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Violence in hot weather: Will climate change exacerbate rates of violence in South Africa?

Worldwide, violence claims more than 1.4 million lives each year, accounting for 1 in 40 of all deaths globally.[1] Alarmingly, South Africa (SA) recorded a homicide rate of 35.8 per 100 000 people in 2017/18,[2] which is the second highest rate in sub-Saharan Africa and among the top 10 in the world, including among countries at war.[1]

While violence in SA has been attributed to the unique historical, social and economic characteristics of the country,[3] the potential contribution of physical environmental factors, such as heat, has largely been ignored. Understanding connections between heat and violence is increasingly important as we witness the warming of our planet, and anticipate more intense and longer-lasting heatwaves in the coming decades. Exposure to extreme heat is already common in many parts of SA; temperatures frequently exceed 40°C in Northern Cape Province, for example, but can also reach those levels in areas with a more temperate climate, such as Johannesburg. In this editorial, we examine evidence on the connections between temperature and interpersonal violence, and consider the implications of these connections for SA.

Evidence of interactions between heat and interpersonal violence

Meteorological conditions, especially temperature, can profoundly influence a person's physiology and behaviour. Heat exposure has a range of physiological sequelae, affecting levels of comfort, emotional stability and sense of wellbeing.[4] Being in an uncomfortably hot environment foments irritability and aggressive thoughts, and reduces positive emotions such as joy and happiness.[4,5] Men appear to be particularly sensitive to the effects of heat on aggression.[6] Hot weather also alters behaviours, for example resulting in people tending to congregate outdoors, with increased opportunities for contact crimes and violence.[7] Additionally, alcohol use, a potent trigger for violence, can increase during hot weather, while dehydration, more common on hot days, is associated with mood disturbance, confusion and anger.[8] It is therefore plausible that together these physiological and behavioural pathways may increase the likelihood of violence, particularly violence committed with the intention of harming other persons rather than violence where the aim is primarily to gain assets, such as robberies.

The potential for heat to trigger violence is supported by a number of population-level studies which found that warmer regions of the globe generally have the highest rates of violence, as do warmer parts of individual countries, even after controlling for potential confounding variables.[4] In most studies, rates of violence are highest in the summer months, especially in hot summers.[9,10] In addition, most time-series studies that compare temperature and rates of violence over different time periods indicate that levels of homicide and other forms of violence increase during hot weather, relative to colder periods in the same setting (Table 1). Associations between temperature and violence are not necessarily linear, however. Correlations are often curvilinear or an inverted U-shape, where rates of violence increase in a linear fashion once temperatures rise above moderately high levels, then plateau at a certain threshold, and decline as temperatures become unbearable and people prefer 'flight' or 'escape' rather than conflict.[11]

Importantly, the degree to which heat impacts on violence varies across settings and is contingent on factors such as gun control, gender inequalities, substance abuse and socioeconomic vulnerability. One study in the USA, for example, showed that associations between heat and violence were considerably stronger in areas with the highest levels of social disadvantage.[12] Some studies have also noted that women suffer higher levels of physical and sexual violence in hot weather.[13,14] This is especially concerning in SA given the already high background levels of violence against women and a femicide rate among the highest in the world.[15] Of note, the pathways leading to these forms of violence are complex and driven by a number of factors, especially social norms that cast aggression and dominance as defining traits of masculinity.[16] Raised temperatures alone therefore cannot explain elevated levels of gender-based violence, but may rather act as a trigger for individual violent episodes.

Surprisingly few studies have examined the impact of temperature on rates of violence in SA, despite a wealth of available data. A study using data from all 1 158 police wards in SA documented higher levels of violence, including homicides, during periods of high temperature.[17] In Tshwane, Gauteng Province, a study assessed 5 years of temperature and crime data and found that the mean number of violent crime incidents was about 50% higher on high-temperature days compared with low-temperature days and random days selected from the dataset after the warmest and coldest days had been extracted.[18] Another study in the same area noted seasonal patterns in crime, with violence most frequent in the summer months.[10] Seasonal quirks, however, such as elevated alcohol consumption and behavioural changes around Christmas, may partially explain the findings of the latter study.

Heat-related violence in SA: Implications for policy and research in a warming climate

Climate change brings concerns about heat-related violence to the fore. We illustrate this by summing evidence on the associations between temperature and homicides, and outlining the potential implications of those findings for SA (Table 1). Sixteen articles were located through targeted searches of Google Scholar and from experts in the field.

Nine of the 16 studies reported an increase in homicides with a rise in temperature. While the remaining studies did not detect a significant association, they were all in the direction of a positive effect. Effect size ranged widely, from small effects in some studies in the USA to an estimated 17% increase in homicides per year in Africa were the temperature to increase by 1°C.[19] Based on the findings of these studies and using a conservative estimate of a 4 - 5% increase in homicides per degree rise in temperature, we estimate that the current number of homicides per year in South Africa (20 336)[2] will increase by between 800 and 1 000 should the temperature in the country rise by 1°C. Additional modelling work using empirical data in SA is needed to refine this estimate and to adjust for other mediating factors.

The heat-violence nexus has important implications for policy and research in SA. Firstly, analysis of existing data could identify specific areas and populations at high risk for heat-related violence.

Table 1. Associations between temperature and homicide rates in 16 studies

Author, date	Years of study	Study population	Study results (changes in homicide rates with temperature)	Direction of effect
Harp and Karnauskas, 2018[25]	1979 - 2016	USA, 49 states	In 60 comparisons (5 regions of the country, each over 12 months), 6 had a significant positive effect, and a further 44 were NS, but in a positive direction	NS, but in direction of effect
Blakeslee and Fishman, 2018[26]	1971 - 2000	India, whole country	Percent change per 100 000 people with a temperature 1 SD above the long-run mean: 1990 - 2000 3.6% (p<0.05), 1980 - 1990 –0.2% (NS), 1970 - 1980 4% (NS). Pre-monsoon 0.1% (NS), monsoon 2.1% (NS), post-monsoon 0.1% (NS)	NS, but in direction of effect
Bruederle *et al.*, 2017[17]	2001 - 2012	SA, whole country	Coefficient = 0.015 (p<0.01), based on 418 327 murders in all 1 158 police wards	+
Hu *et al.*, 2017[27]	2009 - 2014	China, Tanshan	Regression analysis R^2=0.10 (p<0.05)	+
Mapou *et al.*, 2017[28]	2009 - 2013	USA, Chicago, Houston, Philadelphia, Seattle	Homicide rates 85% higher in 75th temperature percentile than in 25th (95% CI –53 - 731; p=0.38)	NS, but in direction of effect
Michel *et al.*, 2016[29]	2007 - 2013	USA, Maryland, Baltimore	Correlation coefficient r=0.071 per day (p=0.002). Incident rate ratio per day for a 1°C increase, controlling for other weather variables = 1.01 (95% CI 0.997 - 1.02; p=0.12)	NS, but in direction of effect
Mares and Moffett, 2016[19]	1995 - 2012	57 countries across the world	Increase in homicides per 1°C increase a year: globally 5.9% (p<0.05), Africa 17.9% (p<0.05), North America, Australia, New Zealand 2.8% (p<0.05), Asia 1.8% (NS), Europe 1.8% (NS), former USSR –0.3% (NS), Latin America 4.4% (NS)	+
Mares, 2013[30]	1990 - 2009	USA, St Louis	0.73% (NS) increase in homicides per 1°F per year. Annual homicides (18 906) would rise by 138/year	NS, but in direction of effect
Ranson, 2012[31]	1960 - 2009	USA, 49 states	Compared with temperatures of 60 - 69°F, homicides per day increased by 0.001 at 80 - 89°F (p<0.05) and by 0.002 per day at 90 - 99°F (p<0.05). No change at a temperature at ≥100°F. An inverted U with inflection at 100°F. Between 2010 and 2099, climate change may cause an additional 23 855 - 29 894 homicides (estimates from two climate models), a 3.1% increase.	+
Gamble and Hess, 2012[32]	1993 - 1999	USA, Texas, Dallas	Mean daily rate for homicide 0.06 per 100 000; 0.00059 (p<0.01) increase per day for every 1°F increase in mean temperature. Inverted U-shape with inflection point at 90°F	+
McDowall *et al.*, 2012[33]	1977 - 2000	USA, 88 cities	Coefficient = 0.017 (NS)	NS, but in direction of effect
Anderson and DeLisi, 2011[34]	1950 - 2008	USA, whole country	4.19 additional serious and deadly assaults per 100 000 people for a 1°F increase in average annual temperature (p<0.05). 12 780 additional serious deadly assaults per year	+
Simister J and van de Vliert, 2005[35]	1977 - 2001	Pakistan, whole country	Regression coefficient = 0.0085 (p<0.01). Approximately linear correlation, no decline at higher temperatures	+
Ceccato, 2005[9]	Jul 2001 - Jun 2002	Brazil, São Paulo	Ordinary least-squares regression coefficient = 0.16 (p<0.05). Homicides tended to be highest on hot evenings during warm weekends	+
Rotton and Cohn, 2003[36]	1960 - 1998	USA, whole country	Many homicides at low and at high temperatures (homicides at low temperatures driven by high rates of homicide in Alaska). Homicides regression coefficient = 0.02 (NS). U-shaped with a minimum at 50.6°F	NS, but in direction of effect
Anderson *et al.*, 1997[14]	1950 - 1995	USA, whole country	Regression coefficient = 0.46 (p<0.05). Annual increase in homicides and serious assaults = 3.68/100 000 people for a 1°F increase (p<0.05). Linear, no threshold effect noted	+

NS = not significant; SD = standard deviation; CI = confidence interval; SA = South Africa.

A more detailed understanding of heat-violence pathways could help identify practical ways of ameliorating the 'felt effects of heat' and thus violence in these 'hot spots'. For example, air conditioning and fans could be used in 'cooling zones' operating in selected areas in specific workplaces, schools and prisons at high risk. This hypothesis may be worth testing given the potential scale of the problem in SA. Evidence from a study in the USA also lends support to the hypothesis. In that study, aggressive crime rates were lower in neighbourhoods where air conditioning use was more frequent.[20]

Secondly, a more nuanced understanding of heat-health interactions could help inform measures taken during heatwaves, where, for example, the police force could be primed to expect more cases of violence on days with high temperatures. Similarly, health services, especially trauma units, could prepare for an increased number of assault cases. As an aside, people with mental health disorders require specific attention during heatwaves, owing to links between mental health and violence, and also because many studies have noted connections between suicide rates and high temperatures.[21] Climate services could therefore incorporate messaging on violence prevention and on the effects of heat on mental health into their public communication during heatwaves.

Heat-aggression pathways may also impact on road traffic injuries, especially among young male drivers.[22,23] This association warrants further investigation. It may, for example, be worth evaluating whether providing air conditioning in combi taxis during heatwaves would reduce driver aggression and improve driver performance. Lastly, quantifying the burden of climate-sensitive conditions, such as violence, could help mobilise support for initiatives to counter the brown energy policies of the SA government.

Conclusions

Evidence increasingly indicates that the propensity for interpersonal violence may increase in uncomfortably hot temperatures. Countries like SA, which already have high levels of violence and a rapidly warming climate, may be particularly vulnerable to this under-appreciated consequence of climate change. There may be a considerable increase in the number of cases of homicide and other forms of violence per year should the mean temperature rise by 1°C, signalling the potential for an even greater burden of violence, centred on already vulnerable groups. Moreover, other consequences of climate change, such as extreme weather events, 'eco-migration' and conflict over food and water, could in themselves raise levels of collective violence and transnational conflict.[24]

Importantly, physical environmental triggers of violence, such as heat, are set against the backdrop of complex social processes, poor governance and historical circumstances that influence violence in SA.[3] Clearly, more detailed assessments are required of the linkages between heat and violence in SA, and interactions between these and other factors. Such analyses may have important practical implications for violence-prevention strategies in the country, and indeed globally.

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