

# The relationship between extreme heat and ambulance response calls for the city of Toronto, Ontario, Canada<sup>☆</sup>

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## Abstract

Concern over the impact of extreme heat upon human health has increased in recent years. Though much research has evaluated the relationships between the two, few studies have attempted to quantify this vulnerability on a sub-metropolitan area level. Using a Geographic Information System (GIS), ambulance calls for a 4-year period from 1999 to 2002 was analyzed in relation to extreme heat for the city of Toronto, Ontario, Canada.

Ambulance response calls were plotted on a map to understand the spatial variability of where calls significantly increase above normal levels during oppressively hot days. Census data were used to identify the demographic characteristics of the population within these areas. Statistical tests were also used to assess the degree of correlation among different meteorological variables and the ambulance call data.

Over the 4-year period, the average number of ambulance calls increases by 10 percent over normal levels on those days considered oppressively hot. A change in the spatial pattern of calls also occurs on such days. The urban core, with the greatest density of calls, experiences the greatest absolute percentage increase in calls from normal on oppressive days. However, it is some areas of the city located along the shore of Lake Ontario, where a high majority of the population goes to cool down, that demonstrate the greatest percentage increase in calls. Other areas of the city exhibiting an increase in calls are located within industrial and recreational areas.

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## 1. Introduction

Heat is the deadliest of all atmospheric hazards (National Center for Environmental Health, 2004). Leiker (2002) estimated that heat claimed the lives of at least 65 000 Americans during the 20th Century. In the 40-year period from 1936 through 1975, the National Weather

Service (2000) estimated that the effects of heat may have brought about nearly 20 000 deaths in the United States. The National Climatic Data Center (2002) estimated that 10 000 deaths occurred from hot weather during the summer of 1980 alone. These findings, in addition to several notable tragic heat waves, have encouraged researchers to more thoroughly evaluate the relationship between heat and human health.

Most research has focused upon analyzing mortality data, specifically within urban areas, which are generally warmer than adjacent rural areas (Oke, 1981). Factors determining how an urban area is affected by oppressively hot weather may include city location, heat-island magnitude, and housing conditions (Sheridan and Kalkstein, 1998). Cities located in the middle latitudes, where summer brings irregularly occurring but intense heat waves, demonstrate the strongest response to heat stress (e.g., Kalkstein and Davis, 1989; Sheridan and Kalkstein, 2004).

*Abbreviations:* GIS, Geographic Information System; USA, United States of America; THHA, Toronto Heat-Health Alert System; EDT, Eastern Daylight Time;  $T_{a17}$ , Apparent temperature at 1700 in degrees Celsius

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Though mortality outside urban areas has been much less studied, an examination of heat vulnerability on a county level across Ohio (USA) found statistically significant increases for heat-related mortality in rural and suburban areas at a rate greater than urban areas (Sheridan and Dolney, 2003).

Other research has attempted to identify the most heat-vulnerable subsets of the population. Many of these studies concur that heat-related mortality is greatest among infants, elderly, people with pre-existing illnesses, low-income groups, and varies considerably across sex and race (e.g., Smoyer-Tomic and Rainham, 2001; Whitman et al., 1997; Kalkstein and Davis, 1989).

As mentioned, these studies base their results on analyses performed using mortality data, with the exception of a few using hospital admission data (e.g., Semenza et al., 1999; Rydman et al., 1999). Overall, heat and human health research is lacking analysis involving morbidity data, largely because adequate data are often difficult to obtain. Research involving mortality data has identified characteristics that can be associated with one's level of vulnerability to extreme heat. Results from analyses involving morbidity data, especially those available on a smaller spatial scale, could provide additional insight by identifying locations where the population may more likely experience the effects of excessive heat. The addition of these results can provide much better spatial resolution in the human response.

This study presents a spatial and temporal analysis of four summers of ambulance call data on oppressively hot days for the city of Toronto, Ontario, Canada. A geographic information system (GIS) was used to plot the location of those ambulance calls occurring on oppressively hot days based on the latitude and longitude of each call. This allowed for the identification of those areas of the city where ambulance calls significantly increase beyond normal levels on oppressively hot days. Census variables were also mapped allowing for the identification of those populations that reside within areas where ambulance calls increase most significantly.

## 2. The Toronto heat-health alert system

Kent et al. (2002) found that in an average year, at least 42 residents of Toronto die from exposure to summer heat. In response to this vulnerability, Toronto is one of an increasing number of cities across North America to develop and implement hot weather response plans to mitigate heat-related illness and death (Sheridan and Kalkstein, 2004). The Toronto Heat Health Alert (THHA) system is one component of these mitigation plans. This web-based system forecasts the likelihood of oppressively hot weather based on previous research associating certain meteorological conditions with an increased probability of negative health impacts. These conditions can be predicted 48 h in advance based on meteorological forecasts submitted by Environment Canada. The system has two levels:

it recommends a heat emergency when, based on algorithms developed using historical data, forecast weather conditions are associated with at least a 90 percent likelihood of excess mortality (i.e., more deaths than would be expected on a normal day) and a heat alert when the forecast likelihood of excess mortality is at least 65 percent. Toronto Public Health and Environment Canada incorporate the system's output in their ultimate decision whether to call a heat emergency, a heat alert, or neither. Signaling a heat alert or a heat emergency triggers a hot weather response (Toronto Public Health, 2001), which includes:

- community agencies working with those populations most vulnerable, including the elderly, isolated seniors, and the homeless, to advise them of extra precautions to take;
- the Red Cross operating a 24-h help line to answer heat-related questions from the public and respond to requests to check on seniors at risk; and
- the opening of cooling centers (heat emergency days only).

## 3. Materials and methods

This study incorporated three main datasets: ambulance-call, meteorological, and census data. A total of 549 884 ambulance calls across 4 years (1999–2002) for the city of Toronto were obtained. For each call, the following variables were utilized:

- latitude;
- longitude;
- response date;
- priority description:
- *Echo*: Serious, potentially life-threatening emergency calls involving illness or injury manifested by extreme breathing difficulties which are identified immediately (2001 and 2002 only).
- *Delta*: Serious, potentially life-threatening emergency calls involving illness or injury.
- *Charlie*: Potentially serious emergency calls involving illness or injury.
- *Bravo*: Potentially serious and unknown type emergency calls involving illness or injury.
- *Alpha*: Less serious emergency calls involving illness or injury.

As the echo priority code was added midway through this study's period of analysis, and is defined as a subset of the original delta category, calls coded as either echo or delta were grouped together for analysis.

For the sake of confidentiality, ambulance call data were not provided with individual demographic information. Thus, in order to help understand the local demographics of the city of Toronto, 1996 census data were provided by Statistics Canada to aid in analysis. While the local demographics do not necessarily reflect those needing an ambulance, it is the best tool available. The following census variables were thus analyzed on the census-tract level:

- age/sex;
- education level;
- ethnicity;
- labor force participation;
- language;
- immigration;

- income;
- time-period housing constructed;
- total population.

These variables were used to assess whether an increase in calls on oppressively hot days could potentially be attributed to the demographic make-up of that area.

An initial citywide analysis of the ambulance data was performed to determine the mean number of calls occurring on a daily and yearly basis. Data were then stratified into several subsets: weekdays and weekends were analyzed separately, as were heat alert days, heat emergency days, and days that were neither. Note that the classification of “oppressive” days as either a heat alert or heat emergency was based on the output from THHA system and not Toronto Public Health’s ultimate decision. Calls were analyzed collectively, as well as stratified by priority code. Following initial analyses, call totals were regressed against several meteorological variables (observed at Pearson International Airport, 27 km northwest of downtown) to evaluate the influence these individual variables have on ambulance activity. These variables included:

- temperature at 0500 Eastern Daylight Time (EDT);
- temperature at 1700 EDT;
- dew point at 1700 EDT;
- apparent temperature at 1700 EDT (defined according to Steadman, 1979).

The spatial variability of ambulance calls on oppressively hot days was then analyzed using a GIS. Within the GIS, the locations of each ambulance call were plotted based on their latitude and longitude. A random sample was taken from the ambulance calls for which supplemental street name information was provided, to confirm that the latitude and longitude did correspond to the correct street. The data were then reduced to include only those calls occurring from 1 May to 30 September for each year, coinciding with the operation of the THHA system. Calls with no latitude or longitude coordinates were eliminated from the dataset (approximately .8 percent of all calls). Separate datasets were created to represent both weekdays and weekends in order to have a comparison of days when the population is more likely to be away from home (weekdays) with those when the population is more likely to be at home (weekends). All holidays were included in the weekend dataset. After all necessary query selections were executed, eight separate subsets for each year and all years combined were created:

- non-alert, non-emergency weekdays;
- weekday heat alerts;
- weekday heat emergencies;
- weekday heat alerts/heat emergencies;
- non-alert, non-emergency weekends;
- weekend heat alerts;
- weekend heat emergencies;
- weekend heat alerts/heat emergencies.

For each of these subsets, the mean daily density of ambulance calls for all days was plotted per square kilometer unit using ArcGIS. A baseline density was then calculated for all days that were not considered heat alerts or heat emergencies. Once these density calculations were completed, differences (both in terms of absolute and percentage changes) from the baseline density were calculated for each subset. For example, the mean density of weekend heat-alert days for all 4 years combined was divided by the mean density of weekend non-alert and non-emergency days for all 4 years combined to provide a ratio. From this, the locations where ambulance calls significantly increase beyond normal levels on heat alert and emergency days within the city of Toronto were determined. Though seasonal stratification could yield additional results, data were not stratified by month due to the small (4 years) sample size. Additionally, statistically significant seasonal differences were not observed. Two-

sample difference-of-means tests (equal variance assumed) were performed to assess whether differences in mean ambulance activity across the subsets described above are statistically significant.

The period of analysis in this study included a visit by Pope John Paul II as part of an 11-day celebration of World Youth Day (23 July to 3 August 2002). Due to the temporary increase in population, all analyses in this study were run both inclusive and exclusive of this period. However, as results between the two separate analyses were nearly identical, the results presented here include the 11-day period.

## 4. Results

### 4.1. Citywide analysis

The mean daily number of ambulance calls during the summer months increases each year over the 4-year period (Fig. 1). During this time, there are an average of 515 ambulance calls occurring on a weekday, and an average of 506 calls on weekend days (Table 1). Similar to the mortality increases observed in Toronto on hot days (Kent et al., 2002), ambulance call totals increase as well. On weekdays, during heat alerts and heat emergencies, the mean number of calls increases to 554 and 578, respectively. These means represent statistically significant ( $P < .05$ ) 8 and 12 percent increases above the mean number of calls occurring on non-alert and emergency days. During the weekend, the mean daily number of calls during heat alerts is 573, with an average of 517 during heat emergencies. The 14 percent increase in heat alert calls above non-heat alert and emergency calls is statistically significant while the 3 percent increase in heat emergency does not demonstrate significance.

Aside from the overall increase in ambulance calls, each of the priority levels was examined separately at a citywide level to evaluate whether a disproportionate share of the heat-related increase in calls is in the most- (echo/delta) or least- (alpha) life threatening priority level. Increases during heat emergencies range from 8 to 11 percent across the different priority descriptions; heat alert increases range from 7 to 14 percent (Table 2). As increases in calls considered the least threatening are not statistically significantly different from the increase in potentially life-threatening calls, no distinction among the levels is made in subsequent analyses.

Using Toronto meteorological data, the relationship between atmospheric variables and the response in ambulance calls was also evaluated. For the four variables tested, all were associated with a statistically significant correlation with ambulance calls ( $P < .01$ ). The apparent temperature has the highest correlation coefficient ( $r$ ) of .351, while the dew point has the weakest positive relationship (.230). A multiple linear regression analysis was also performed on the data, yielding the following relationship:

$$\text{CALLS} = 444.9 - 11 \text{ DAY} + 3.1(T_{a17}) \quad (R = .363),$$

where DAY is equal to 0 on weekdays and 1 on weekends/holidays, and  $T_{a17}$  is the apparent temperature at 1700 in degrees Celsius. The equation signifies that there are 11 fewer ambulance calls during the weekend, while for every

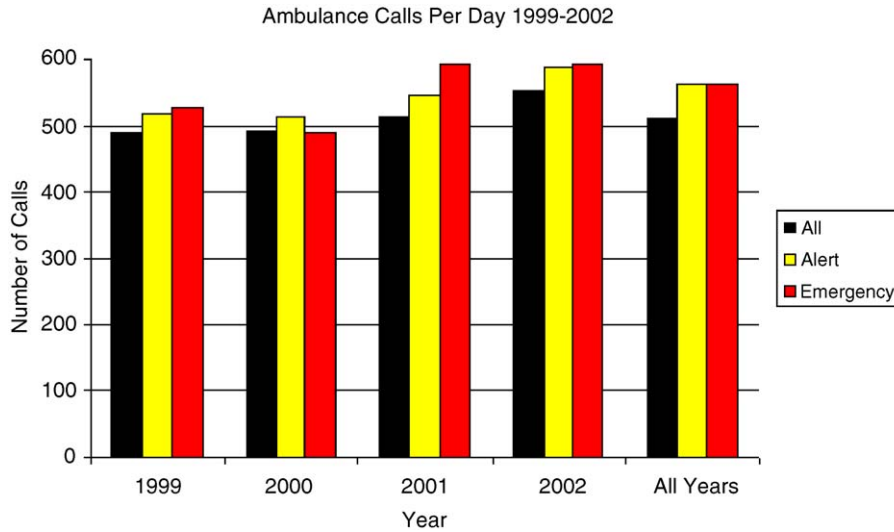


Fig. 1. Mean daily number of ambulance calls for Toronto, Ontario, Canada, by year.

Table 1

Mean daily number of ambulance calls during the period 1999–2002, by level of heat alert or emergency and whether the day was a weekday or weekend

Categorization of day	Weekday			Weekend		
	Mean	<i>n</i>	<i>P</i>	Mean	<i>n</i>	<i>P</i>
Heat emergency	578	15	<.001	517	6	.602
Heat alert	554	18	<.001	573	11	.003
Non-heat alert/emergency	511	389	—	501	173	—
All days	515	422	—	506	190	—

*P* refers to the level of significance when comparing the particular subset to its non-oppressive counterpart utilizing a two-sample difference of means test.

Table 2

Percentage increase of ambulance calls relative to normal, for all 4 years combined, by level of heat alert or emergency and severity rating

Categorization of day	Echo/Delta	Charlie	Bravo	Alpha
Heat emergency	11%	8%	10%	8%
Heat alert	7%	7%	11%	14%
Non-heat alert/emergency	–1%	–1%	–1%	–1%
Mean daily total	182.9	55.8	177.8	95.1

The increases during heat alerts and heat emergencies for all severity ratings are statistically significant ( $P < .01$ ) when compared to non-heat alert and heat emergency days (via two-sample difference of means test). Within each day categorization (e.g. heat emergency), the difference across the severity levels is not statistically significantly different from each other.

degree Celsius the apparent temperature at 1700 increases, there are approximately three additional ambulance calls.

## 5. Geographic information system (GIS) analysis

### 5.1. Overall mean distribution

Fig. 2 presents the mean distribution of weekday ambulance calls; the greatest call density by far lies within the urban core, where mean daily call density peaks at nearly 10 calls/km<sup>2</sup>. During the weekend, a change occurs

in the mean ambulance call distribution (Fig. 3). Though the peak call area remains within the urban core, a statistically significant drop ( $P < .01$ ) of up to 1.67 calls/km<sup>2</sup> appears there, with corresponding increases of up to 2.04 calls/km<sup>2</sup> in the residential areas neighboring downtown, especially to the west.

### 5.2. Weekday heat alerts and emergencies

The changes in weekday ambulance activity on the 29 heat alerts and emergencies for 1999–2002 is illustrated

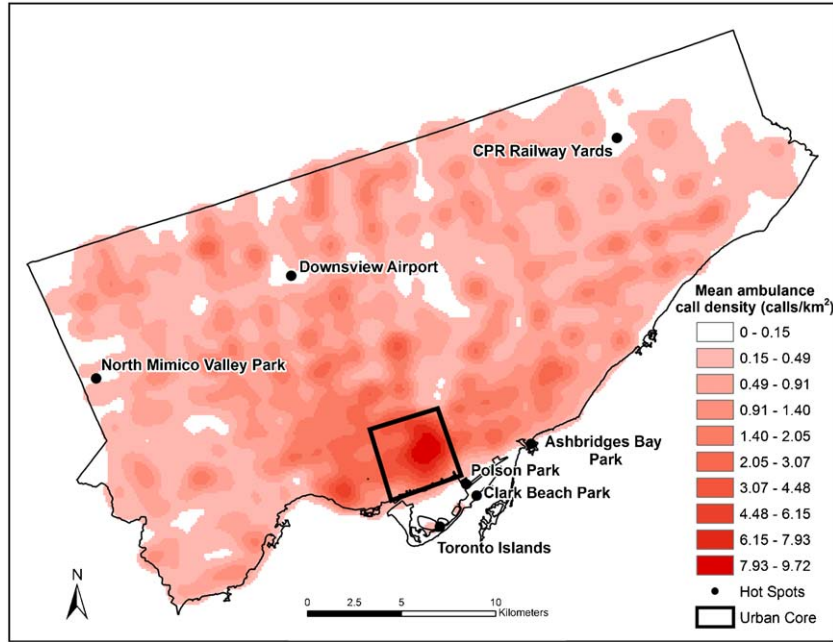


Fig. 2. Mean density of ambulance calls during weekdays (all analyses performed on a square kilometer grid) along with specific locations referred to in the text. Source: Streetline map provided by Land Information Toronto, 2002.

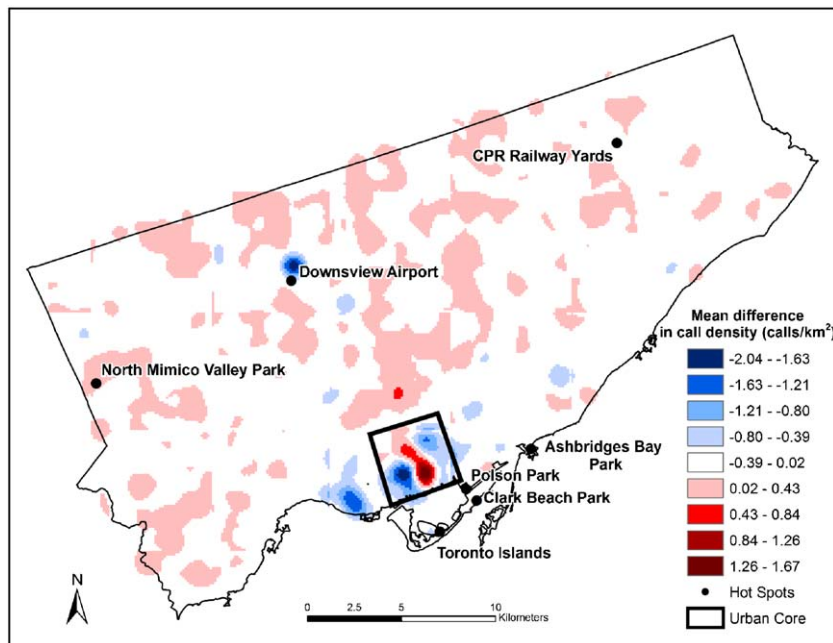


Fig. 3. Mean change in ambulance call density from weekday to weekend. Dark red areas denote locations where call density is greater during weekdays; dark blue areas represent those where call density is greater on the weekend.

utilizing both absolute (Fig. 4) and percentage (Fig. 5) changes. These two figures show striking differences in terms of where calls increase above normal levels. The greatest absolute increase in calls occurs in the urban core, whereas the greatest percentage increase occurs in other areas of the city. In evaluating absolute changes, increases are relatively small in number outside of the urban core as only one small area in the northwest shows a noticeable

increase (1.75 calls/km<sup>2</sup>), whereas mean daily call density increases up to 3.8 calls/km<sup>2</sup> within the urban core on heat alert and emergency days. Analyses upon solely the urban core (as depicted in the figures) yielded a statistically significant ( $P < .001$ ) 14 percent increase in weekday calls on oppressively hot days. In most other areas of the city, sample size is too small for any large-scale statistically significant regions to be identified.

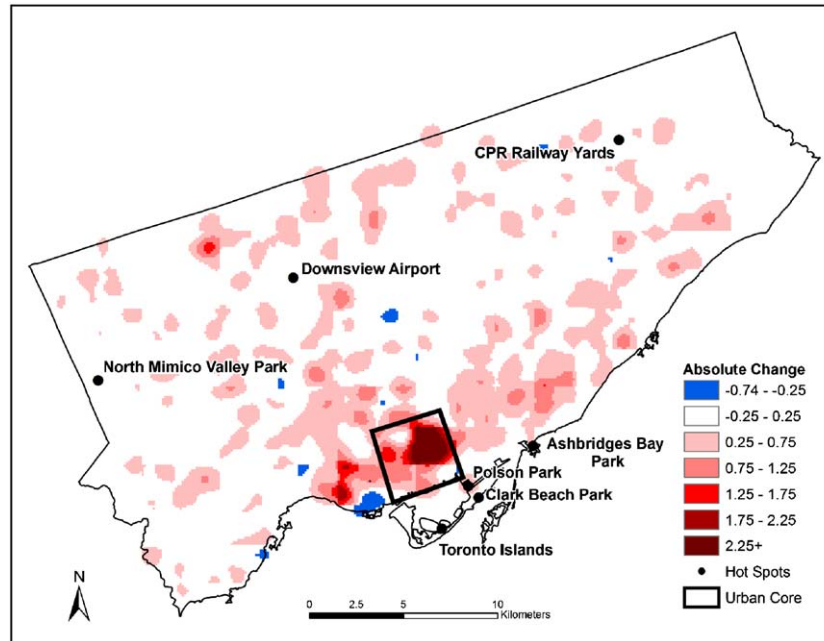


Fig. 4. Absolute change in the mean daily ambulance call density during weekday heat alerts and emergencies, compared to weekday non-heat alert and emergency days. Analysis performed on a square kilometer grid.

Conversely, the percentage increase map (Fig. 5) shows several “hot spots” (locations associated with ambulance calls above 250 percent of normal) on the outskirts of the city boundary, with a few hot spots within the inner city. While numerous hot spots occur, those discussed here are those that consistently appear when each year is analyzed separately (not shown) as well as with all years combined (Fig. 5). Within an industrial, commercial, and institutional area in the northwest is a prominent hot spot near North Mimico Valley Park. Another hot spot is located on Toronto’s southernmost tip, Toronto Island. Here, hot spots are found in utility and transportation areas, with a small portion of open space. Residences within this area are a combination of elderly and laborers, who generally reside in older housing. Additional hot spots are located along the lakeshore in the recreational areas of Polson, Clark Beach, and Ashbridges Bay Parks, with the former two collocated with an industrialized area containing a thermal generating station. One final hot spot appears in the northeast within the CPR Railway yards in a highly industrialized area surrounded by several small parks and schools. High immigrant, minority, and elderly populations comprise this area.

### 5.3. Weekend heat alert and emergencies

Analyses are also presented for the 21 weekend heat alerts and emergencies from 1999 to 2002 in terms of absolute (Fig. 6) and percentage (Fig. 7) changes. The only similarity between these two maps and Figs. 4 and 5 is the hot spot located in the northern part of the city. This spot near Downsview Airport is very evident on the absolute

change map as the mean daily call density increases up to 1.3 calls/km<sup>2</sup> on heat alert and emergency days. It encompasses institutional, industrial, and residential areas with an elderly and working population that has a high median income. No other significant areas demonstrate a substantial absolute decrease or increase as mean values across the city are within .25 calls/km<sup>2</sup> of non-heat alert and emergency days. Indeed, changes in ambulance activity on heat alert and heat emergency days within the urban core are not statistically significant on weekends.

In evaluating weekend percentage increases (Fig. 7), fewer significant changes are observed as many of the results are similar to those depicted on the weekday maps. The decrease within the urban core is particularly significant on heat emergency days, when ambulance call totals fall up to 60 percent below weekend mean levels. There are still several parts of the city where calls increase beyond 250 percent of normal, many of which are also hot spots during weekdays: Toronto Island, Polson and Clark Beach Parks, Ashbridges Bay Park, and the CPR Railway Yards. The North Mimico Valley Park hot spot during weekdays does not appear as a hot spot on weekends.

## 6. Discussion

### 6.1. Citywide results

The results presented here depict a citywide rise in ambulance calls on hot days that supports all previous research showing additional strain placed on human well-being during oppressive weather. The increase in ambulance calls of approximately 10 percent on heat alert and

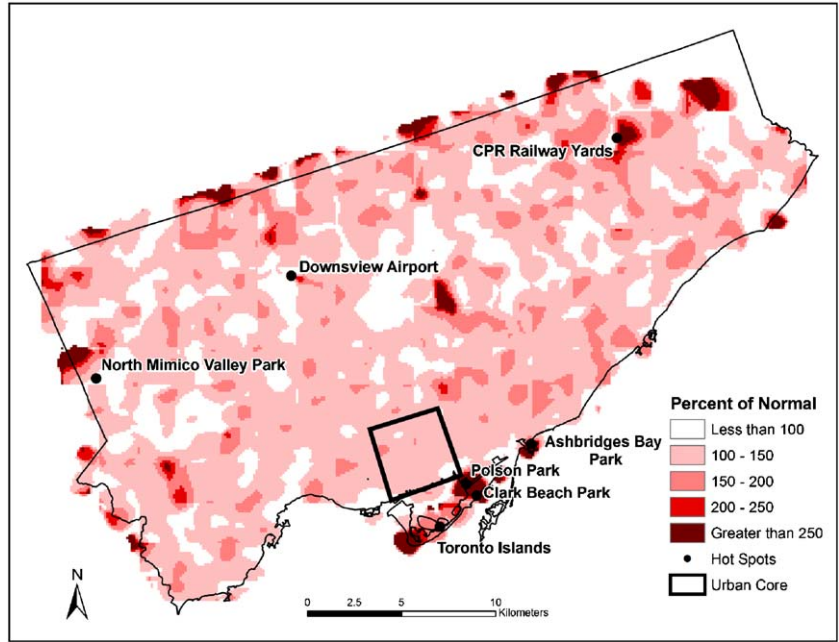


Fig. 5. Ratio of mean daily ambulance call density during weekday heat alerts and emergencies to call density on weekday non-heat alert and emergency days. Analysis performed on a square kilometer grid.

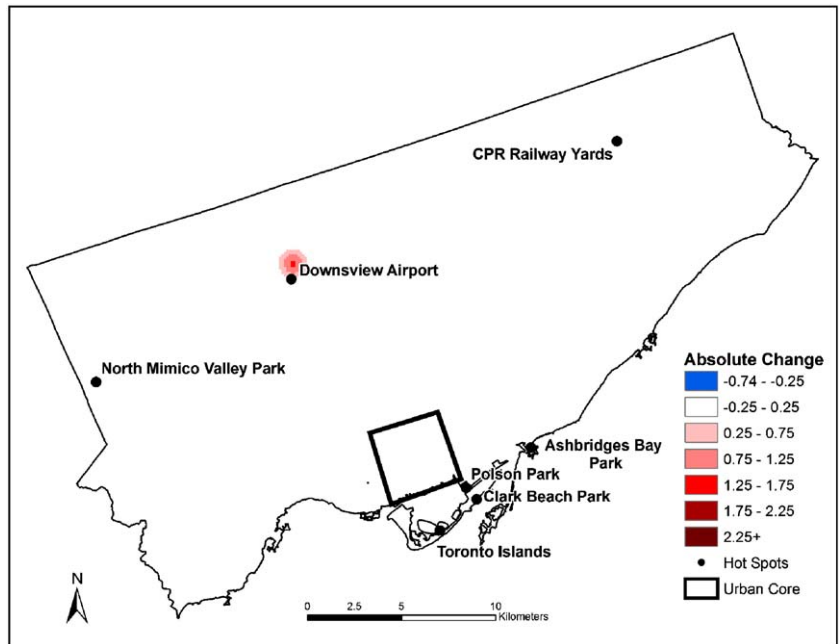


Fig. 6. Same as Fig. 4 except for weekends.

emergency days is similar to the 11 percent increase in hospital admissions [Semenza et al. \(1999\)](#) found during the week of the 1995 Chicago heat wave, and to the range of mortality increases typically seen in mid-latitude cities ([Sheridan and Kalkstein, 2004](#)).

In analyzing the results further, interesting differences between weekdays and weekends emerge. During weekdays, average citywide ambulance calls during heat alerts rise 8 percent, while during the more severe heat emergencies they increase an average of 12 percent above

the weekday normal. The progression of these increases is in line with the regression equation previously mentioned, which suggests that as the weather becomes more oppressive, ambulance calls should further increase in number. On weekends, however, while heat alerts are associated with a 14 percent increase in ambulance calls, heat emergencies only produce a 3 percent rise on average. This smaller increase on weekend heat emergency days may suggest that a greater percentage of the population stays home during these days, and takes the heat emergency into

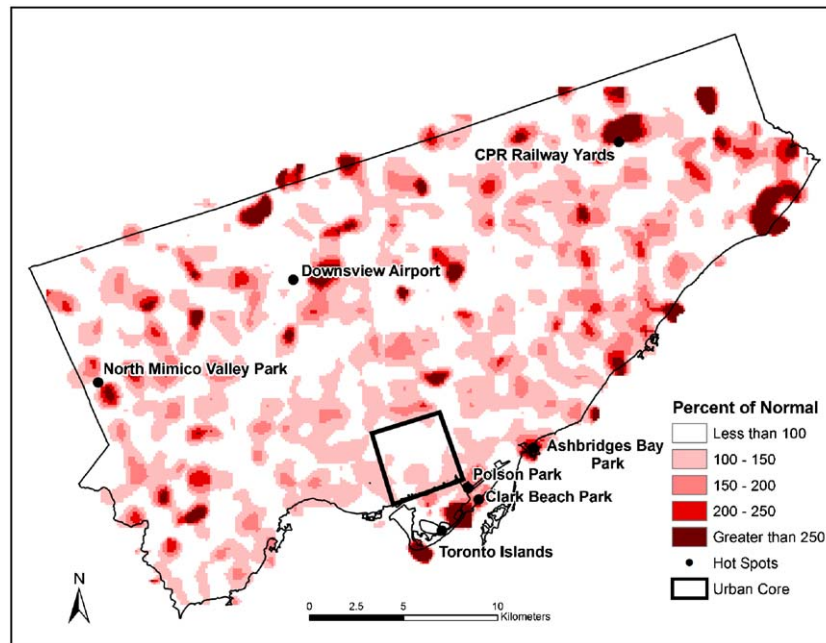


Fig. 7. Same as Fig. 5 except for weekends.

consideration. During the workweek, however, the 12 percent increase in calls during heat emergencies suggests that the population generally continues to carry out their daily activities.

### 6.2. Spatial variability

Several areas (hot spots) have been identified where, on oppressive days, ambulance calls significantly increase above normal levels during weekdays and/or weekends for all 4 years combined. A summary of the demographic characteristics and land-use types located within these hot spots is presented in Table 3. Of these areas, none is more consistent than Toronto Island, where significant increases appear on every map produced. The island is a prime example of where the mean number of ambulance calls is low, but when examining calls on heat alert and emergency days, the percentage of calls significantly increases. Though the population of this island in 2001 was only 658, more than 1 225 000 people visit it annually, primarily in summer, where it serves as a prime getaway for urban residents. The Island measures 230 ha and contains one ambulance and fire station. Though much of the land is used by utilities, the bulk of the human activity on the island is highly recreational with a summer activity center, several picnic areas, and bicycling trails.

The increase in ambulance calls during heat events on Toronto Island, along with the nearby hot spot locations of Polson and Clark Beach Parks and Ashbridges Bay Park, is likely attributable to the temporary increase in population on those days. However, a confounding factor may be an increase in ozone levels near the lakeshore, due to the lake breeze associated with the maritime inversion on such days (Hastie et al., 1999). Further research into increased ozone

levels along the lakeshore may be needed to help increase the understanding of the complex relationship among ozone, extreme heat, and human health. In studying heat-stress-related mortality of five cities in Southern Ontario from 1980 to 1996, Smoyer et al. (2000) suggested that further analysis of heat stress in the Toronto–Windsor corridor would benefit from the addition of air pollution data.

In many cases, the large percentage increases are not statistically significant; however, their consistent appearance on all maps analyzed suggest they may be important for emergency planning. Further, though these high percentage increases along the lakeshore often translate into small absolute increases (typically one or two ambulance calls), it should also be noted that the vulnerability of people on Toronto Island, along with the other park locations, may be underestimated by the ambulance call data, as those requiring medical treatment for heat-related illness may have a more difficult time contacting emergency services due to their being away from home. Further, with no hospitals easily accessible on Toronto Island, only the most extreme cases related to heat stress may get transported for medical treatment.

The other two consistent hot spots, North Mimico Valley Park and the CPR Railway Yards, are both located within industrial areas. The first of these hot spots is significant as the stratification of this research into weekdays and weekends depicts increases during the week, but not on the weekend. Being an industrial area, this suggests variability in the number of laborers working heat-sensitive jobs in the area between weekend and weekday may be associated with the significant differences observed.

One significant area that does not show consistent increases in ambulance calls is the urban core. Most



Table 3  
Demographic characteristics and land-use types associated with the prominent hot spots discussed in the text

Hot spot	Demographics	Land use
Toronto Island	Elderly Population in the labor force Older housing	Utilities/transportation Industrial Commercial recreation Open space
Polson & Clark Beach Parks	Older housing Industrial	Commercial recreation
Ashbridges Bay Park	None	Commercial recreation
North Mimico Valley Park	None	Industrial Institutional
CPR Railway Yards	Minorities Elderly Immigrants	Utilities/transportation Industrial
Downsview Airport	Population in the labor force High median income Elderly	Institutional Industrial Residential

Demographics reflect the 1996 census population within each hot spot and therefore may not reflect the characteristics of those who utilized the ambulance. Categories listed under demographics are statistically significant in terms of spatial autocorrelation at  $\leq .05$  (using Moran's I statistic).

interestingly, while the urban core features the highest absolute increases in calls during the week, on weekend heat alerts and emergencies the mean number of calls falls significantly below weekend means. This difference reflects the overall city results discussed above, and could signify that, while on weekdays workers have no choice but to be in downtown, Torontonians take notice when a heat alert or heat emergency is forecast on the weekend, and choose to stay home or go elsewhere.

### 6.3. Issues regarding the data

No complete information regarding the reason for the call, or whether the call was even related to heat, was specified. Although comments about some calls were available, generally there was not enough to base a decision on whether the call was related to heat, nor would it have been feasible to manually analyze comments associated with several hundred thousand calls.

A GIS was used to map census information allowing for an understanding of the demographic make-up around the area where calls significantly increased beyond normal levels on oppressive days. Information of this kind is somewhat unrepresentative when dealing with a mobile population. This is especially an issue during heat alerts and emergencies when it is suggested the population go to cooler locations. Analysis of the demographic characteristics in the vicinity of the hot spots is then confounded, especially in areas such as Toronto Island. Those needing medical attention during oppressive days are most likely not the population of the Island represented in the census but rather one of the 1.2 million annual visitors. Therefore, results should be interpreted with caution as there is no way to directly link census and ambulance call data

together. Nevertheless, though census data do not provide ideal demographic information, they represent the best available and feasible dataset for this analysis.

## 7. Conclusions

While the majority of heat and human health research has analyzed mortality data, this research has used morbidity data and a GIS to assess the relationship between extreme heat and health. This study is also one of few to quantify this relationship on a sub-metropolitan area level.

As the average number of ambulance calls has increased over the 4-year study period, so too have the average number of calls taking place during heat alerts and emergencies. Calls during these oppressively hot days significantly increase above normal levels, with differences noted between weekdays and weekends. The increase in calls on oppressively hot days is directly, statistically significantly correlated with several meteorological factors including the apparent temperature, air temperature, and the dew point.

Results from this research have identified several areas of Toronto, Ontario, Canada where ambulance calls consistently increase above normal levels on oppressively hot days. The urban core contains the largest absolute increases on weekdays; however, during weekend heat events ambulance activity falls below normal levels. In terms of percentage increases, several areas that mostly include significant industrial and recreational space are identified. However, it is difficult to identify the characteristics of the population within these areas as they contain a mobile population. An increased number of calls in industrial and recreational areas on hot days may be due

to heat-sensitive workers in the former and increased recreational activity in the latter.

Toronto's hot weather response plan includes Toronto EMS staffing a Red Cross vehicle, in partnership with the Canadian Red Cross, equipped with emergency medical and other equipment to provide treatment for persons at risk of heat-related illness. This vehicle may be most beneficial if positioned near areas identified by this study as most vulnerable during oppressive days. Aside from equipping a vehicle, EMS staffing could be increased to compensate for the greater need of their assistance on oppressive days. Citywide staffing could be increased in response to the percentage increase of calls depending on whether it is a weekday or weekend and an alert or emergency. Another component of the hot weather response plan is the opening of several cooling centers. These centers could either be relocated into areas where calls significantly increase or perhaps additional buildings could be equipped with the necessary equipment.

In studying out-of-hospital cardiac arrest victims during 1991 and 1996 in East Anglia, England, however, an increase in the number of paramedic crews seemed to have little impact on survival rates (Absalom et al., 1999). Heat-health alert systems and heat mitigation plans both inform the population of the dangers posed by extreme heat, but protecting oneself begins with individual behavior. Smoyer (1998) found that despite increased air conditioning use from 1980 to 1995, several victims of the 1995 St. Louis heat wave had their units turned off, possibly for economic reasons. Further, those not listening to the radio or watching television may not be aware that a heat alert or emergency is in effect. This emphasizes the importance of educating the public to recognize the premonitoring signs of heat stress and calling for help when noticed.

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