

# Definitions

**B**elow are definitions of words, phrases and terminology used within the Minnesota Extreme Heat Toolkit. It is important to note that some of the below definitions may differ outside the context of this toolkit. The definitions below clarify the usage of these words within the toolkit.

### **At risk**

People who are “at risk” are people who are at an increased risk for heat-related illnesses because they have certain risk factors, e.g., young children, people with pre-existing conditions or diseases.

### **Extreme heat event**

An extreme heat event is a period of time with abnormally high air temperatures and/or high dew point temperatures that affect human health. An exact definition of an extreme heat event varies by geographic location.

### **Extreme heat response plan/excessive heat annex**

A plan/annex for states, communities, governments, etc. to use in the event of an extreme heat event and contains information on strategies for preventing heat-related illnesses and identifies who will perform the strategies.

Modified from: [http://www.getreadyforflu.org/pg\\_glossary.htm](http://www.getreadyforflu.org/pg_glossary.htm)

### **Risk factor**

A risk factor is a characteristic that is statistically associated with, although not necessarily causally related to, an increased risk of morbidity (i.e., illness, disease, or condition) or mortality (i.e., death). For example, age is a risk factor for heat-related illnesses.

Modified from: <http://dictionary.webmd.com/terms/risk-factor>

### **Vulnerable population**

Subpopulations who are at increased risk of heat-related illnesses because they have certain risk factors.

Modified from: <http://www.hc-sc.gc.ca/dhp-mps/homologation-licensing/gloss/index-eng.php>

### **Ways the human body loses heat**

The human body loses heat in four different ways:<sup>1</sup>

**1. Radiation** – transfer of heat through electromagnetic waves (i.e., the body releases heat simply by being in an environment cooler than the body temperature). This is similar to heat leaving a woodstove. Radiation is a normal process of heat moving away from the body when air temperatures are lower than 68°F.<sup>2</sup>

---

<sup>1</sup> Platt M and Vicario S. (2010). Heat Illness in Rosen's Emergency Medicine: Concepts and Clinical Practice, 7th Ed. p1882-3.

**2. Evaporation** – conversion of liquid into a gas, which transfers heat energy to the gas and away from the skin (i.e., the body sweats and the evaporation of the sweat from the skin cools the body). During intense exercise, the body loses 85% of its heat through sweating.<sup>2</sup>

**3. Convection** – direct transfer of heat to water vapor molecules surrounding the skin. Heat is carried and dispersed from the body due to fluid motion. This is similar to sitting in front of a fan.<sup>2</sup>

**4. Conduction** – transfer of heat to air or water surrounding our bodies. Heat is lost when temperatures are lower than 68°F. This is heat lost from sleeping on the cold ground or when the body is submerged in water. Water causes more heat loss than air, so heat can be lost from the body very quickly when it is placed in cold water.<sup>2</sup>

As air temperature and humidity increases, the ability to cool the body through radiation is dramatically reduced. Under direct sunlight, heat is actually transferred back to the skin, reversing the process of heat transfer and warming the body. As air temperature rises, evaporation becomes the dominant mechanism of heat transfer through sweating; however as humidity increases, the ability to transfer heat and cool the body through evaporation is dramatically reduced. Convection is minimal when there is little movement in the air around the skin but can become more important as wind speed increases. Convection does not cool the body when air temperatures are high. Only 2% of our body heat is lost through conduction when surrounded by air; however, heat loss through conduction in water can be 25 times greater.

---

<sup>2</sup> Healthwise. (2011). WebMD: First Aid & Emergencies: Ways in Which the Body Loses Heat. Available online: <http://firstaid.webmd.com/ways-in-which-the-body-loses-heat>. Accessed April 16, 2012.



# References

- <sup>1</sup> Centers for Disease Control and Prevention (CDC). (2004). Extreme heat: a prevention guide to promote your personal health and safety. Available online: [www.bt.cdc.gov/disasters/extremeheat/heat\\_guide.asp](http://www.bt.cdc.gov/disasters/extremeheat/heat_guide.asp).
- <sup>2</sup> Centers for Disease Control and Prevention (CDC). (2006). Heat-related deaths---united states, 1999--2003. *Morbidity and Mortality Weekly Report*, 55(29), 796-798.
- <sup>3</sup> Luber, G & McGeehin. (2008). Climate Change and Extreme Heat Events. *Am J Prev Med* 2008;35(5).
- <sup>4</sup> Haines, A., Kovats, R., Campbell-Lendrum, D., & Corvalan, C. (2006). Climate change and human health: impacts, vulnerability, and mitigation. *Lancet*, 367(9528), 2101-2109. doi:10.1016/S0140-6736(06)68933-2
- <sup>5</sup> The Telegraph. (August 6, 2010). Russian heatwave kills 5,000 as fires rage out of control. <http://www.telegraph.co.uk/news/worldnews/europe/russia/7931206/Russian-heatwave-kills-5000-as-fires-rage-out-of-control.html>.
- <sup>6</sup> UN News Centre. (January 24, 2011). UN: 2010 among deadliest years for disasters, urges better preparedness. <http://www.un.org/apps/news/story.asp?NewsID=37357&Cr=disaster+reduction&Cr1>.
- <sup>7</sup> Huber, D., Gullede, J. (2011). Extreme weather & climate change: understanding the link and managing the risk. Center for Climate and Energy Solutions. <http://www.pewclimate.org/docUploads/white-paper-extreme-weather-climate-change-understanding-link-managing-risk.pdf>.
- <sup>8</sup> Palecki, M.A., S.A. Changnon, and K.E. Kunkel. (2001). The nature and impacts of the July 1999 heat wave in the midwestern United States: Learning from the lessons of 1995. *Bulletin of the American Meteorological Society* 82(7):1353-1368.
- <sup>9</sup> Minnesota Department of Health, Minnesota Environmental Public Health Tracking Program (personal communication, March 7, 2012).
- <sup>10</sup> Luber, G & McGeehin. (2008). Climate Change and Extreme Heat Events. *Am J Prev Med* 2008;35(5).
- <sup>11</sup> Western Regional Climate Center. (2011). Minnesota Temperature 1890 – 2010: 12 month period ending in December. Generated online November 2011. Available online: <http://www.wrcc.dri.edu/spi/divplot1map.html>
- <sup>12</sup> Zandlo, J. (2008). Observing the climate. Minnesota State Climatology Office. Available online: <http://climate.umn.edu/climateChange/climateChangeObservedNu.htm>
- <sup>13</sup> Galatowitsch, S., et al. (2009). Regional climate change adaptation strategies for biodiversity conservation in a midcontinental region of North America. *Biol. Conserv.*, doi:10.1016/j.biocon.2009.03.030
- <sup>14</sup> Hayhoe, K. et al. (2010). Regional climate change projections for Chicago and the US Great Lakes. *Journal of Great Lakes Research.*, doi:10.1016/j.jglr.2010.03.012
- <sup>15</sup> Minnesota State Climatology Office. (2010). 108 Years of Twin Cities Dew Point Temperature Records: 1902 – 2010. Available online: [http://climate.umn.edu/doc/twin\\_cities/mspdewpoint.htm](http://climate.umn.edu/doc/twin_cities/mspdewpoint.htm).
- <sup>16</sup> Relative humidity. (n.d.) The American Heritage Dictionary of the English Language, Fourth Edition. (2003). Retrieved April 17 2012 from <http://www.thefreedictionary.com/relative+humidity>
- <sup>17</sup> National Oceanic and Atmospheric Administration. (2005). Dew point temperature. Retrieved April 17, 2012 from <http://answers.noaa.gov/noaa.answers/consumer/kbdetail.asp?kbid=536&start=91>
- <sup>18</sup> Horstmeyer, Steve (2006-08-15). "Relative Humidity....Relative to What? The Dew Point Temperature...a better approach". Steve Horstmeyer, Meteorologist, WKRC TV, Cincinnati, Ohio, USA. Available online: <http://www.shorstmeyer.com/wxfaq/humidity/humidity.html>
- <sup>19</sup> Platt, M. & Vicario, S. (2010). Heat Illness. In Rosen's Emergency Medicine: Concepts and Clinical Practice, 7th Ed. p1882-3.
- <sup>20</sup> Minnesota State Climatology Office. (2011). Record Dew Point Temperature in the Twin Cities: July 19, 2011. Available online: [http://climate.umn.edu/doc/journal/dew\\_point110719.htm](http://climate.umn.edu/doc/journal/dew_point110719.htm).
- <sup>21</sup> Minnesota State Climatology Office. (2011). Record Dew Point Temperature for Minnesota. Available online: [http://climate.umn.edu/doc/journal/record\\_state\\_dew\\_point.htm](http://climate.umn.edu/doc/journal/record_state_dew_point.htm).
- <sup>22</sup> Kling, G.W., K. Hayhoe, L.B. Johnson, J.J. Magnuson, S. Polasky, S.K. Robinson, B.J. Shuter, M.M. Wander, D.J.

Wuebbles, D.R. Zak, R.L. Lindroth, S.C. Moser, and M.L. Wilson (2003). *Confronting Climate Change in the Great Lakes Region: Impacts on our Communities and Ecosystems*. Union of Concerned Scientists, Cambridge, Massachusetts, and Ecological Society of America, Washington, D.C. Available online: [http://ucsusa.org/assets/documents/global\\_warming/greatlakes\\_final.pdf](http://ucsusa.org/assets/documents/global_warming/greatlakes_final.pdf).

<sup>23</sup> U.S. Environmental Protection Agency. (2005). Heat island effect. U.S. Environmental Protection Agency. Available online: <http://www.epa.gov/heatisland/index.html>.

<sup>24</sup> National Weather Service. (2012). Service area map for the six National Weather Service stations serving Minnesota and Western Wisconsin. Available online: [http://www.crh.noaa.gov/images/mpx/nwsmn\\_wi\\_responsibility.gif](http://www.crh.noaa.gov/images/mpx/nwsmn_wi_responsibility.gif)

<sup>25</sup> Friedlein, M. National Weather Service Meteorologist - Twin Cities/Chanhassen, MN. (Personal communication, September 13, 2011)

<sup>26</sup> Friedlein, M. National Weather Service Meteorologist - Twin Cities/Chanhassen, MN. (Personal communication, August 29, 2011)

<sup>27</sup> Lugo-Amador N.M., Rothenhaus T., Moyer P. (2004). Heat-related illness. *Emerg Med Clin North Am*;22:315–27.

<sup>28</sup> Glazer, J.L.. (2005). Management of Heatstroke and Heat Exhaustion. *Am Fam Physician*. Jun 1;71(11):2133-2140. <http://www.aafp.org/afp/2005/0601/p2133.html>

<sup>29</sup> Kalkstein, L. S. and Greene, J. S. (1997). An Evaluation of Climate/Mortality Relationships in Large U.S. Cities and the Possible Impacts of a Climate Change. *Environ. Health Perspect.*, 105, 84-93.

<sup>30</sup> Semenza JC, Rubin CH, Falter KH, et al. (1996). Heat-related deaths during the July 1995 heat wave in Chicago. *N Engl J Med*;335:84 –90.

<sup>31</sup> Schwartz J, Samet JM, Patz JA. (2004). Hospital admissions for heart disease: the effects of temperature and humidity. *Epidemiology*;15:755– 61.

<sup>32</sup> Bernard SM, Samet JM, Grambsch A, Ebi KL, Romieu I. (2001). The potential impacts of climate variability and change on air pollution-related health effects in the United States. *Environmental Health Perspectives Vol 109, Supplement 2*, pp 199-209.

<sup>33</sup> Knowlton, K., et. al. (2004). Assessing Ozone-Related Health Impacts Under a Changing Climate. *Environmental Health Perspectives, Volume 112, Number 15*.

<sup>34</sup> World Health Organization (WHO) Europe. (2009). Improving public health responses to extreme weather/ heat-waves – EuroHEAT: Technical summary. Available online: [http://www.euro.who.int/\\_data/assets/pdf\\_file/0010/95914/E92474.pdf](http://www.euro.who.int/_data/assets/pdf_file/0010/95914/E92474.pdf).

<sup>35</sup> U.S. Environmental Protection Agency. (2011). Ground-level Ozone: Health and Environmental Effects. Available online: <http://www.epa.gov/air/ozonepollution/health.html>.

<sup>36</sup> Bernard SM, Samet JM, Grambsch A, Ebi KL, Romieu I. (2001). The potential impacts of climate variability and change on air pollution-related health effects in the United States. *Environmental Health Perspectives Vol 109, Supplement 2*, pp 199-209.

<sup>37</sup> World Health Organization (WHO) Europe. (2009). Improving public health responses to extreme weather/ heat-waves – EuroHEAT: Technical summary. Available online: [http://www.euro.who.int/\\_data/assets/pdf\\_file/0010/95914/E92474.pdf](http://www.euro.who.int/_data/assets/pdf_file/0010/95914/E92474.pdf).

<sup>38</sup> Bernard SM, Samet JM, Grambsch A, Ebi KL, Romieu I. (2001). The potential impacts of climate variability and change on air pollution-related health effects in the United States. *Environmental Health Perspectives Vol 109, Supplement 2*, pp 199-209.

<sup>39</sup> Changnon, S. A., & Kunkel, K. E. (1996). Impacts and responses to the 1995 heat wave: A call to action. *Bulletin of the American Meteorological Society*, 77(7), 1497.

<sup>40</sup> McAuliffe, B & Hughlett, M. (July 21, 2011). "Heat relief is coming, but too late for some." *StarTribune*. Available online: <http://www.startribune.com/local/125895693.html>.

<sup>41</sup> Bouchama A, Knochel JP. (2002). Heat stroke. *N Engl J Med*;346:1978–88.

- <sup>42</sup> Knowlton K, Rotkin-Ellman M, King G, Margolis HG, Smith D, and Solomon G, et al. (2009). The 2006 California heat wave: impacts on hospitalizations and emergency department visits. *Environ Health Perspect* 117:61-67.
- <sup>43</sup> Foster, K. G., Ellis, F. P., Dore, C. et al. (1976). Sweat Responses in the Aged. *Age and Ageing*, 5, 91-101.
- <sup>44</sup> Schifano P, Cappai G, De Sario M, Michelozzi P, Marino C, Bargagli AM, et al. (2009). Susceptibility to heat wave-related mortality: a follow-up study of a cohort of elderly in Rome. *Environ Health*; 8:50-.
- <sup>45</sup> Minnesota Department of Administration, Office of the State Demographer. (2012). Minnesota Population Projections by Age and Gender, 2010-2060. Available online: <http://www.demography.state.mn.us/resource.html?id=32539>.
- <sup>46</sup> Basu R, Ostro BD. (2008). A multicounty analysis identifying the populations vulnerable to mortality associated with high ambient temperature in California. *Am J Epidemiol.*;168(6):632-7.
- <sup>47</sup> Bridger, C. A., Ellis, F. P. and Taylor, H. L. (1976). Mortality in St. Louis, Missouri, during Heat Waves in 1936, 1953, 1954, 1955, and 1966. *Environ. Res.*, 12, 38-48.
- <sup>48</sup> Bytomski JR, Squire DL. (2003). Heat illness in children. *Curr Sports Med Rep.*;2(6):320-4.
- <sup>49</sup> Rowland T. (2008) Thermoregulation during exercise in the heat in children: old concepts revisited. *J Appl Physiol.*;105(2):718-24.
- <sup>50</sup> Null J. (2012) Hyperthermia Death of Children in Vehicles. Department of Geosciences, SFSU. Available online: <http://ggweather.com/heat/index.htm>. Accessed March 15, 2012.
- <sup>51</sup> McLaren C, Null J, Quinn J. (2005). Heat stress from enclosed vehicles: moderate ambient temperatures cause significant temperature rise in enclosed vehicles. *Pediatrics.*;116(1):e109-e12.
- <sup>52</sup> King K, Negus K, Vance JC. (1981). Heat stress in motor vehicles: A problem in infancy. *Pediatrics.*;68(4):579.
- <sup>53</sup> NOAA's National Weather Service. (2012) Heat: A Major Killer. Available online: <http://www.nws.noaa.gov/os/heat/index.shtml>.
- <sup>54</sup> O'Neill MS, Zanobetti A, Schwartz J. (2003). Modifiers of the temperature and mortality association in seven US cities. *Am J Epidemiol.*;157(12):1074-82.
- <sup>55</sup> Hajat S, Kovats RS, Lachowycz K. (2007). Heat-related and cold-related deaths in England and Wales: who is at risk? *Occup Environ Med.*;64(2):93-100.
- <sup>56</sup> Curriero FC, Heiner KS, Samet JM, Zeger SL, Strug L, Patz JA. (2002). Temperature and mortality in 11 cities of the eastern United States. *Am J Epidemiol.*;155(1):80-7.
- <sup>57</sup> Semenza JC, Rubin CH, Falter KH, Selanikio JD, Flanders WD, Howe HL, et al. (1996). Heat-related deaths during the July 1995 heat wave in Chicago. *N Engl J Med.*;335(2):84-90.
- <sup>58</sup> American Medical Association Council on Scientific Affairs. (1997). Heat-Related Illness During Extreme Weather Emergencies. Report 10 of the Council on Scientific Affairs (A-97). Presented at the 1997 AMA Annual Meeting.
- <sup>59</sup> Green H, Gilbert J, James R, and Byard, RW. (2001). An analysis of factors contributing to a series of deaths caused by exposure to high environmental temperatures. *The American Journal of Forensic Medicine and Pathology*, 22(2), 196.
- <sup>60</sup> Centers for Disease Control and Prevention. (2006). Heat-related deaths—United States, 1999-2003. *Morbidity and Mortality Weekly Report.*; 55(29), 796-798.
- <sup>61</sup> Baccini M, Biggeri A, Accetta G, Kosatsky T, Katsouyanni, K, et al. (2008). Heat effects on mortality in 15 European cities. *Epidemiology*, 19 (5), 711.
- <sup>62</sup> Kaiser R, Le Tertre A, Schwartz J, Gotway CA, Daley WR, and Rubin CH. (2007). The effect of the 1995 heat wave in Chicago on all-cause and cause-specific mortality. *American Journal of Public Health*, 97(Supplement 1), S158.
- <sup>63</sup> S. Vandentorren, P. Bretin, A Zeghnoun, L. Mandereau-Bruno, A. Croisier, C. Cochet, J. Ribéron, I. Siberan, B. Declercq and M. Ledrans. (2006). August 2003 Heat Wave in France: Risk Factors for Death of Elderly People Living at Home. *Eur J Public Health.*, 16 (6): 583-591.doi:10.1093/eurpub/ckl063



- <sup>64</sup> Swartz J. (2005). Who is sensitive to extremes of temperature?: A case-only analysis. *Epidemiology*, 16(1), 67.
- <sup>65</sup> Hansen A, Bi P, Ryan P, Nitschke M, Pisaniello D, and Tucker G. (2008). The effect of heat waves on mental health in a temperate Australian city. *Environmental Health Perspectives*, 116(1), 1369.
- <sup>66</sup> Bouchama, A., Dehbi, M., Mohamed, G. et al. (2007). Prognostic Factors in Heat Wave Related Deaths: A Meta-Analysis. *Arch. Intern. Med.*, 167, 2170-2176.
- <sup>67</sup> Thomas NS. (2002). Preventable Tragedies: Heat Disaster and the Elderly. *Journal of Gerontological Social Work*. 38:53-65.
- <sup>68</sup> Naughton MP, Henderson A, Mirabelli MC, Kaiser R, Wilhelm JL, Kieszak SM, et al. (2002). Heat related mortality during a 1999 heatwave in Chicago. *Am J Prev Med*;22:221–27.
- <sup>69</sup> U.S. Environmental Protection Agency. (2012). Heat island effect. Available online: <http://www.epa.gov/hiri/>
- <sup>70</sup> U.S. Environmental Protection Agency. (2006). Excessive heat events guidebook. Available online: <http://www.epa.gov/heatisland/about/heatguidebook.html>.
- <sup>71</sup> U.S. Census Bureau. (2000). Urban and Rural [6], (P002) for the state of Minnesota. Census 2000 Summary File 1 (SF1) 100-Percent Data. Available for download at <http://factfinder2.census.gov/>.
- <sup>72</sup> U.S. Environmental Protection Agency. (2006). Excessive heat events guidebook. Available online: <http://www.epa.gov/heatisland/about/heatguidebook.html>.
- <sup>73</sup> Bernard SM, McGeehin MA. (2004). Municipal heat wave response plans. *Am J Public Health*;94:1520-2.
- <sup>74</sup> U.S. Department of Education. (2012) Consolidated State Performance Reports (CSPR) for SY2008-2009. Available online: <http://www2.ed.gov/admins/lead/account/consolidated/index.html>.
- <sup>75</sup> U.S. Environmental Protection Agency. (2006). Excessive heat events guidebook. Available online: <http://www.epa.gov/heatisland/about/heatguidebook.html>.
- <sup>76</sup> Luber, G & McGeehin. (2008). Climate Change and Extreme Heat Events. *Am J Prev Med* 2008;35(5).