable subgroups.

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REFERENCES

Alberdi JC, Diaz J, Montero JC, Mirón I. 1998. Daily mortality in Madrid community 1986–1992: relationship with meteorological variables. Eur J Epidemiol 14(6):571–578; PMID:9794124.

Bartacini P, Dukic V, Ignaccolo R. 2012. Modeling the short-term effect of traffic and meteorology on air pollution in Turin with generalized additive models. Adv Meteorol, article ID 609283; doi:10.1155/2012/609283.

Burkart K, Canário P, Breitner S, Schneider A, Scherber K, Andrade H, et al. 2013. Interactive short-term effects of equivalent temperature and air pollution on human mortality in Berlin and Lisbon. Environ Pollut 183:40–49; doi:10.1016/j.envpol.2013.06.002.

Čulic V, Eterovic D, Miric D, Grgiæevic L, Lukin A, Fabijaniæ D. 2004. Triggering of ventricular tachycardia by meteorologic and emotional stress: protective effect of B-blockers and anxiolytics in men and elderly. Am J Epidemiol 161(11):1047–1058; doi:10.1093/aje/kvh325.

Čulic V, Silic N, Miric D. 2005. Triggering of ventricular ectopic beats by emotional, physical and meteorologic stress: role of age, sex, medications, and chronic risk factors. Croat Med J 46(6):894–906; PMID:16342342.

Čulic V, Silic N, Miric D. 2012. Triggering of supraventricular premature beats. The impact of acute and chronic risk factors. Int J Cardiol 158(1):112–117; doi:10.1016/j.ijcard.2012.04.059.

Čulic V, Silic N, Hodzic M. 2013. Triggering of supraventricular tachycardia by physical activity and meteorological factors. Int J Cardiol 168(4):4295–4300; doi:10.1016/j.ijcard.2012.04.195.

Čulic V. 2014. Inflammation, coagulation, weather and arrhythmogenesis: is there a link? Int J Cardiol 176(1):289–293; doi:10.1016/j.ijcard.2014.06.078.

Ilen I, Selcic AT. 2008. Investigating the impacts of some meteorological parameters on air pollution in Balkay, Kosovo. Environ Monit Assess 140(1–3):267–277; doi:10.1007/s10661-007-9865-1.

Ito K, Thurston GD, Silverman RA. 2007. Characterization of PM2.5, gaseous pollutants, and meteorological interactions in the context of time-series health effects models. J Exp Sci Environ Epidemiol 17(suppl 2):S45–S60; doi:10.1038/sj.ess.7500627.
China (Langrish et al. 2014). Exposure to neither air pollutants in isolation nor ambient Beijing air pollution was associated with cardiac dysrhythmia in either patients with coronary heart disease or healthy volunteers. As such, our studies do not address the influence of meteorological conditions on an individual’s risk of cardiac arrhythmia; indeed, the meteorological conditions in Beijing were fairly constant throughout our studies (Langrish et al. 2009, 2012).

There is emerging evidence that cardiovascular morbidity and mortality is associated with meteorological and environmental conditions, and we agree with Čulić’s statement that further research on the health impacts of atmospheric factors is important both for public health and for better understanding the interaction between urban air pollution and external influences.

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REFERENCES
Brook RD, Rajagopalan S, Pope CA III, Brook JR, Bhatnagar A, Diez-Roux AV, et al. 2010. Particulate matter air pollution and cardiovascular disease. An update to the scientific statement from the American Heart Association. Circulation 121:2331–2378; doi:10.1161/CIRC.0b013e3181f8d1c1.
Čulić V. 2015. Atmospheric interactions and cardiac arrhythmias. Environ Health Perspect 123(8):A144; doi:10.1289/ehp.1409636.
Hoek G, Krishnan RM, Beelen R, Peters A, Ostro B, Brunekreef B, et al. 2013. Long-term air pollution exposure and cardio-respiratory mortality: a review. Environ Health 12:43; doi:10.1186/1476-069X-12-43.

Langrish JP, Mills NL, Chan JK, Leseman DL, Aitken RJ, Fokkens PH, et al. 2009. Beneficial cardiovascular effects of reducing exposure to particulate air pollution with a simple facemask. Part Fibre Toxicol 6:8; doi:10.1186/1743-8977-6-8.
Langrish JP, Frampton M, Blomberg A. 2010a. Human exposure studies: In Cardiovascular Effects of Inhaled Ultrafine and Nanosized Particles (Cassee F, Mills N, Newby D, eds). Hoboken, NJ: John Wiley & Sons, 217–239.
Langrish JP, Mills NL, Donaldson K, Newby DE. 2010b. Response to Peter Joseph. Heart 96(8):472–473; doi:10.1136/hrt.2009.189308.
Langrish JP, Li X, Wang S, Lee MM, Barnes GD, Miller MR, et al. 2012. Reducing personal exposure to particulate air pollution improves cardiovascular health in patients with coronary heart disease. Environ Health Perspect 120(3):367–372; doi:10.1289/ehp.1103988.
Langrish JP, Watts SJ, Hunter AJ, Shah AS, Bosson JA, Unosson J, et al. 2014. Controlled exposures to air pollutants and risk of cardiac arrhythmia. Environ Health Perspect 122(7):747–753; doi:10.1289/ehp.1307337.
Lim SS, Vos T, Flaxman AD, Danaei G, Shibuya K, Adair-Rohani H, et al. 2012. A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010. Lancet 380(9859):2224–2260; doi:10.1016/S0140-6736(12)61766-8.