The Environment and Blood Pressure

Robert D. Brook, MD

KEYWORDS

• Air pollution • Temperature • Altitude • Noise • Hypertension • Cardiovascular risk

KEY POINTS

- Numerous environmental factors including cold weather, winter season, higher altitude, loud noises, and air pollutants can acutely increase blood pressure.
- Long-term exposures to many of these environmental factors may promote the development of chronic hypertension.
- Health care providers should be aware of these associations and take practical steps to monitor blood pressure closely during exposures to avoid worsening of hypertension.

Hypertension most often arises as a consequence of adverse lifestyle environmental factors (eg, high sodium intake, obesity) in the setting of an underlying polygenetic predisposition.[1] In modern-day societies it is a burgeoning public health epidemic whereby high blood pressure (BP) now accounts for nearly half of all cardiovascular events and is the leading risk factor for morbidity and mortality worldwide.[1,2] Fortunately, many medications and behavioral interventions (eg, reduced sodium intake, weight loss) have proven to lower BP and reduce cardiovascular risk in numerous clinical trials.[1] On the other hand, far less attention in clinical practice has been paid to the importance of several additional environmental factors also associated with high BP.[3] Mounting evidence shows that colder outdoor temperatures, winter season, higher altitudes, loud noises, and ambient air pollutants are each capable of elevating BP.[3] Although the individual BP-raising effects are generally modest (5–15 mm Hg), billions of people are affected daily given their omnipresent nature. Hence, the adverse impacts on overall BP control and cardiovascular risk at the global public health level are likely substantial. This review discusses the evidence linking exposures to several environmental factors with high BP and briefly outlines the potential implications for clinical practice.[3]

COLD AMBIENT TEMPERATURE AND WINTER SEASON

Colder outdoor temperature levels increase BP over a few hours to days (**Table 1**).[3–13] A wide range of studies across many populations and climates has consistently reported an inverse association between BP and ambient temperature during the preceding few days.[3–10,14–24] In a large study of more than 500,000 people across China, a 10°C colder temperature was associated with a 5.7-mm Hg increase in systolic BP.[14] Compared with summer, systolic BP was approximately 10 mm Hg higher during winter seasons. In Michigan, similar associations were observed among 2078 cardiac rehabilitation patients. A reduction in outdoor temperature levels by 10.4°C during the prior 1 to 7 days promoted a 3.6-mm Hg increase in systolic BP.[21] Several additional recent studies are notable for reporting similar findings including in patients with cardiovascular disease,[15] individuals residing in rural China (eg, 13% lower hypertension control rate during winter),[16] and in Dutch (n = 101,377)[18] and Italian populations.[19,20]

Disclosures: The author has nothing to disclose.
Division of Cardiovascular Medicine, University of Michigan, 24 Frank Lloyd Wright Drive, PO Box 322, Ann Arbor, MI 48188, USA
E-mail address: robdbrok@umich.edu

Cardiol Clin 35 (2017) 213–221
http://dx.doi.org/10.1016/j.ccl.2016.12.003

Table 1
Environmental exposures and blood pressure

	Exposure Effect on Blood Pressure	Possible Mechanism(s)
Temperature	Overall: Inverse association	Thermoregulation-mediated vasoconstriction
Cold	Colder ambient temperature increases BP	HPAA and SNS activation, sodium retention Impaired endothelial-dependent vasodilatation
Heat	Warmer daytime associated with higher nocturnal BP	Possibly reduced sleep quality
Season	Overall: Winter associated with higher BP	Cold-induced mechanisms (above)
Winter	BP may be 5–10 mm Hg higher during winter.	Possible additional alterations may play roles: lower vitamin D, reduced activity, weight gain, shifts in fluid balance (aldosterone increase), and increased arterial stiffness
Geography	Overall: Higher altitude (>2500 m) raises BP	Altitude-induced hypoxemia activates the chemoreflex causing increased SNS and adrenal activity. Long-term acclimatization may lead to differing responses.
Altitude	Magnitude of effect may be impacted by race, acclimatization and rate of ascent, as well as duration of exposure.	Other factors such as cold and stress may also play a role. Long-term increases in red blood cell mass may contribute
Loud noises	Overall: Exposure to loud noises raises BP. Living near loud noise conditions (traffic) promotes chronic hypertension Numerous conditions implicated (traffic, airports)	Acute SNS activation, HPAA activation, endothelial dysfunction Possibly impaired sleep quality
Pollutants	Overall: Exposure to air pollutants raises BP	Acute activation of the SNS, systemic inflammation, or constituents reaching the systemic vasculature and promoting vasoconstriction
Ambient PM	Short and long-term PM exposures related to higher BP and increased hypertension onset	
Indoor PM	Multiple size ranges (fine, coarse, ultrafine) of PM and sources (urban, rural, biomass, and personal-level) of exposures implicated	Chronic exposures likely alter vascular tone via endothelial dysfunction or reduced arterial compliance due to PM-mediated inflammation and oxidative stress in the vasculature and in the central nervous system.
SHS	SHS exposure increases BP	
Other Exposures	Metals (lead, cadmium, arsenic, mercury), POP, bisphenol A strong odors, phthalates	Unclear

Abbreviations: PM, particulate matter; POP, persistent organic pollutants.

BP levels are often highest during winter months.[14] Some findings support that this chronic seasonal variation occurs above and beyond the acute impact of cold ambient temperature levels during the prior few days.[14,16,19] Moreover, an opposite hemodynamic effect of nocturnal ambient temperatures has been illustrated. Nighttime BP is found to be higher during summer (ie, warmer days) compared with winter months.[7,10,19,20] There are also potential differential effects of indoor versus outdoor temperature exposures and important considerations with regard to the possible