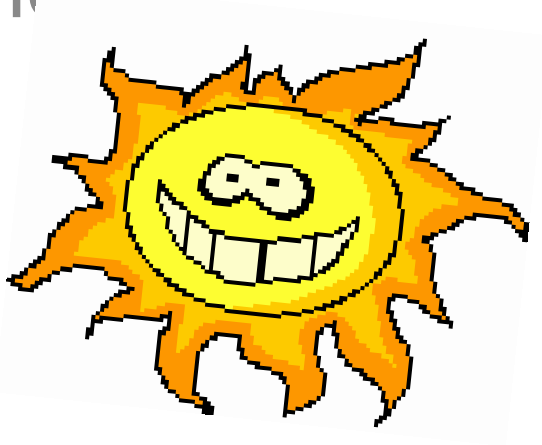
BC Centre for Disease Control
An agency of the Provincial Health Services Authority

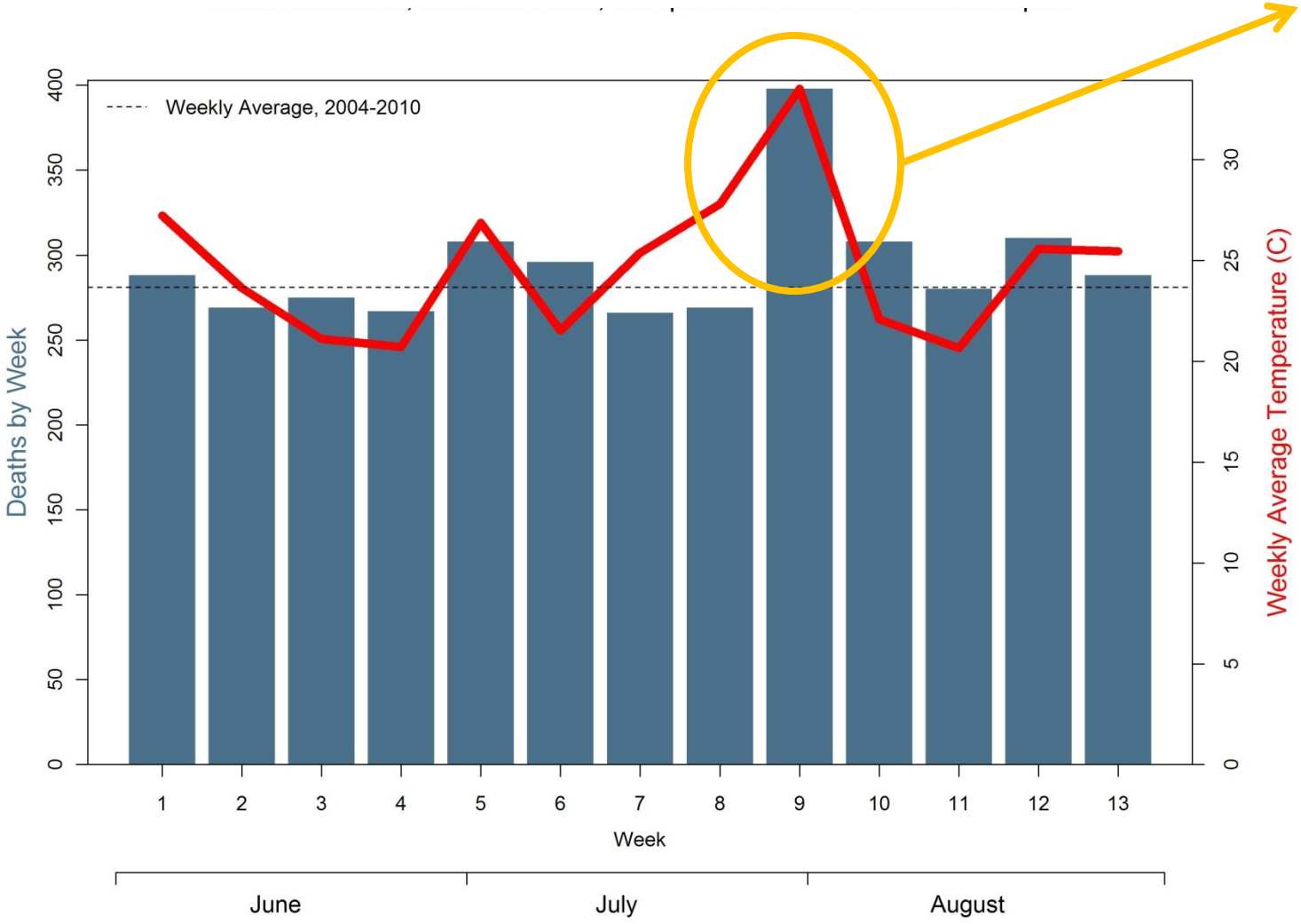
Research to support public health action on heat and health

Tom Kosatsky
Environmental Health Services
BCCDC
May 2011



BC Lower Mainland Weekly Mortality

Summer 2009



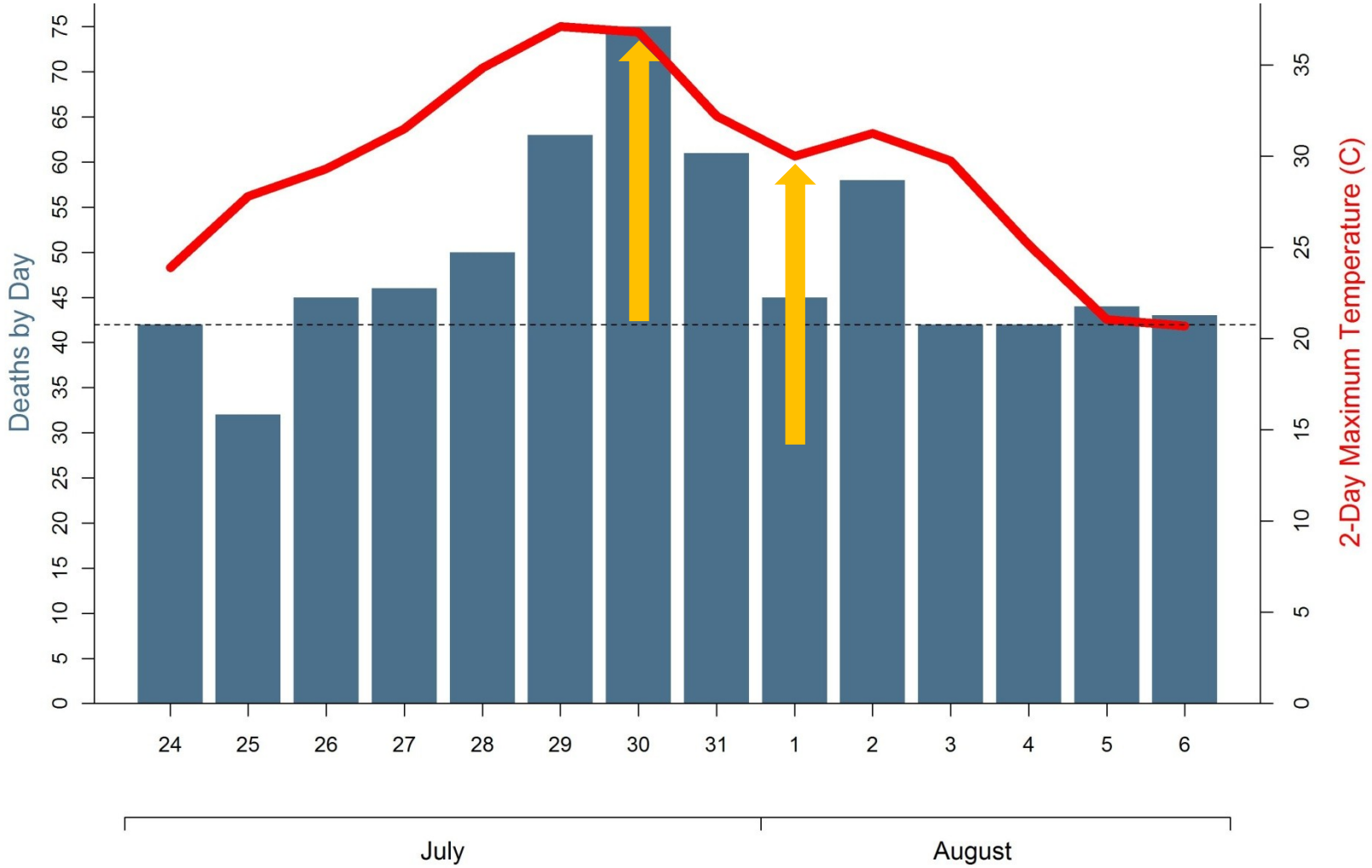
Hottest 7-day period on record (Abbotsford Airport) since 1986. This unprecedented event was associated with ~122 excess deaths

Weekly average 2004-2010 = 281 (stable over this period)

Kosatsky, Pollock, Henderson, 2011 submitted

BC Lower Mainland **Daily** Mortality, Summer 2009

Average of **2-DAY** Maximum Temperature (Abbotsford)



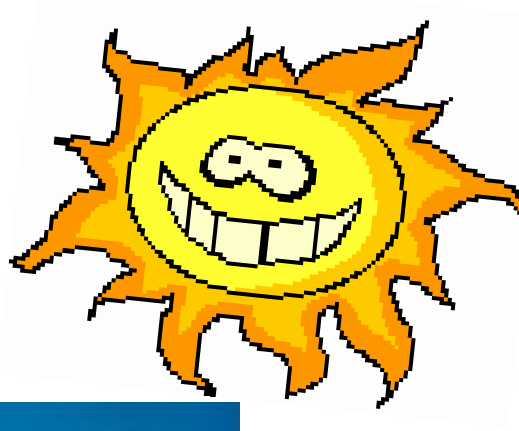
Kosatsky, Pollock, Henderson, 2011 submitted

deaths by cause during the 2009 BC Lower Mainland heat event and during comparison weeks

cause of death	2009 hot weather event		8 previous weeks summer 2009		5 same weeks summer 2004-8	
	n	%	n	%	n	%
all	413		2325		1406	
heat*	4	1	1	.04	0	
respiratory	52	13	251	11	129	9
cardiovascular	112	27	660	28	429	31
other	245	60	1411	6	848	60

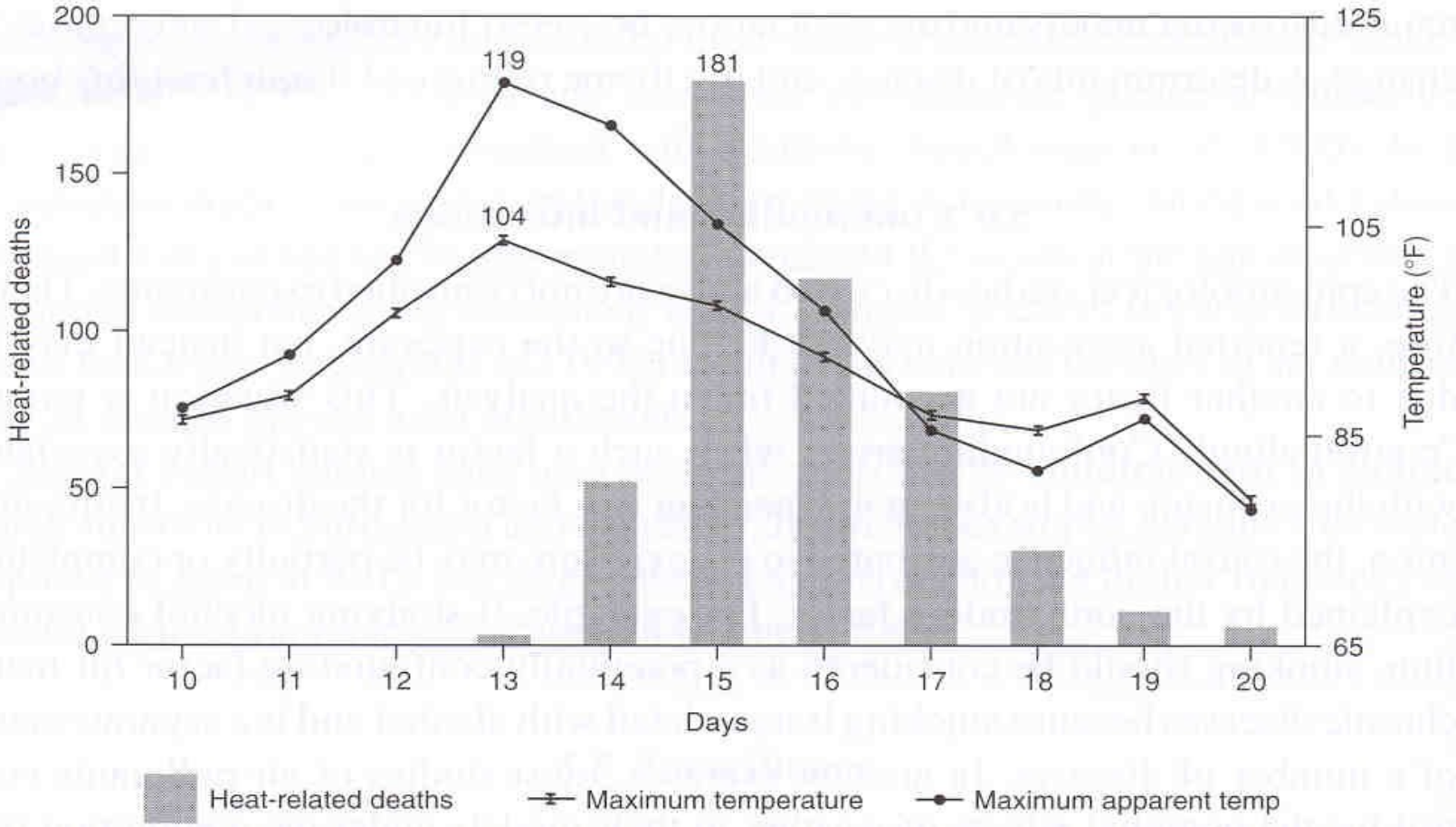
ICD – 10 code X30 = exposure to excessive natural heat

death caused **directly** by heat:
some of what we know



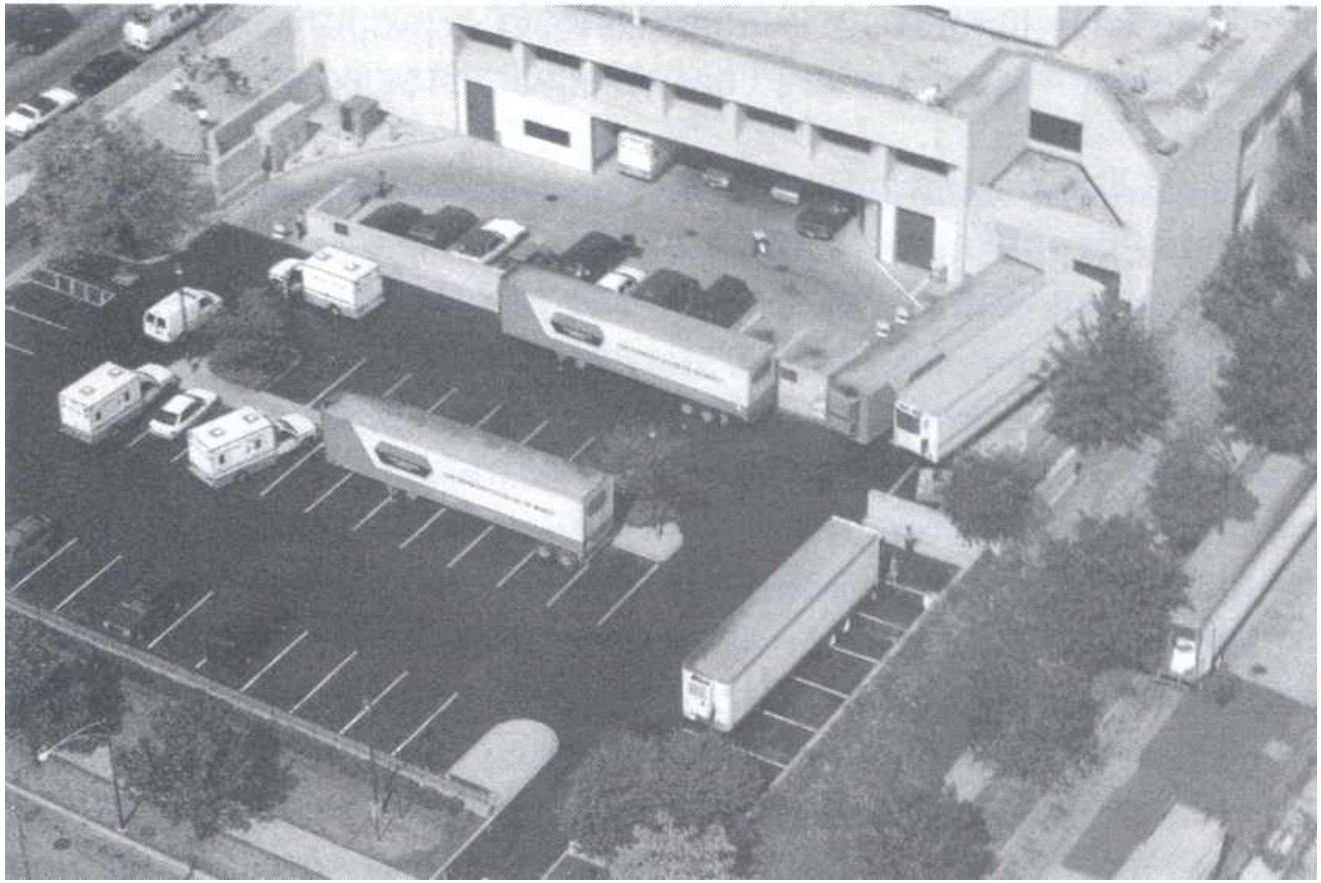
heat-related deaths in Chicago during July 1995

Whitman,1997



heat wave, Chicago 1995

refigerator trucks outside City morgue



Klinenberg, 2002

deaths versus survival during the 1995 Chicago heat wave

Klinenberg, 2002

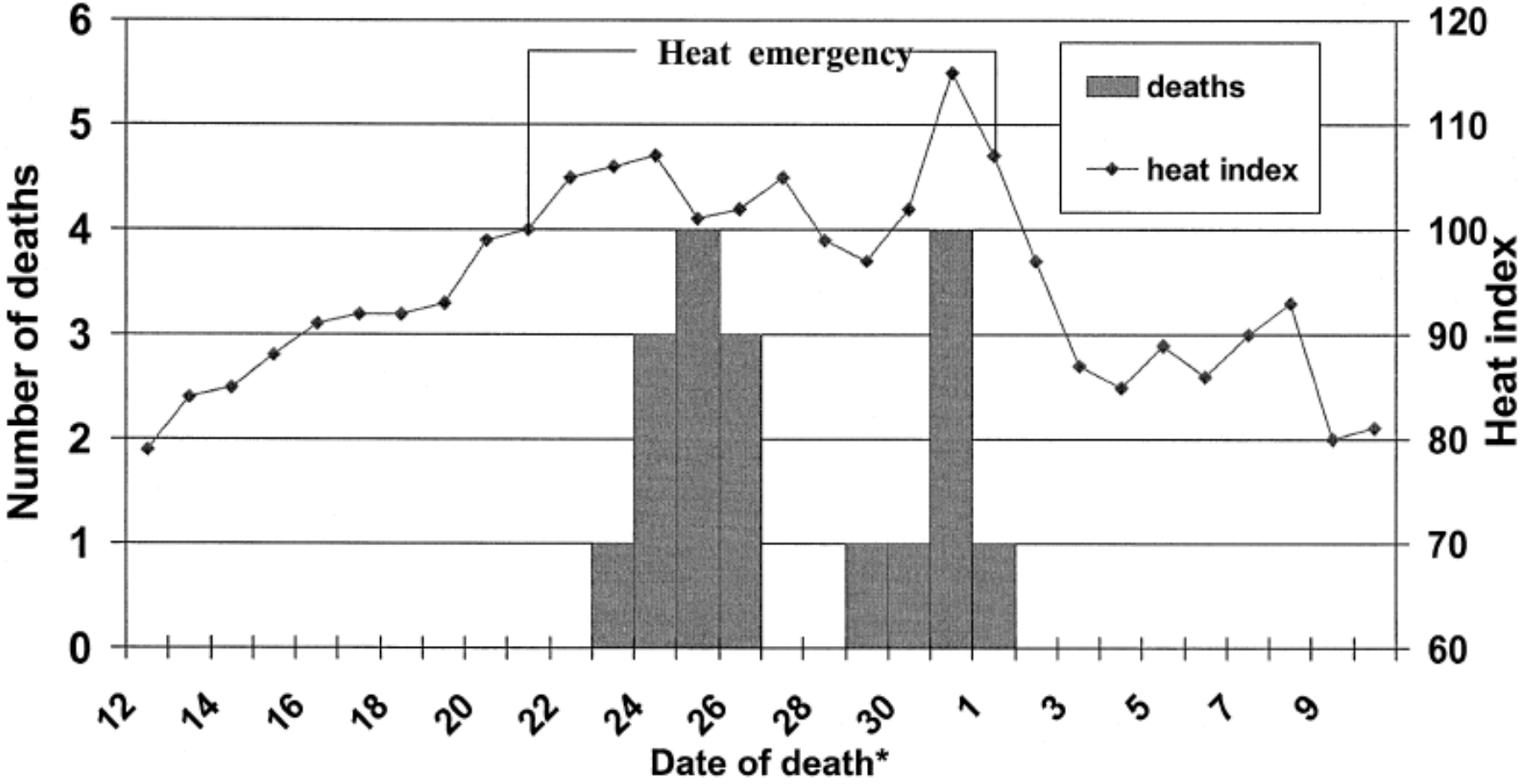
Chicago, poor African-American neighbourhood

Figure 29. Ogden Avenue, once a major commercial artery in North Lawndale. Photo by Caitlin Zaloom.

nearby Hispanic neighbourhood during the 1995 heat wave: life is outdoors

heat-related deaths, Cincinnati, Ohio, July 12–August 10, 1999 (n=18)* *in some cases, date of death was estimated by the Coroner based on criteria such as decomposition of the body, temperature in the residence, date last seen alive, and/or date of last newspaper found at the premises of the decedent*

Kaiser, 2001



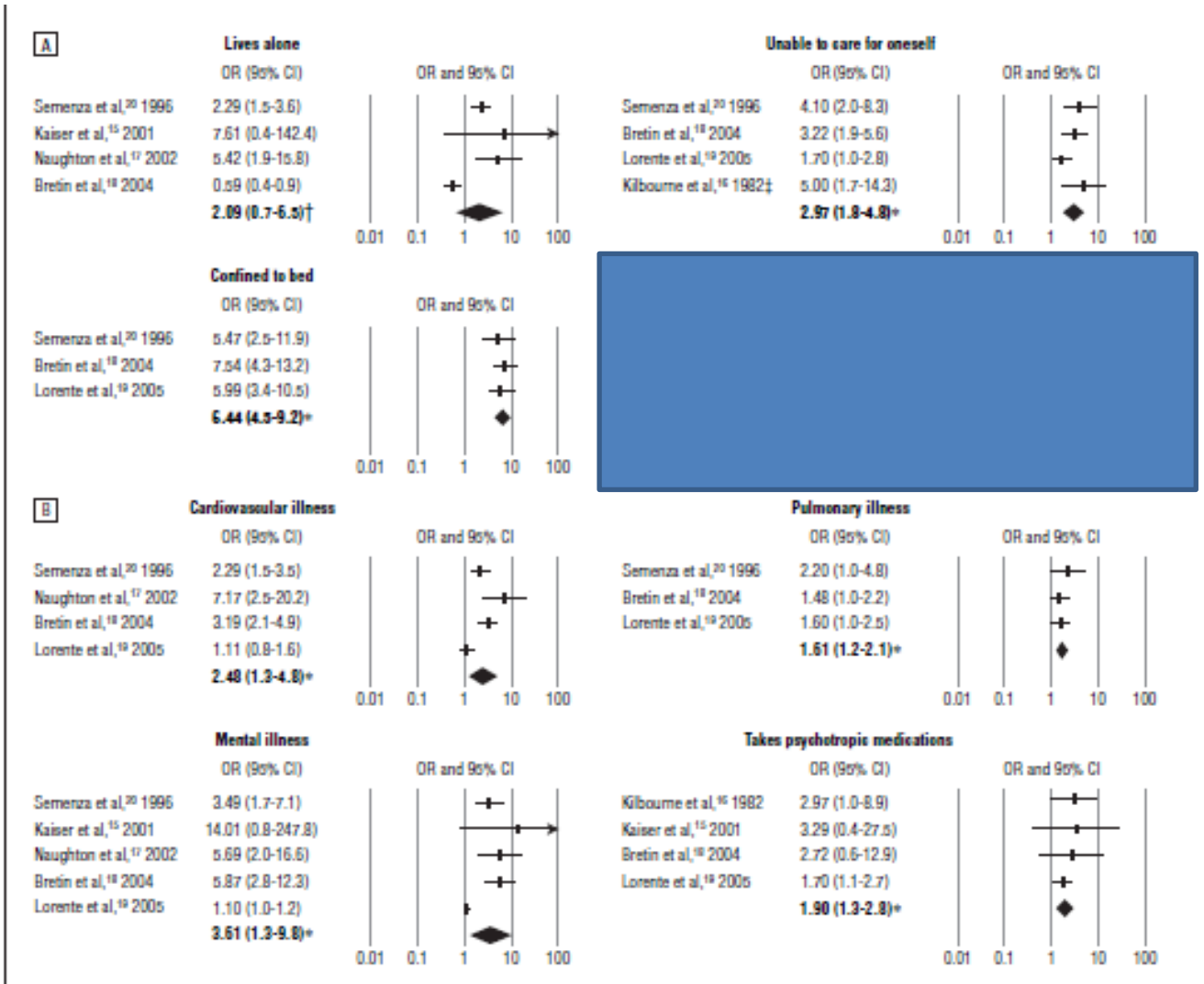
protective and risk factors associated with heat-related death, Cincinnati, Ohio, 1999

Kaiser, 2001

Variable	Case subjects [n(%)][a]	Controls [n(%)][a]	Crude odds ratio (95% CI)
Reduced outside activity	3 (25)	22 (65)	0.2 (0.02–0.9)
Working fan	16 (94)	32 (97)	0.5 (0.01–39)
Mental illness	8 (47)	4 (12)	14.0 (1.8–633)
Income			
≤$10,000/year	8 (67)	10 (42)	8.2 (0.9–393)
Living alone	11 (65)	13 (38)	7.6 (0.9–355)
Medication			
Psychotropic	4 (24)	3 (9)	3.3 (0.5–38.1)
Anticholinergic	6 (35)	3 (9)	4.0 (0.9–24.7)

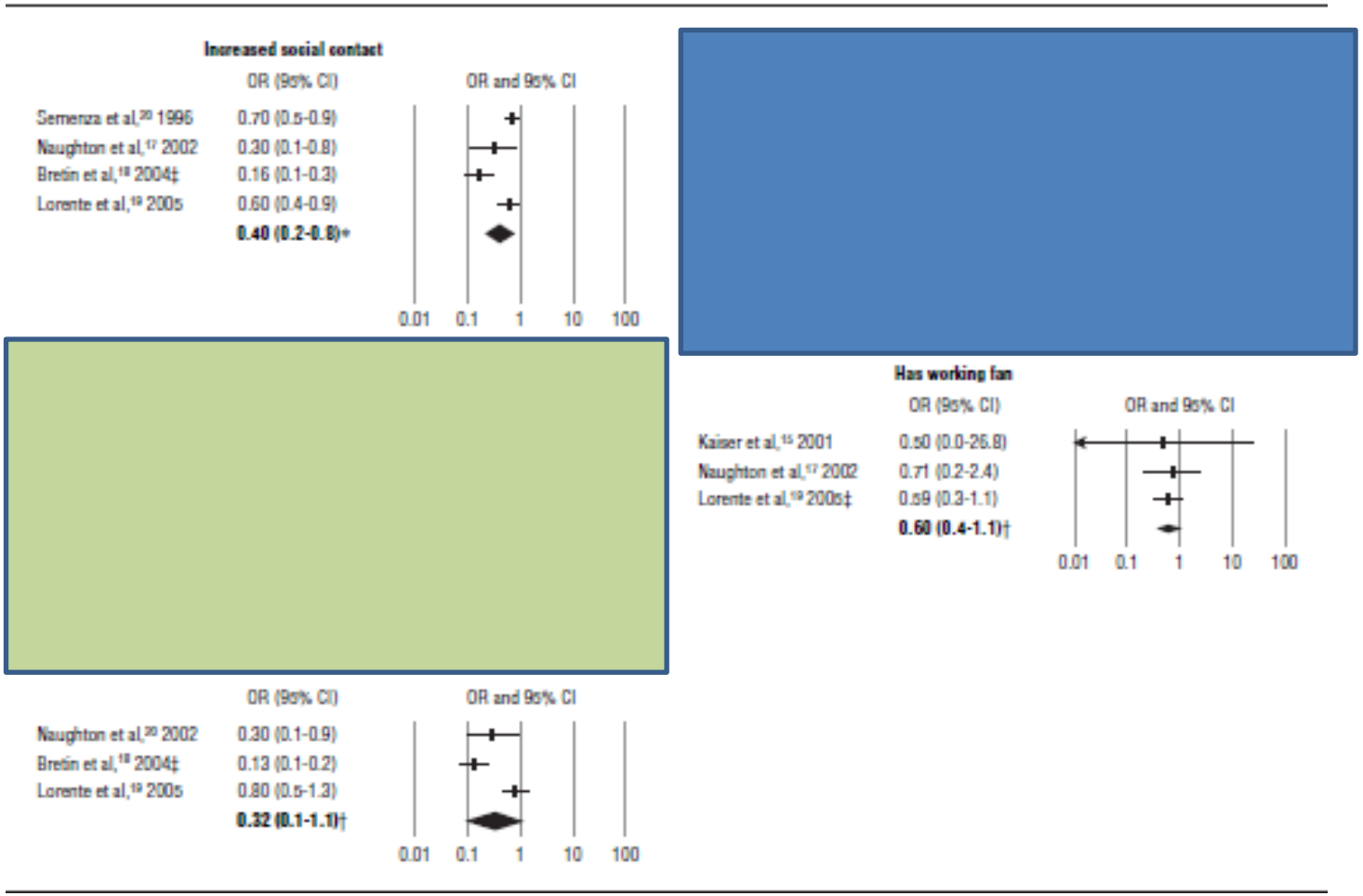
[a]Percentage may be different for same number because of missing values.

prognostic factors in heat wave–related deaths: *a meta-analysis* Bouchama, 2007



prognostic factors in heat wave–related deaths: *a meta-analysis*

Bouchama, 2007



hyperpyrexia due to air-conditioning failure in a nursing home

JOHN Z. SULLIVAN-BOLYAI, MD, MPH ROBERT M. LUMISH, MD EDWARD W. P. SMITH, MD JAMES T. HOWELL, MD, MPH DENNIS J. BREGMAN, MS MARJORIE LUND, RN, MPH ROBERT C. PAGE, MD, 1979

Table 1. Mean age distribution of residents with and without fever in a nursing home, southeastern Florida, August 1976 [1]

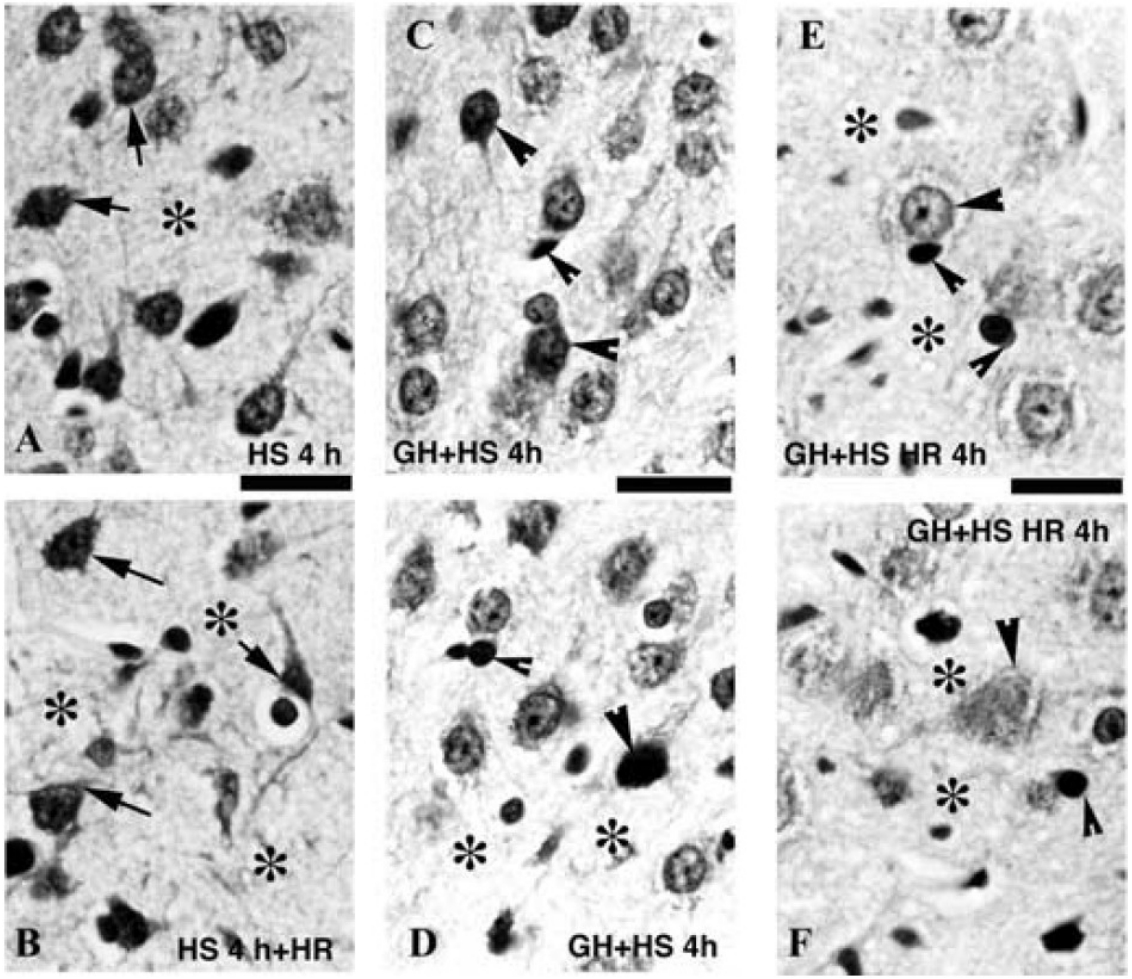
Residents	Mean age (years)	Standard deviation
Hyperpyrexia cases:		
Patients who died	78.6	8.5
Survivors	83.9	7.6
Others	81.6	8.8

[1] Mann-Whitney U test, $P > 0.05$.

Table 2. Distribution of residents in a nursing home, by ambulation code, southeastern Florida, August 1976

Code	Hyperpyrexia cases: Patients who died	Hyperpyrexia cases: Survivors	Other residents
4: Fully ambulatory	1	0	14

Structural changes in the cerebral cortex of normotensive and hypertensive rats after hyperthermia and their modification with growth hormone (GH) treatment. **Heat stress** induced marked neuronal damage (**A) in the cerebral** cortex after 4 h. Several neurons were distorted, and chromatolysis (arrows) is clearly evident in many nerve cells. The magnitude and intensity of neuronal damage was further enhanced in **hypertensive** rats (**B). Thus, loss of neurons, perineuronal edema, degeneration** of neuronal cell membranes, sponginess, and edema (∗) are more frequent in this group (arrows).

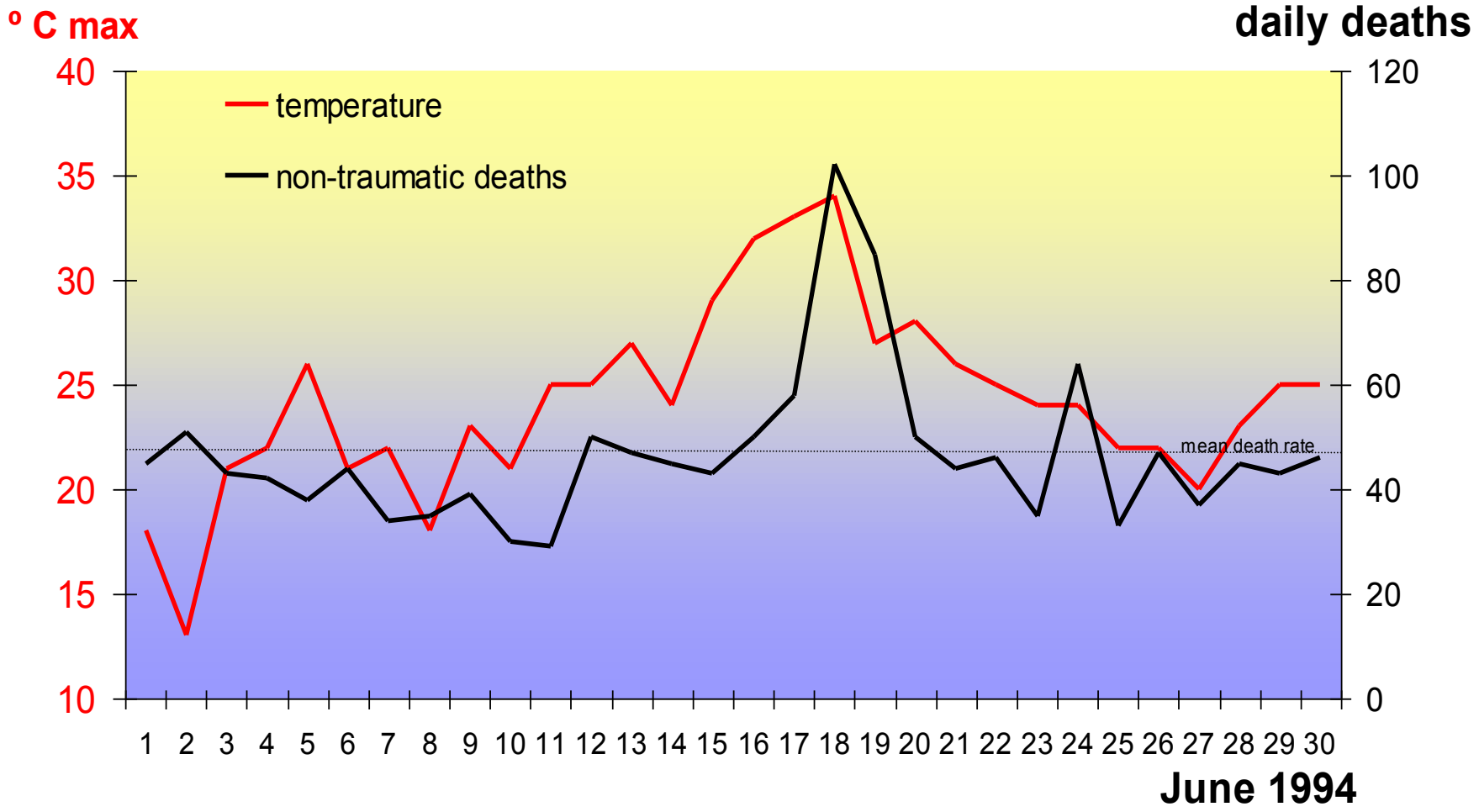


Pretreatment with GH (50 g/kg/min for 60 min before heat exposure) in **normotensive** (sham operated) rats exhibited **marked neuroprotection** (**C, D). Many** nerve cells appear normal, and edematous expansion of the neuropil is less intense. Only a few nerve cells (arrowheads) show cell damage (**C, D). On the other hand, GH treatment** in **hypertensive** rats after heat stress (**E, F) was not that effective, degenerated** neurons and perineuronal edema (arrowheads) are still frequent in this group. Edematous expansion of the neuropil was also seen (∗) in hypertensive rats treated with GH. Bars: **A, B = 25m; C, D = 30m; E, F = 40m. Paraffin sections (3 m, Nissl).**

Meransu, 2007

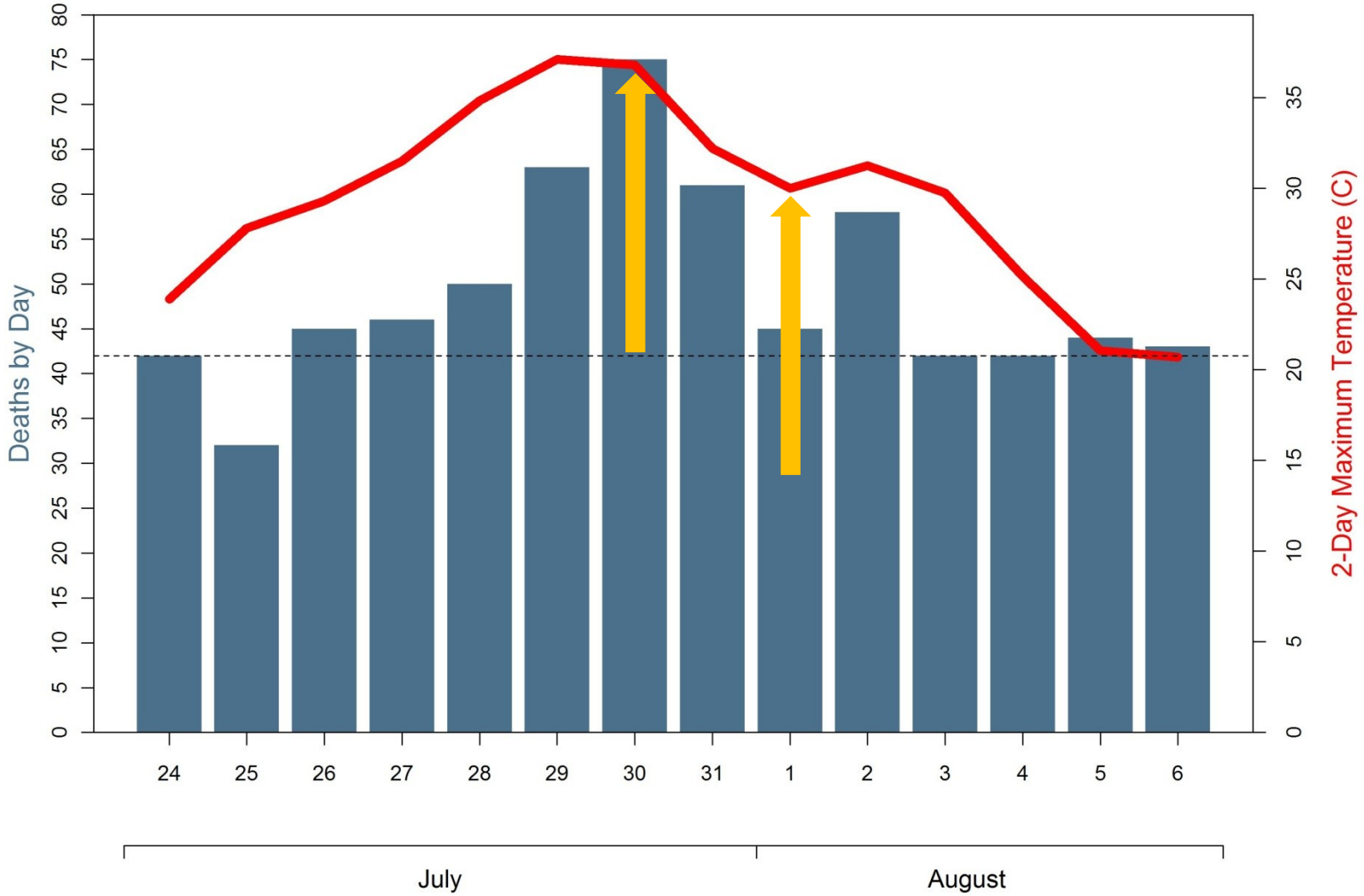
deaths during extreme heat events beyond numbers expected

Montreal : June 1994 heat wave with attendant mortality



BC Lower Mainland Daily Mortality, Summer 2009

Average of **2-DAY** Maximum Temperature (Abbotsford)



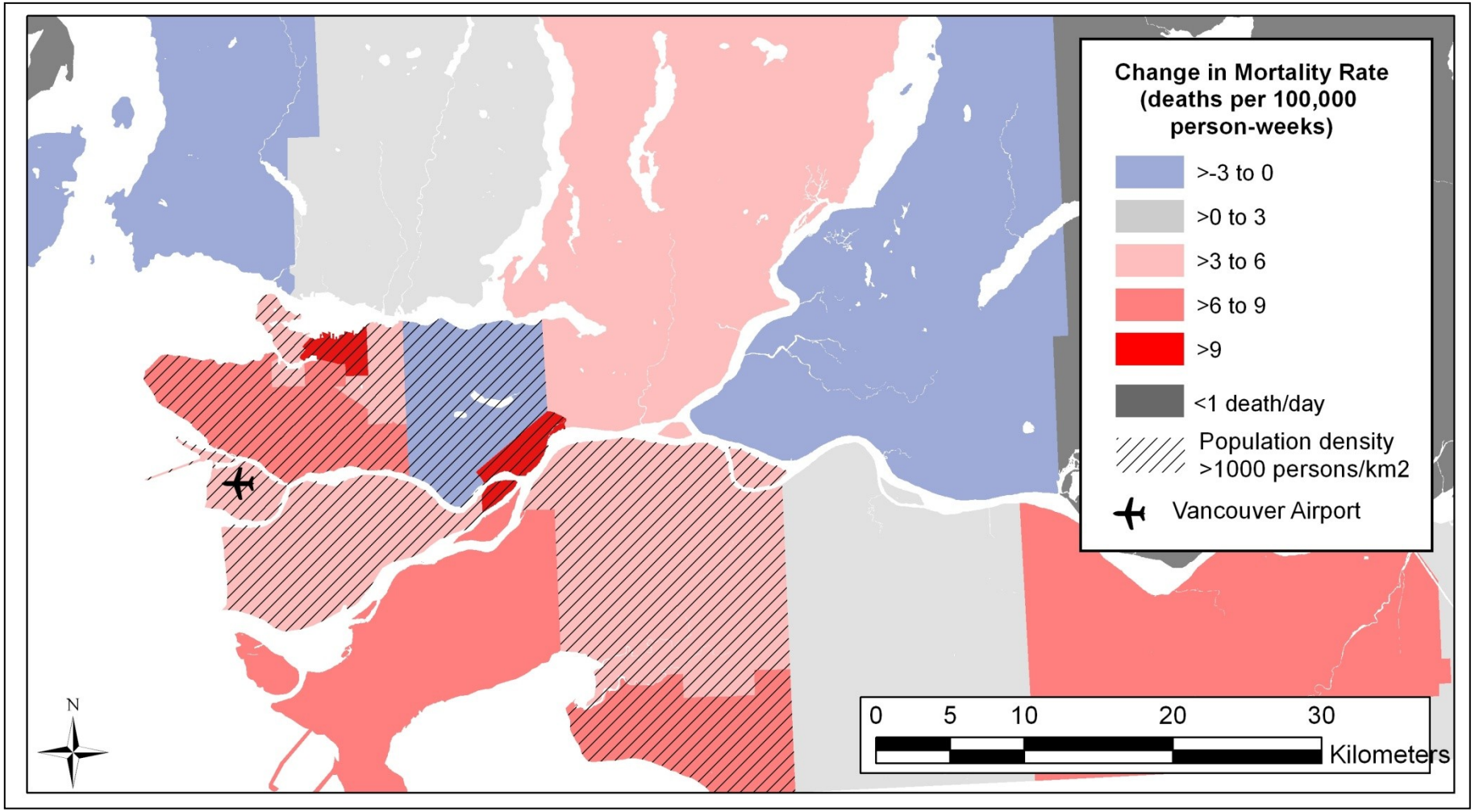
Kosatsky, Pollock, Henderson, 2011 submitted

who died and where during 2009 Vancouver heat event and during comparison weeks

	2009 hot weather event	8 preceding 2009 weeks (average)	5 preceding same summer weeks (average)
age			
85+	114	92	81
75-84	110	86	84
65 – 74	80	42	44
< 65	108	70	71
where			
hospital	184	156	-
home	89	48	-
institution	118	79	-
other	20	7	-

changes in BC Lower Mainland mortality by population density

summer 2009



excess mortality as a function of marital status, by sex, Paris 2003/2000-01-02

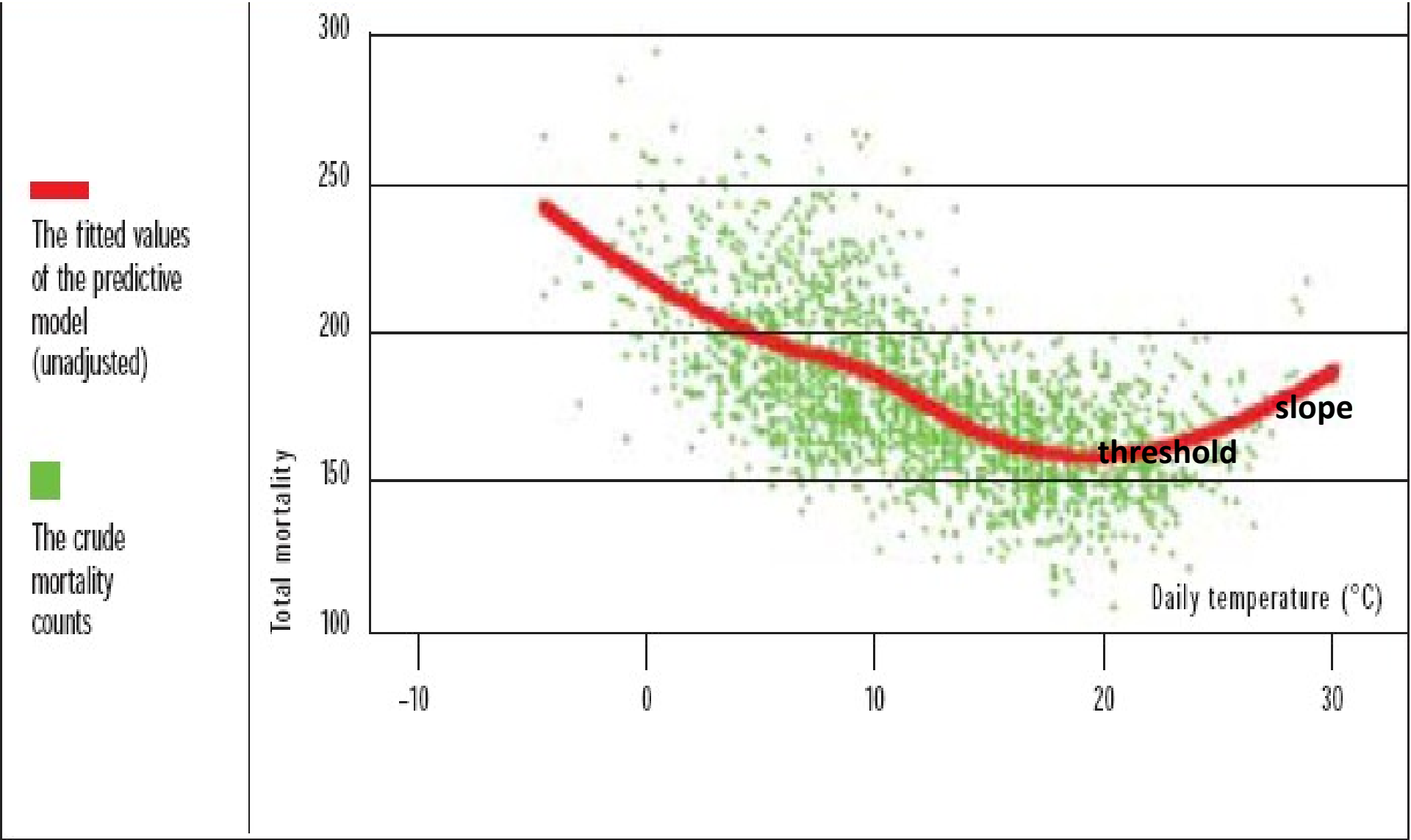
Canoui-Poitrine, 2005

		Deaths expected [a] N(%)	Deaths observed N(%)	OR [95% CI]
Men	Married	36 (45,0)	95 (32,3)	1
	[redacted] [b]	44 (55,0)	199 (67,7)	1,71[1,20-2,44]
Total		80 (100,0)	294 (100,0)	
Women	Married	12 (12,8)	61(9,4)	1
	[redacted] [b]	81,7 (87,2)	587 (90,6)	1,41[0,91-2,19]
Total		93,7 (100)	648 (100,0)	

[a] mean of number of deaths in reference years (2000-2001-2002)

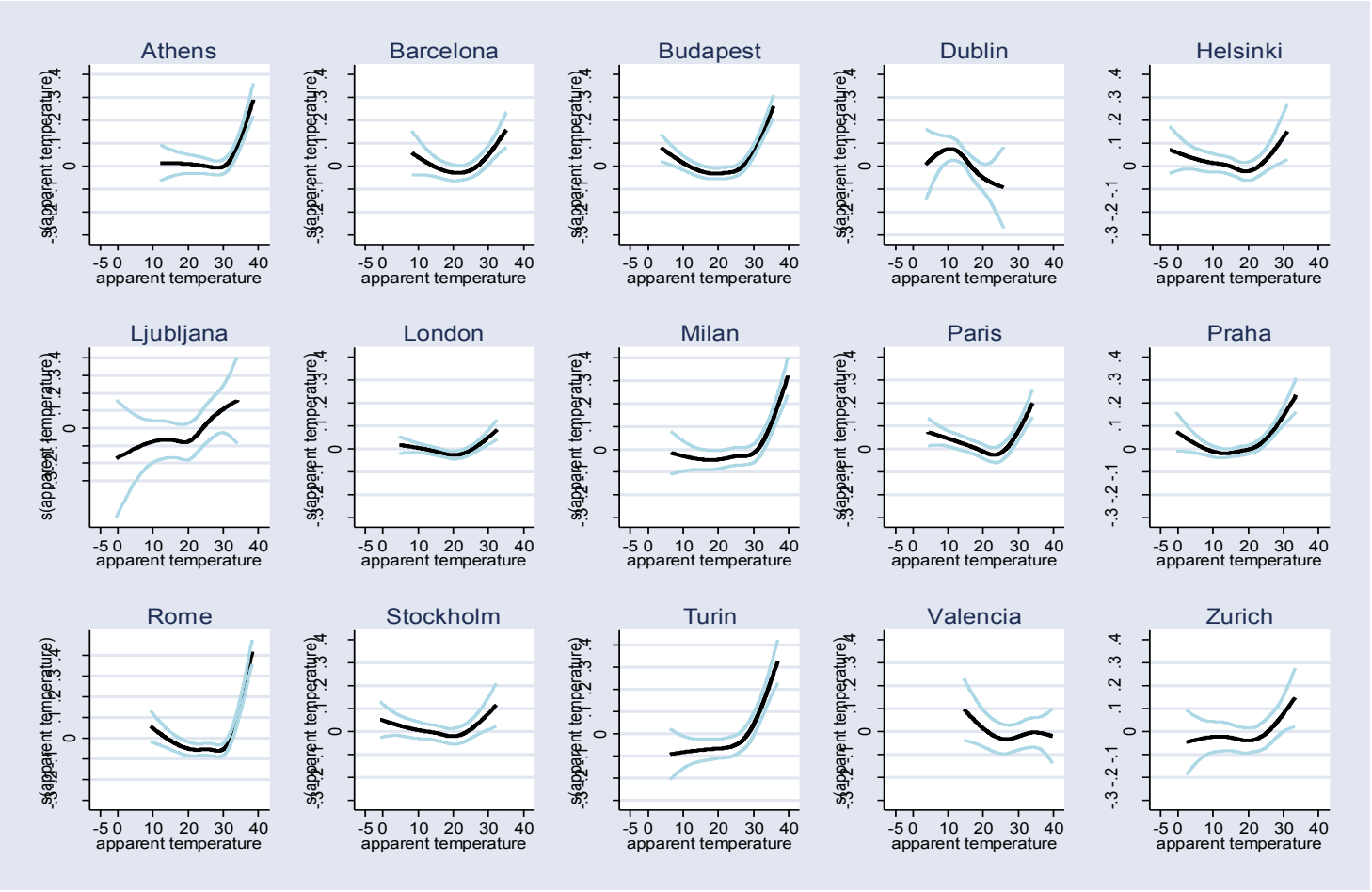
[b] single, divorced or widowed

general relationship between maximum daily temperature and mortality in a European city



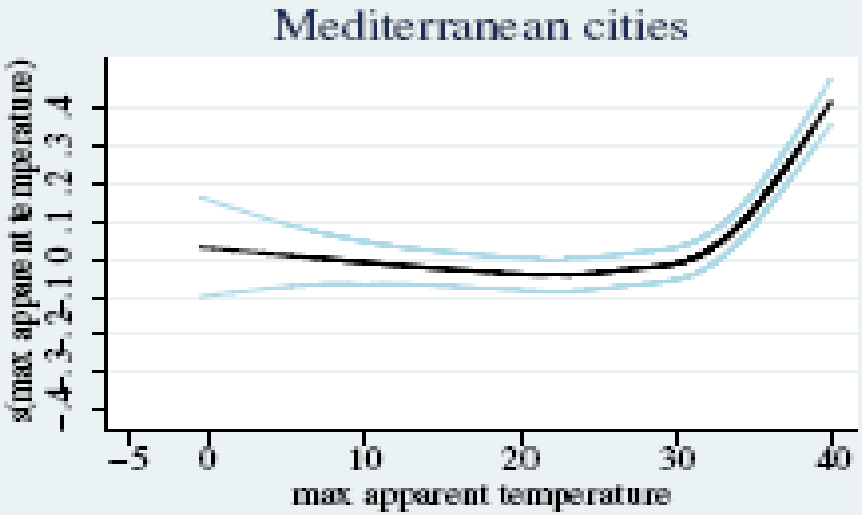
summer deaths by 4-day apparent Tmax, 15 PHEWE cities, 1990-2000

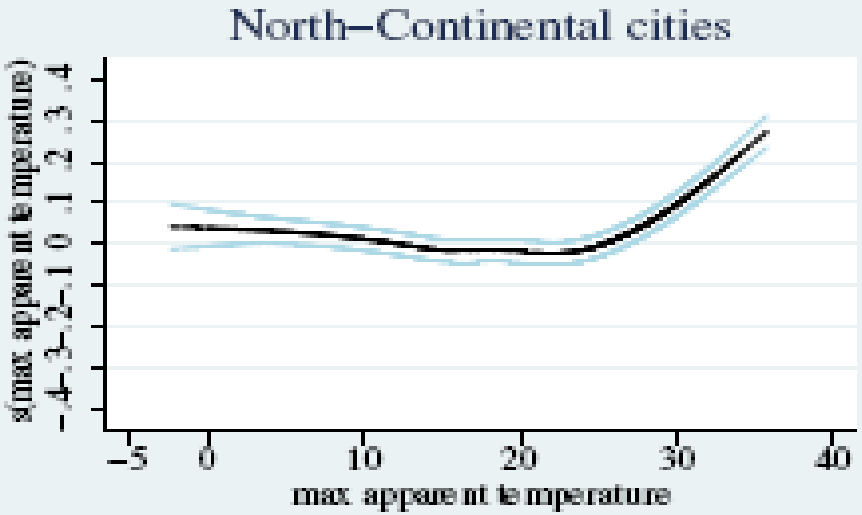
Baccini, 2008

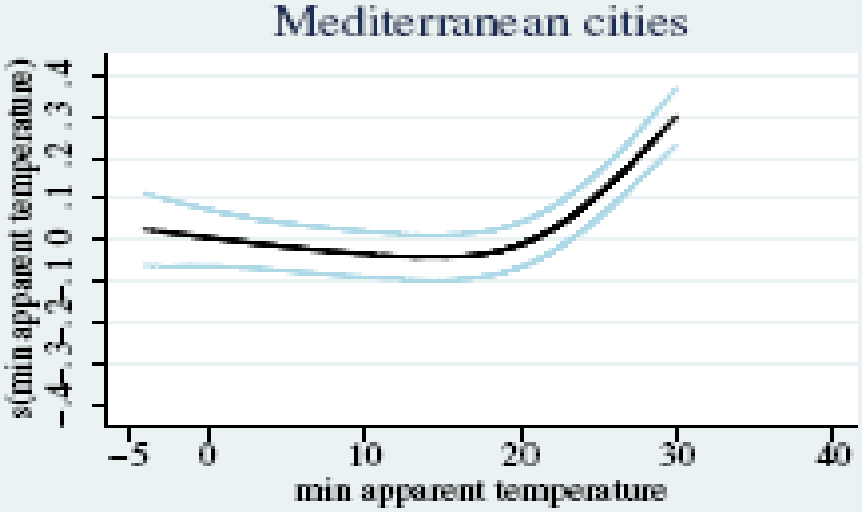


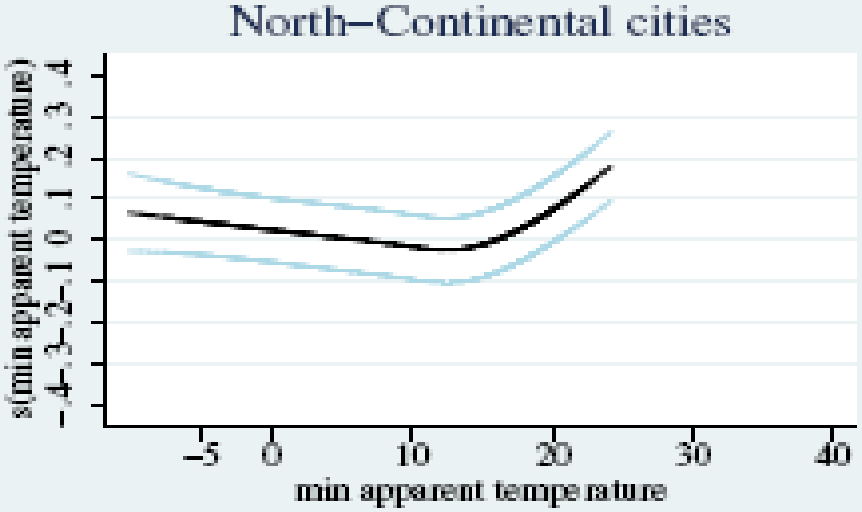
Bayesian *meta-analyses* of the temperature-mortality function for Mediterranean and Northern European city groupings

Baccini, 2008

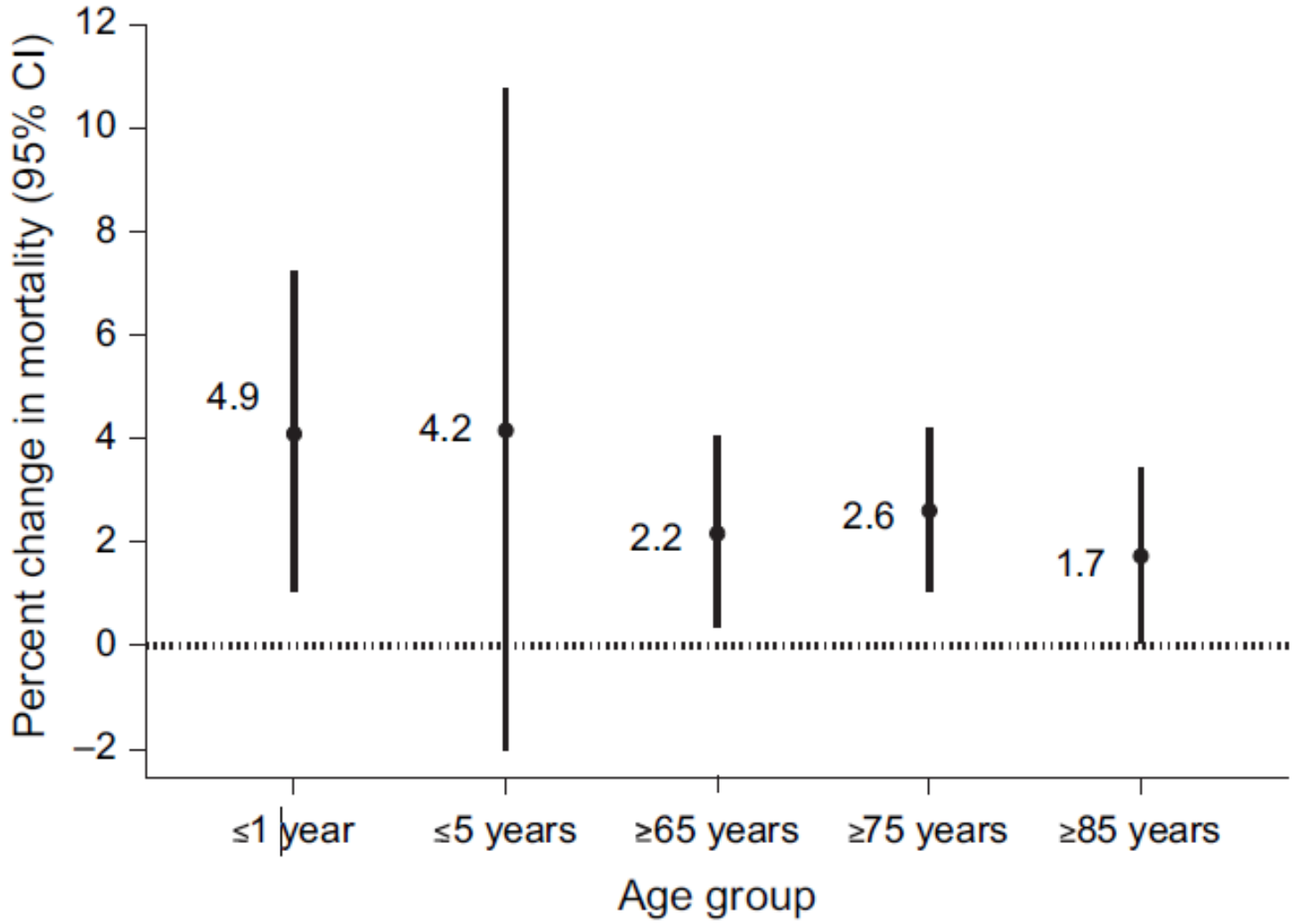








estimated percent change associated with a 10°F (4.7°C) increase in mean daily apparent temperature and non-accidental mortality by age group in nine counties, California, May through September, 1999–2003. **Basu, 2008**



Urban micro-climate in Montreal

- Importance de considérer ce qui est à proximité de l'îlot de chaleur urbain. Le milieu environnent influence directement le comportement thermique des secteurs
  Exemple:
  2 secteurs de densité résidentielle moyenne, situés tous deux dans Mercier/Hochelaga-Maisonneuve, cumulent des températures très différentes (35oC et 29oC). Le secteur le plus chaud est à proximité d'une zone industrielle (Emballages Paperboard inc.) alors que le plus frais côtoie une zone de verdure.
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-
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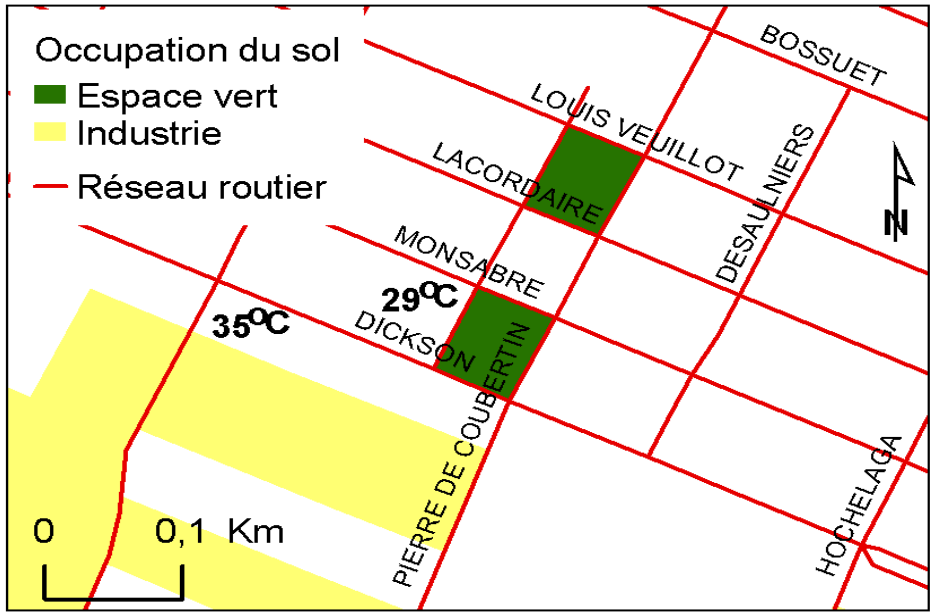
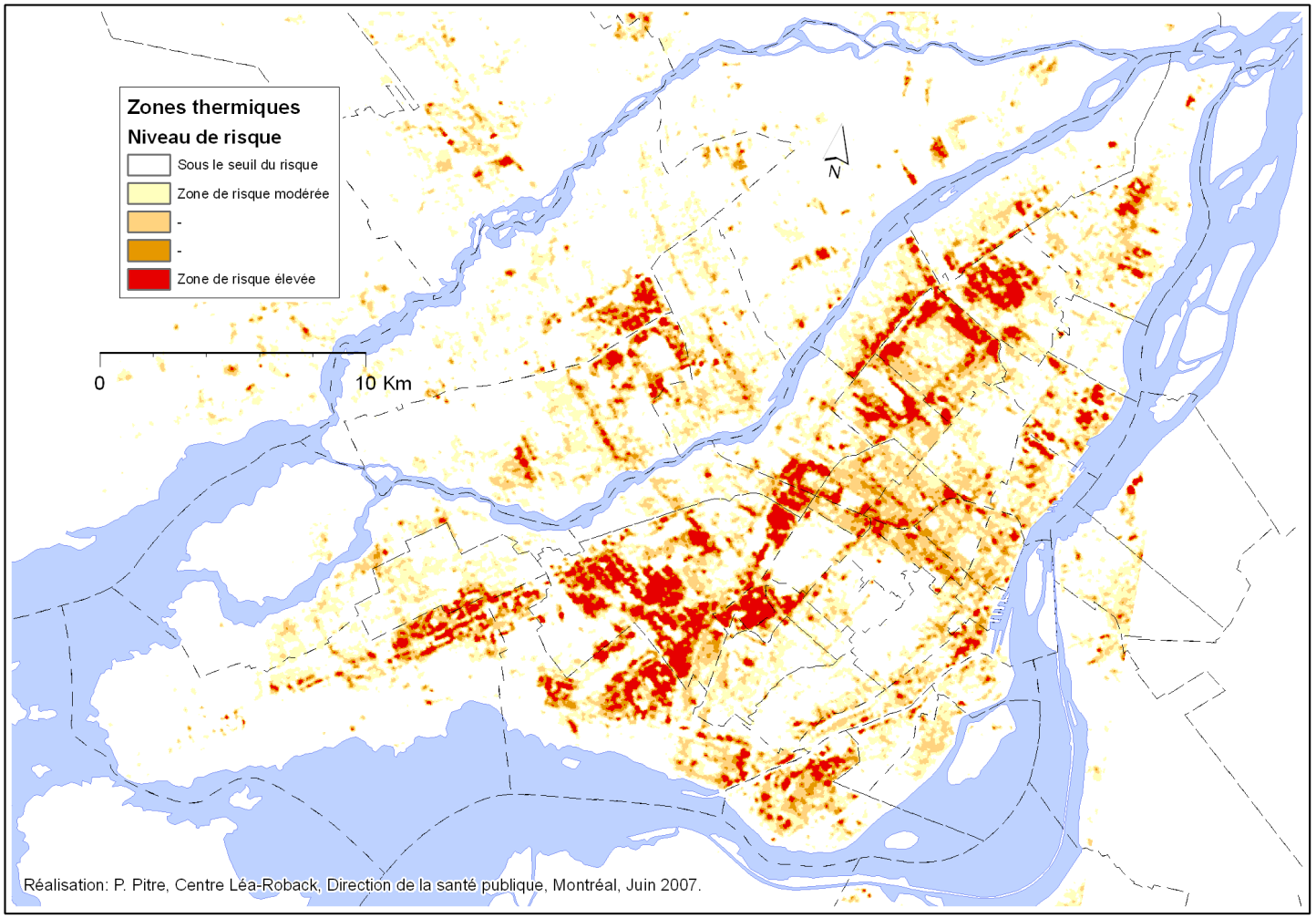
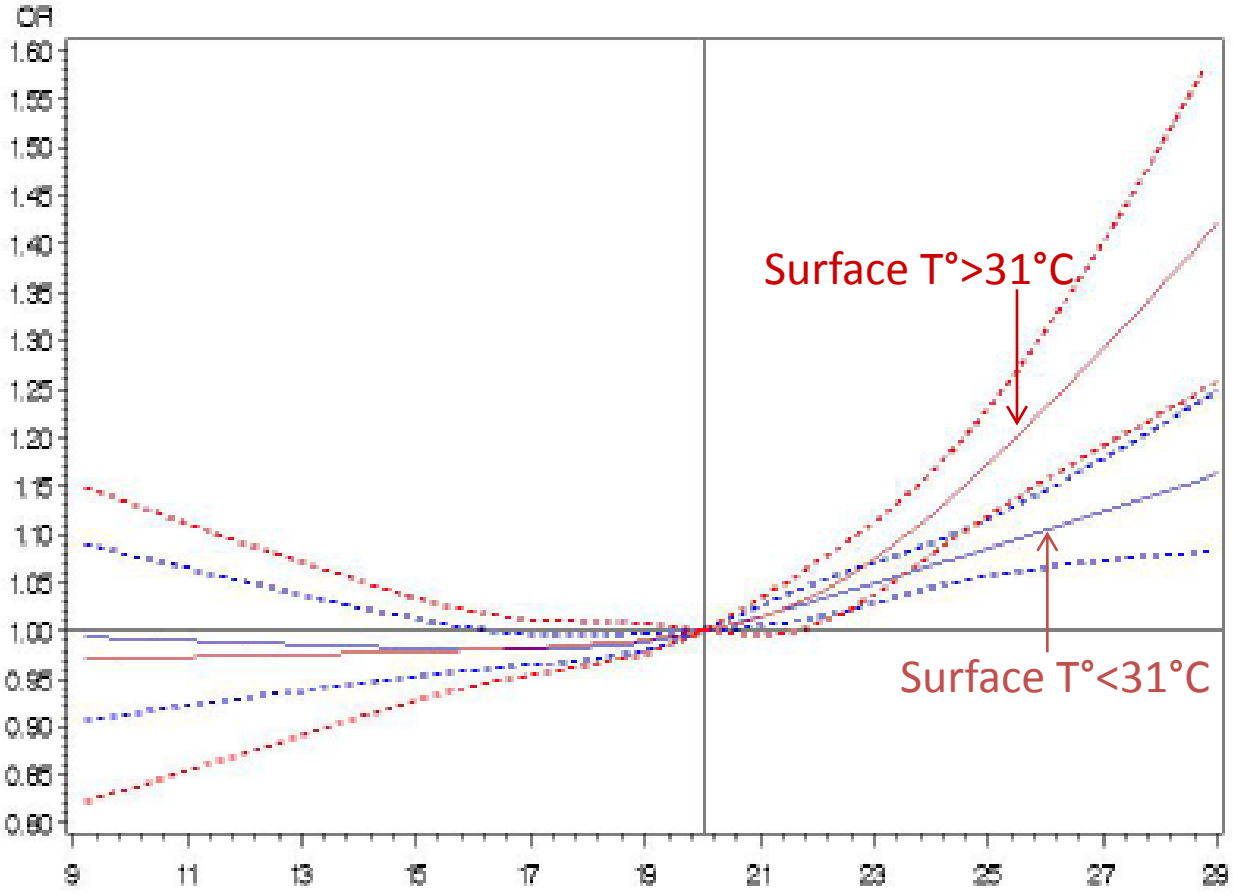


satellite imagery-based heat capture index, Montreal

(the redder, the hotter)



acute mortality risks in hot versus cool Montreal neighbourhoods, 1990-2003

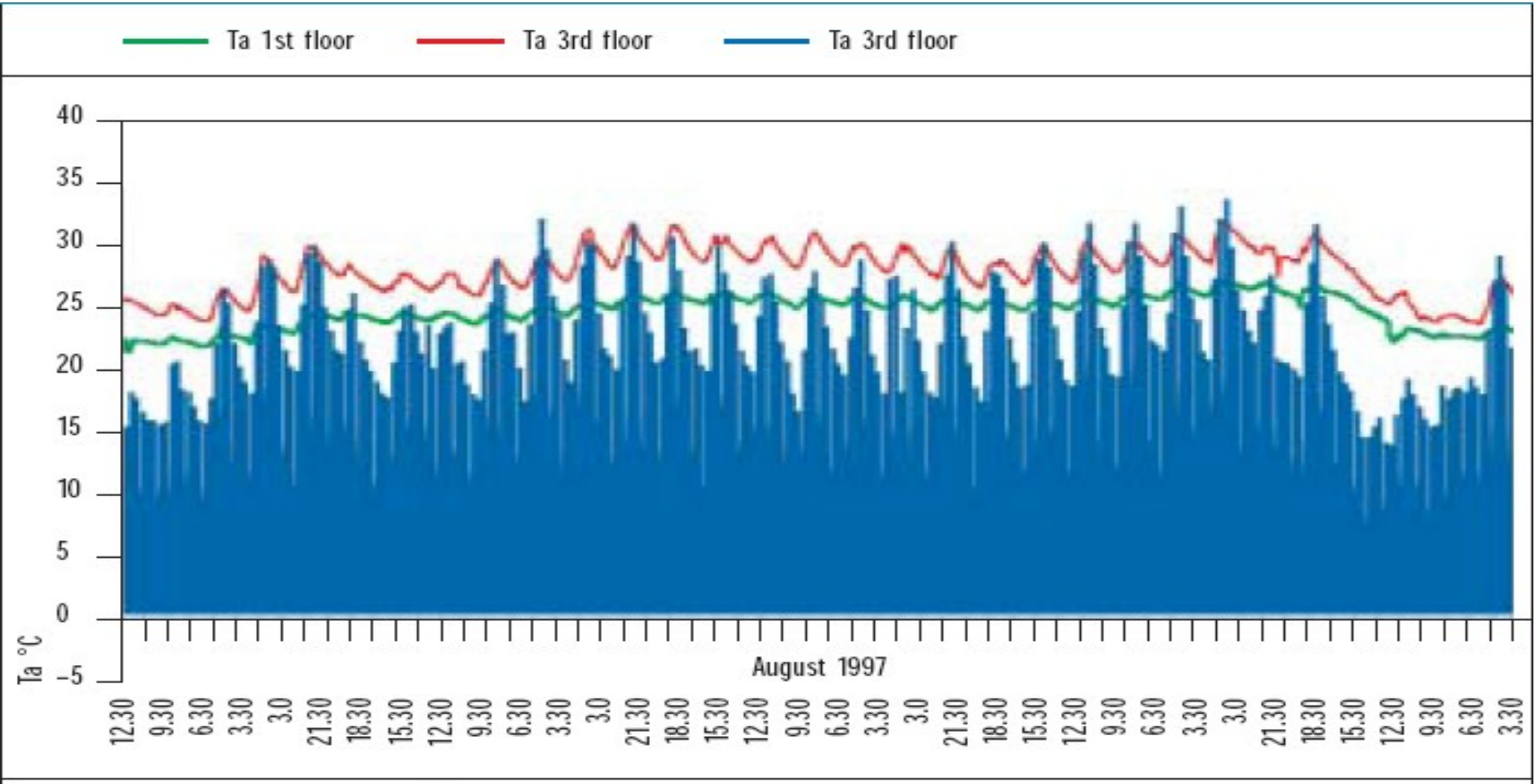


Smargiassi, 2009

annual number of days with heat stress in Berlin

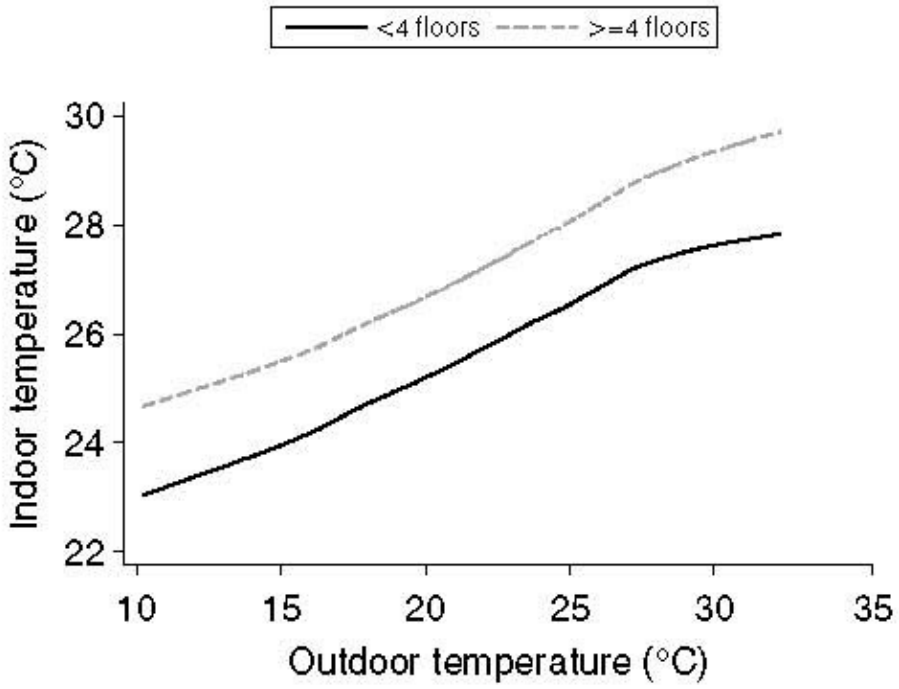
Source: Grätz & Jendritzky (1998).

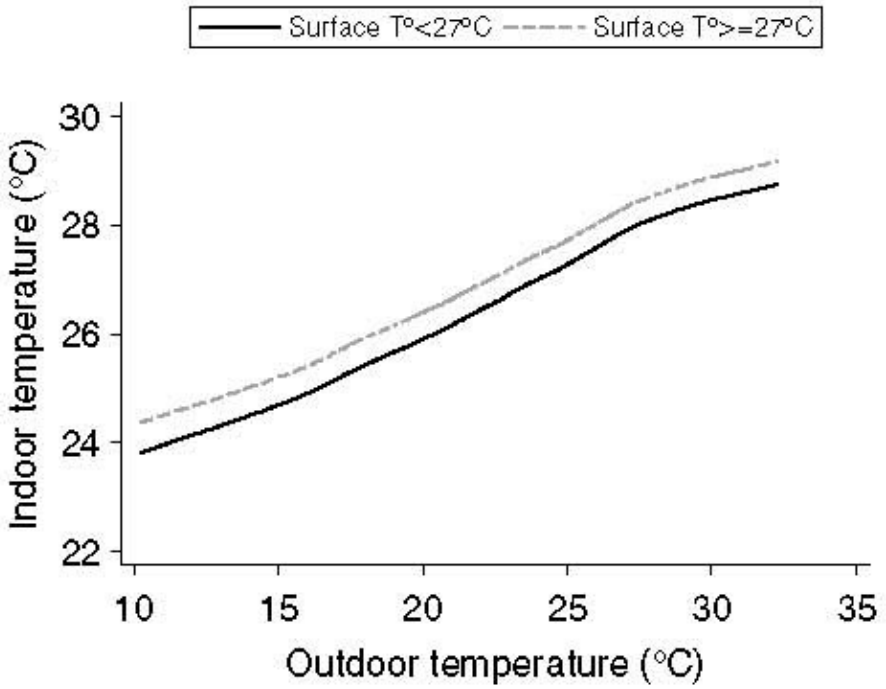
indoor temperature on the first (Ta 1st floor) and third floor (Ta 3rd floor) of a building compared with outdoor temperature (Ta DWD) in Freiburg, Germany



Source: Andreas Matzarakis, Meteorologisches Institut, Universität Freiburg, Freiburg, Germany, personal communication, 2003.

effect on indoor temperature of apartment level and heat capture zone, Montreal





research to build community adaptive capacity

How do Montreal's heart and lung patients cope with heat

Tom Kosatsky[1], Lucie Richard[2] , Annie Renouf[1], Julie Dufresne[1], Dave Stieb[3], Nadia Giannetti[4] ,Jean Bourbeau[5]

Montreal Public Health[1], Faculty of Nursing, University of Montreal[2], Air Pollution Effects Division, Health Canada[3], Heart Failure and Heart Transplant Centre, Royal Victoria Hospital[4], COPD Clinic and Pulmonary Rehabilitation Programme, Montreal Thoracic Institute[5]

Funded by: Climate Change Action Funds Contract, NR Canada A-575

Study objectives

- Describe health-related behaviours around heat in a vulnerable population
- Develop a predictive model to explain the adoption of protective behaviours
- Evaluate the impact of high heat warnings on this population
- Suggest strategies to better reach and influence this group

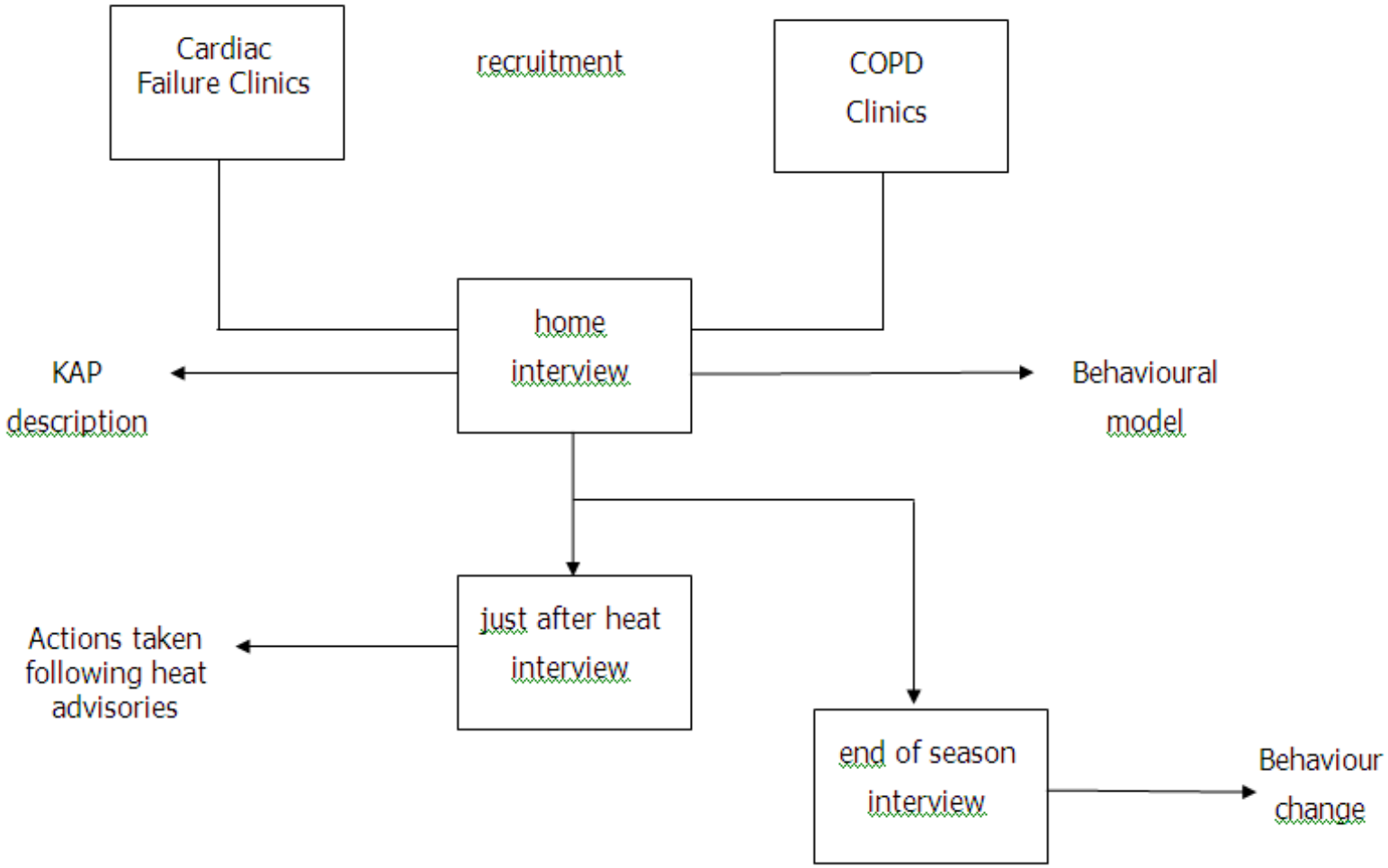
Study characteristics

-238 persons with chronic lung and heart disease recruited at five Montreal university hospital clinics

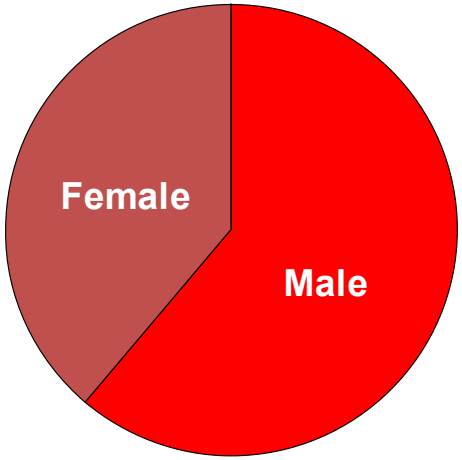
-Face-to-face survey queried knowledge, awareness, attitudes and practices around extreme heat

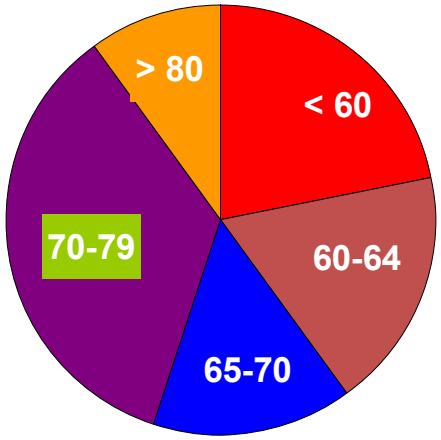
-Interviews conducted June-September 2005, a record hot summer, with daily mean temperatures 2.4°C above the long-term seasonal average

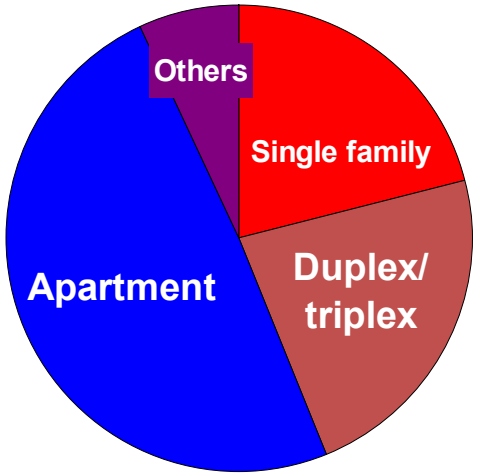
KAP around heat: study architecture

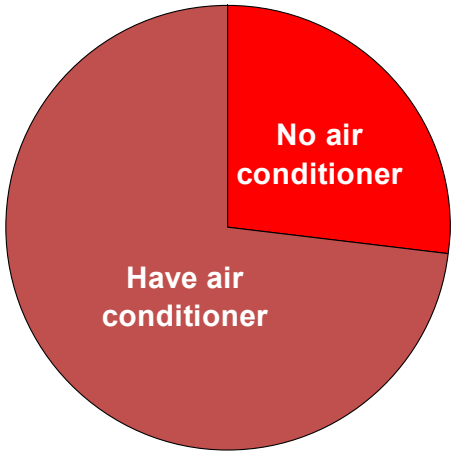


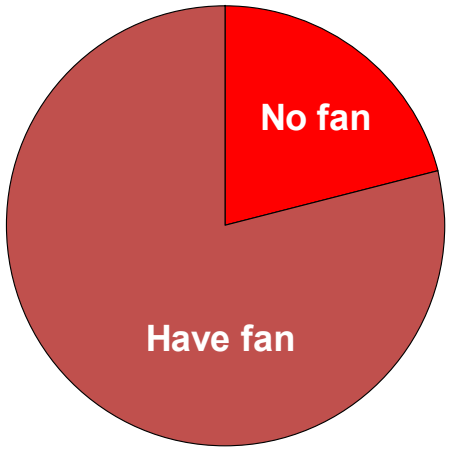
238 respondents : demography and residential characteristics





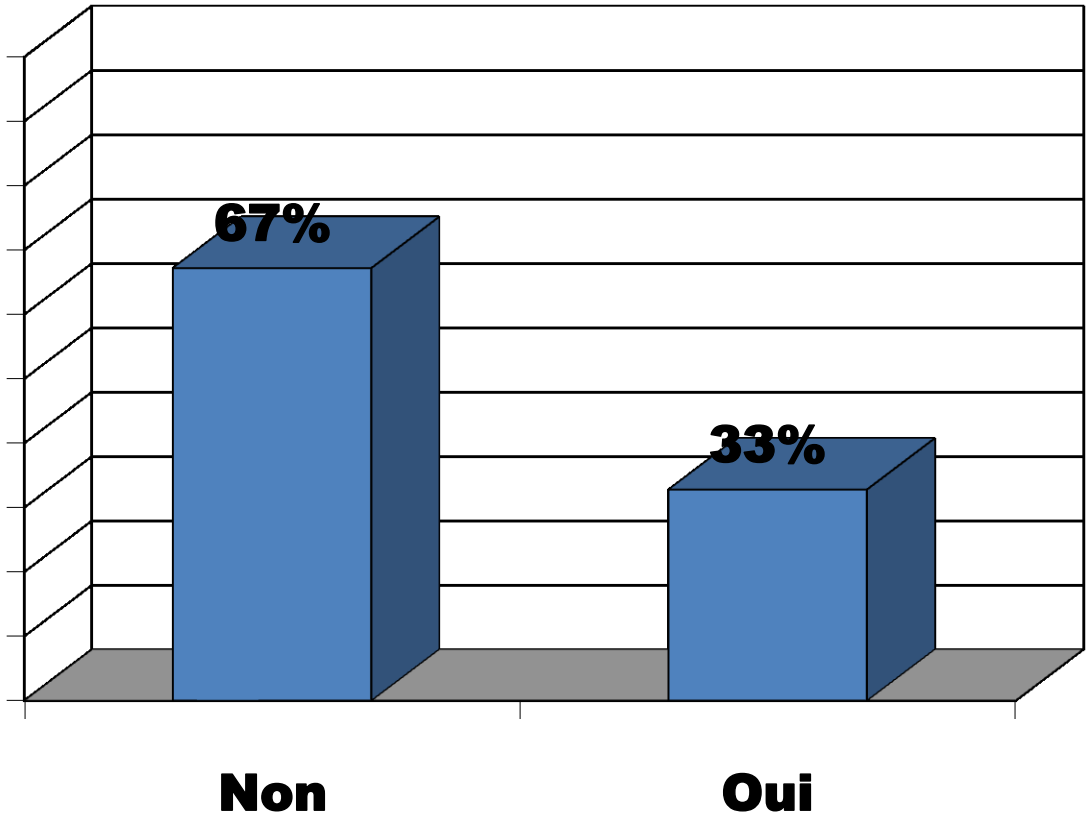






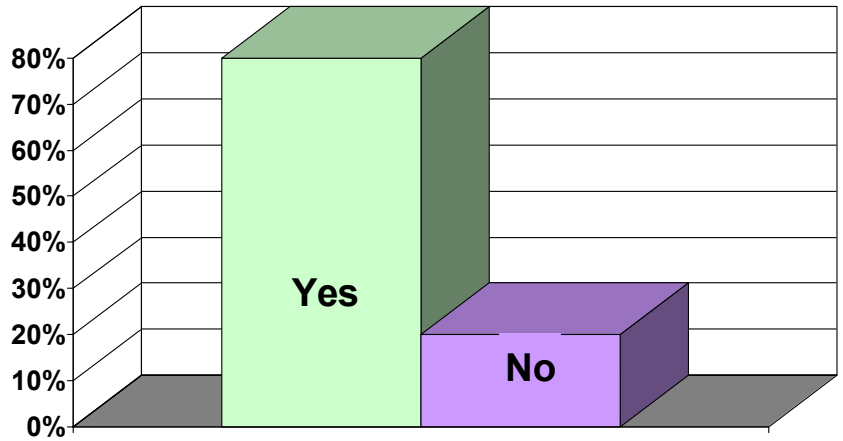
Cooling appliances

intention to buy a home air conditioner? (N=61)

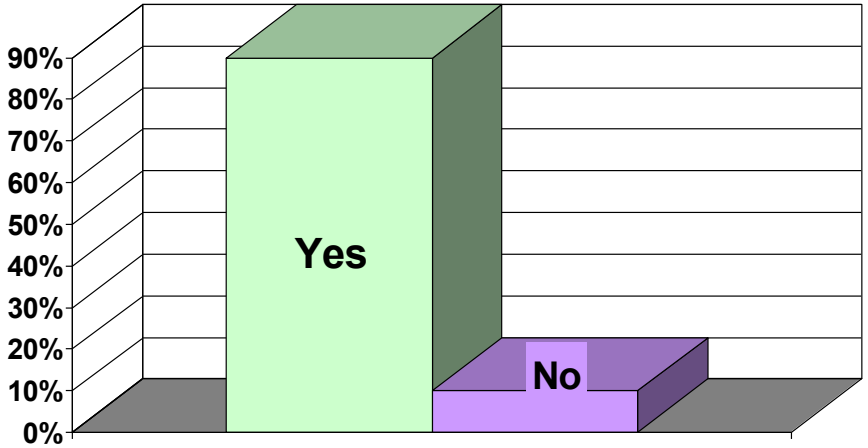


Knowledge about extreme heat (n = 238)	
If after a hot day, temperature remains high at night, it has a worse effect on health (should answer "true“)	87
People suffering from lung or heart disease are hospitalised more often during heat waves ("true")	97
Heat can affect your health even before you feel any of the warning signs ("true")	95
The humidex is based on two factors. Which? ("temperature and humidity")	46
Heat waves have a greater effect on people’s health when they occur ("at the beginning of summer")	12

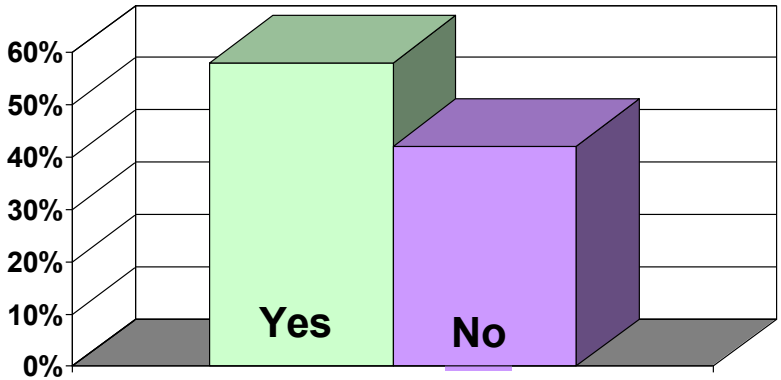
Awareness of heat and its consequences



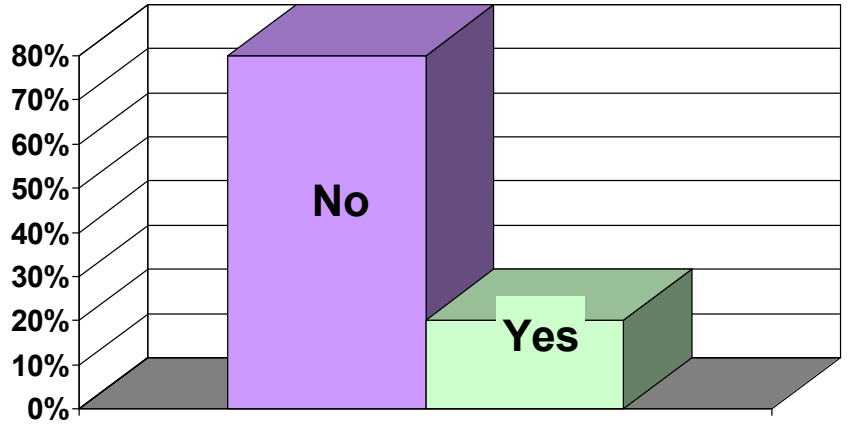
Informed about weather daily



Ever heard a heat advisory

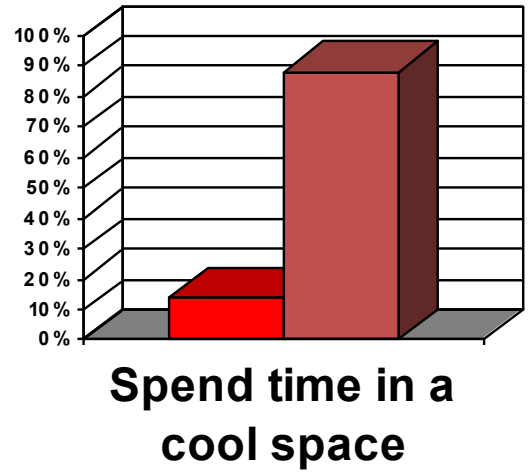


My doctor told me I am vulnerable to heat

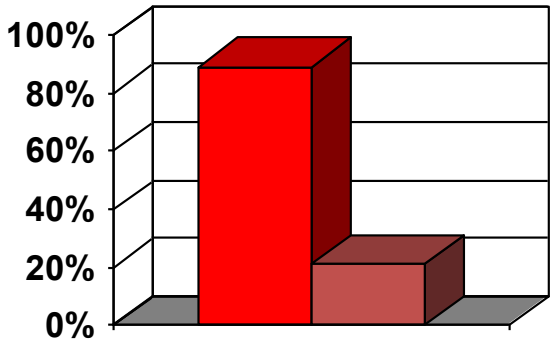


My doctor/pharmacist told me my meds make me vulnerable

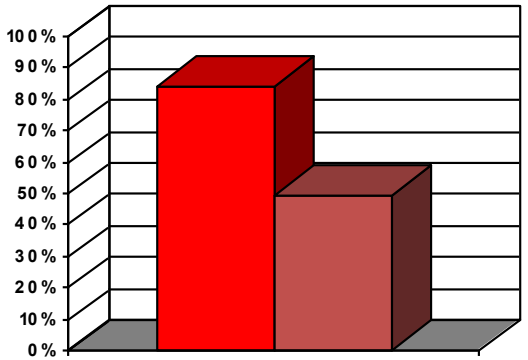
Actions: On a hot day, I "often" or "always"



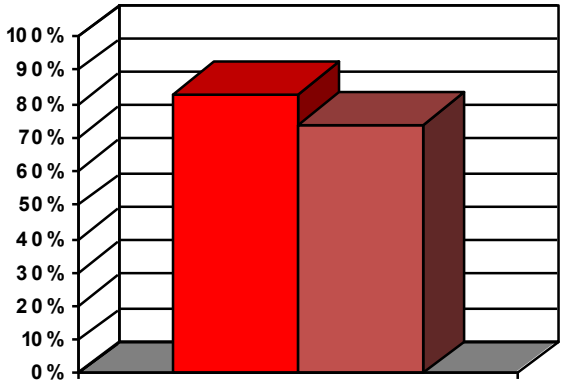
Spend time in a cool space



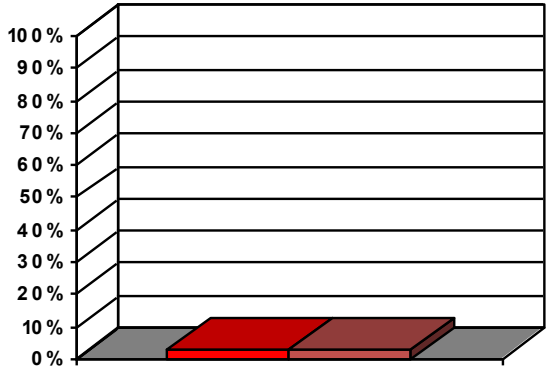
Open windows at night



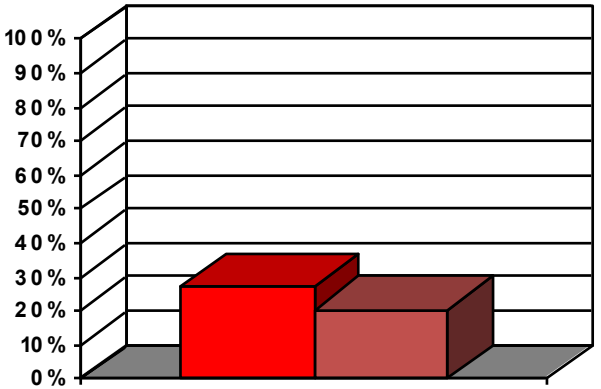
Use a fan



Drink at least 1 litre of water



Reduce my diuretic dose

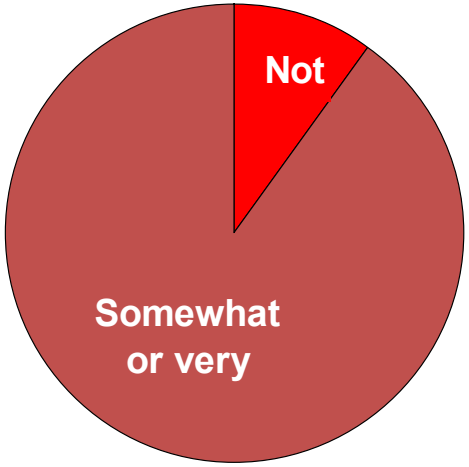


Ask for help with daily activities

No home a/c

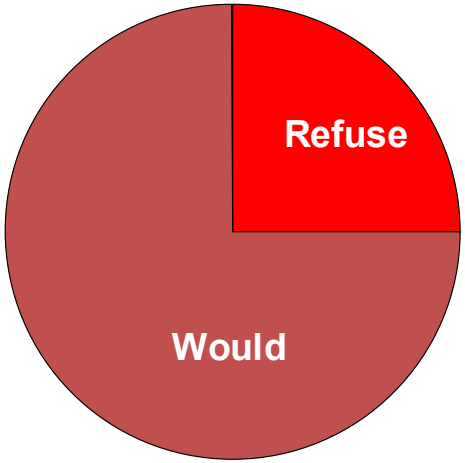
Have home a/c

Resistance to heat warnings



Are warnings important for your health? (*persons who recall hearing warnings*)

If MD advised to acquire air conditioner, would you? (*persons without a/c*)



In an emergency, if you were advised to spend the night in an air conditioned shelter (*persons without a/c*)

Conclusion:

Portrait of 238 persons vulnerable to extreme heat

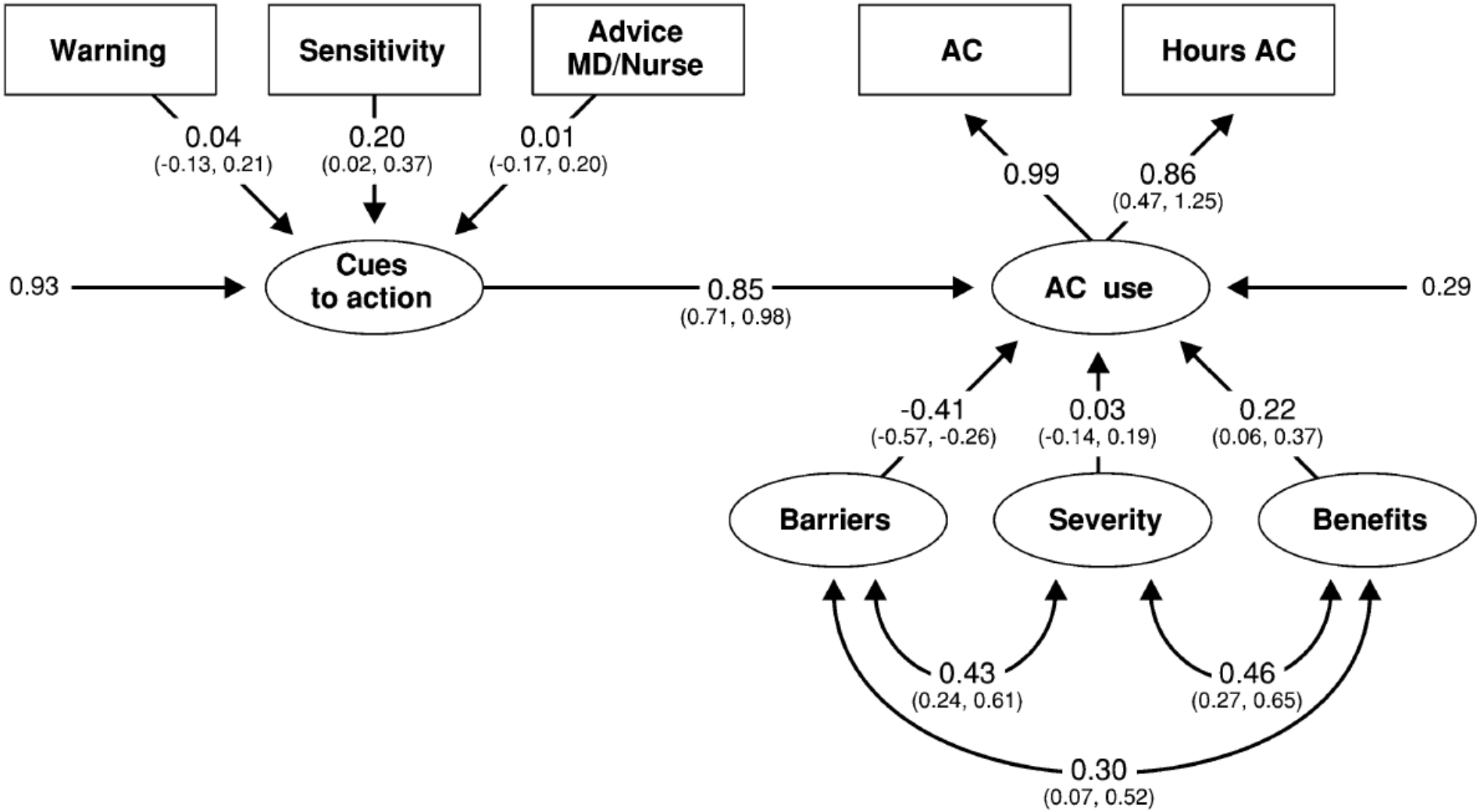
- *perceive their susceptibility*
- *have confidence in prevention*
- *listen for and trust forecasts of hot weather*
- *when it's hot, seek out cool environments or implement other recommended health protective measures*

Gaps identified

- *need for better understanding of how to cue their protective behaviours*
- *pre-heat wave planning can be improved*
- *optimisation of medical therapy in the face of hot weather*
- *need to reach and influence those resistant to taking effective preventive and emergency measures, even if urged by their caregivers or by city authorities.*

causal model depicting links between perceived benefits, perceived barriers, perceived severity, cues to action and AC use, with standardized causal coefficients.

(Unstandardized residual variances for Cues to Action and AC use were constrained to 0.3. The coefficient linking AC use to AC was constrained to 1.0) **Richard, 2010**



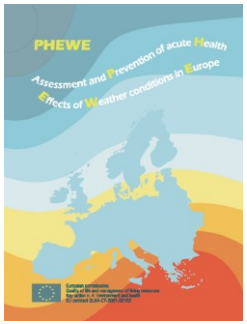
What I did yesterday (Q2), *versus*
What heat advisories say we should do (Q1)

What I did yesterday (Q2) // *Heat advisories say we should (Q1)*	**I did % (n=62)**	***We should % (n=49)***
Spent time in an air conditioned environment *stay in an air conditioned environment/go to the mall*	**87**	*33*
Used a fan//*Use a fan*	**80**	*2*
Cooled off with a wet towel, a cool bath or shower//*Take a bath*	**65**	*2*
Reduced or put off activities which require physical effort *reduce/limit physical activities*	**82**	*39*
Did not go outdoors (31/62) *not go outside/stay inside*	**51**	*82*
Stopped outdoor activities which require physical effort (24/31) *limit outdoor activities/do not exercise outdoors*	**77**	*5*
Looked for shaded areas outdoors (25/31) *Stay where it is shaded/do not stay in the sun*	**81**	*29*
Drank at least one litre of water per day	**86**	*43*
Did someone ask you or did you inform someone of how you were doing?	**83**	0
Did someone offer you help or did you ask for help with your daily activities?	**33**	0



Preparedness of European cities for heat emergencies

WORLD HEALTH ORGANIZATION
EUROPE



Dipartimento di Epidemiologia
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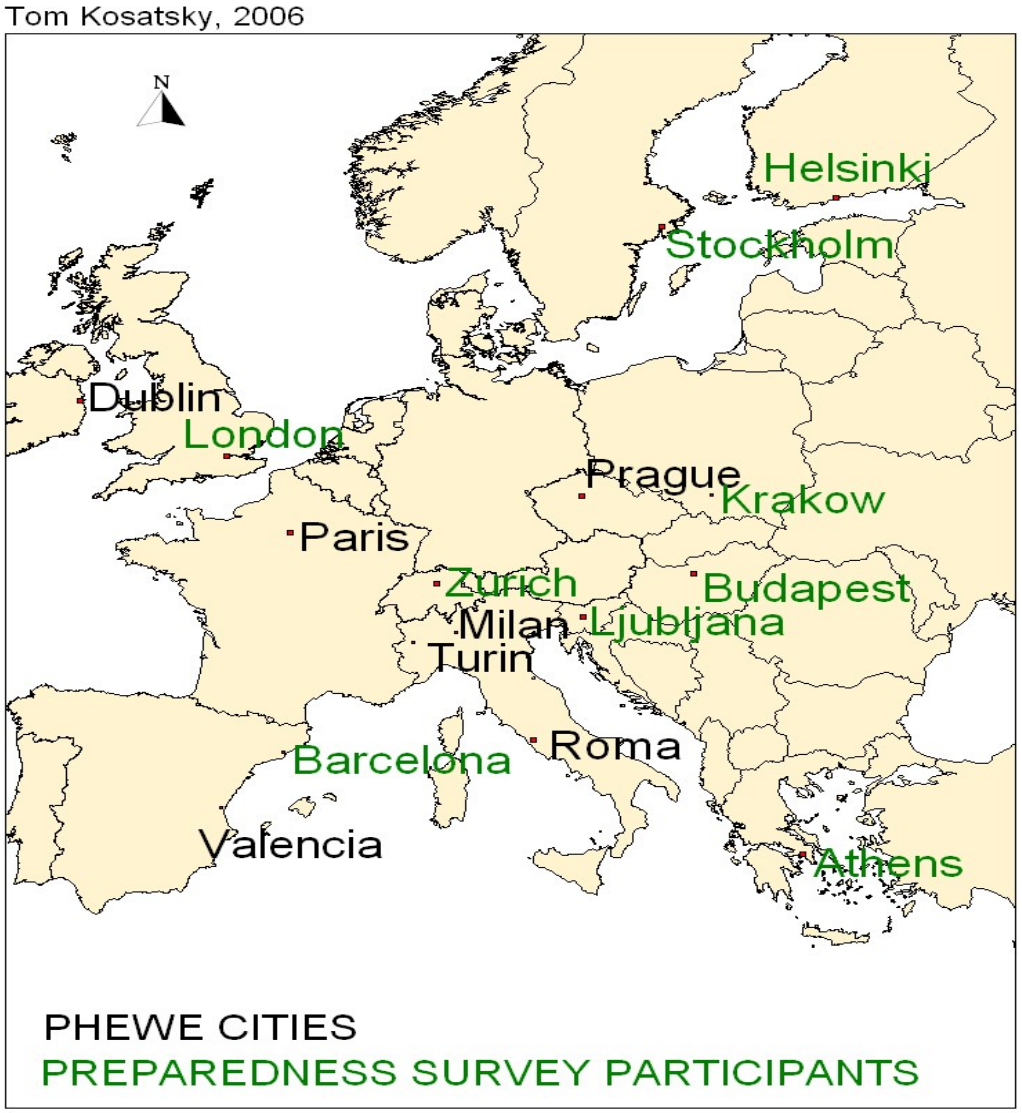
PHEWE city survey objectives

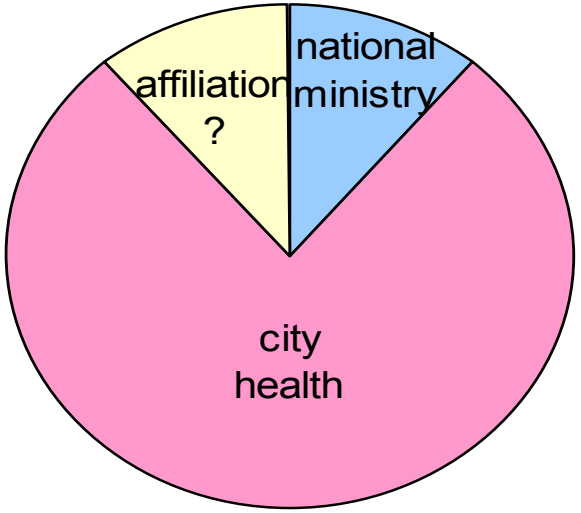
1. Describe prevention activities related to population health during extreme weather events in 16 PHEWE cities
2. Support development of best practices

Preliminary Assessment: October 2004

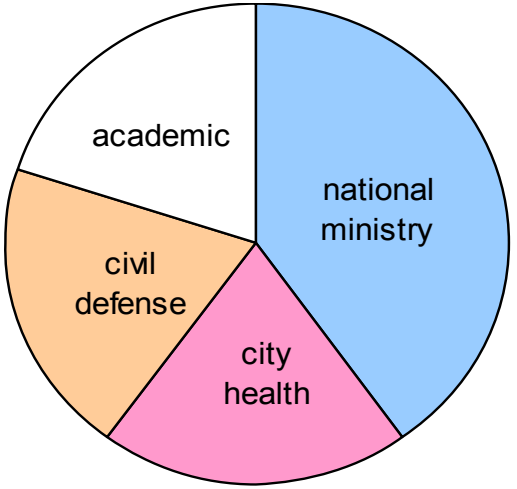
- E-mailed, mailed questionnaire
- Addressed to directors of PHEWE city health departments
- cc PHEWE co-ordinators
- Solicited an « involved, knowledgeable respondent »
- Provided framework for follow-up interview
- In English

Cities surveyed and responding





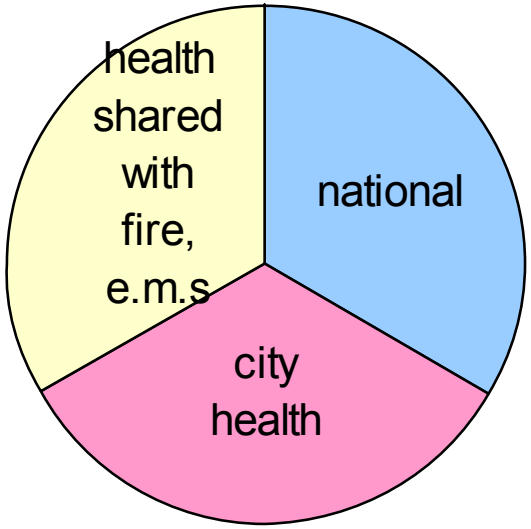
Primary respondent



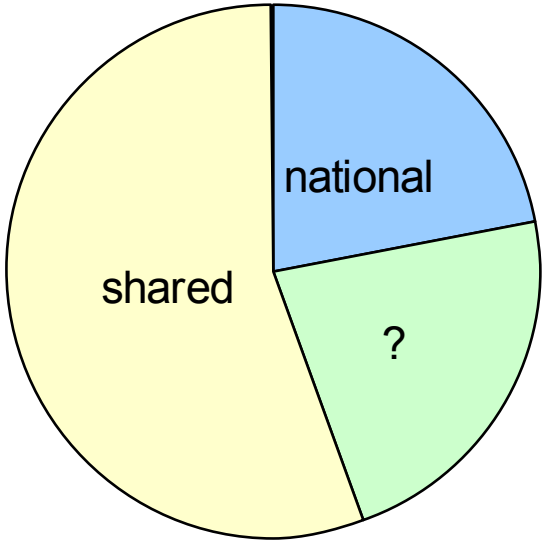
Secondary respondent

(5)

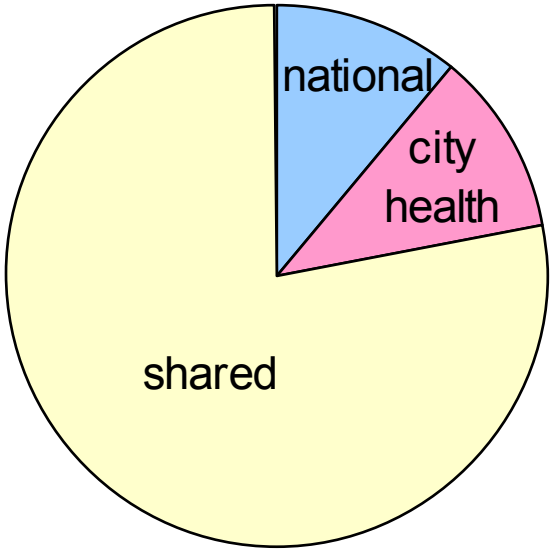
Extreme weather mandates



Environmental Health Protection

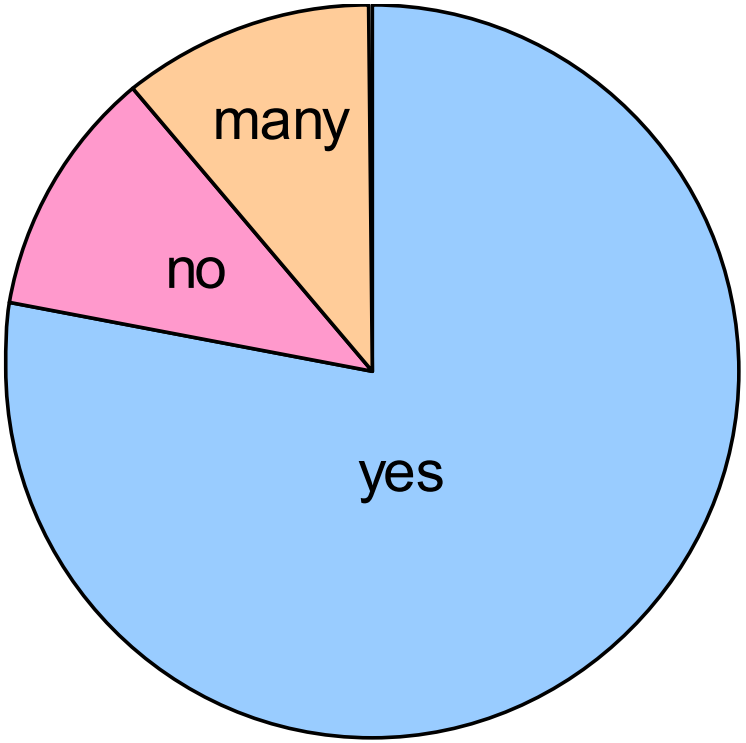


Disaster Preparedness



Emergency Response

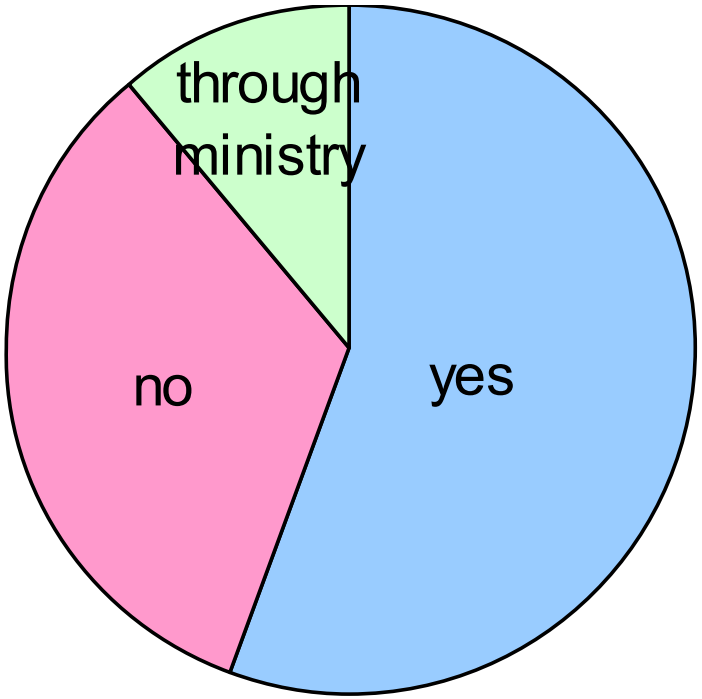
City has a health disaster plan



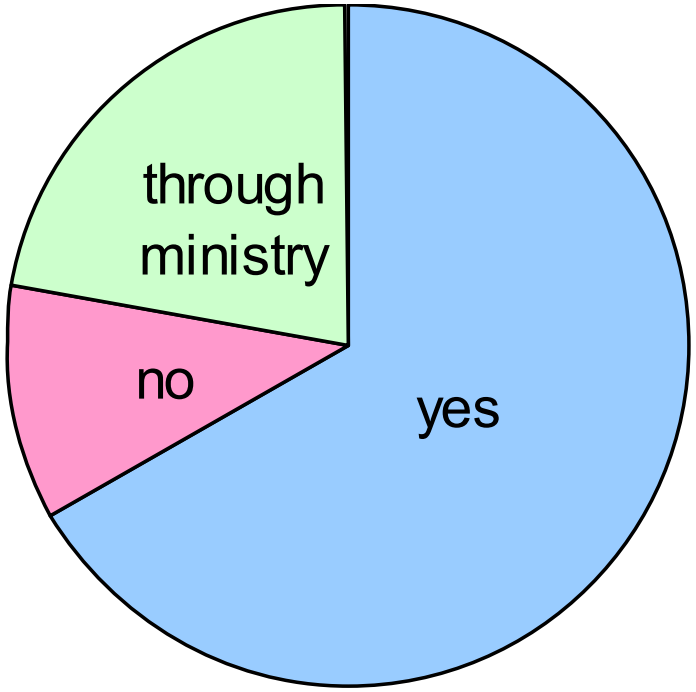
all 8 revised since 2000

Covers	
earthquakes	4
chemical spills	6
floods	5
cold	4
heat	5

Co-operative agreements



with weather service

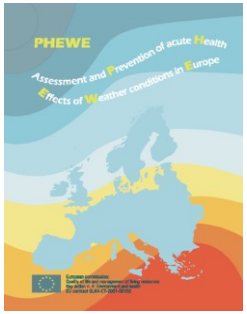


with civil defense

Limits of the survey

1. Preliminary questionnaires, not plan review
2. Responses are a function of local public health context
3. Language?
4. 9/17 responded
5. Information provided was not validated
6. High apparent respondent influence

WORLD HEALTH ORGANIZATION
EUROPE



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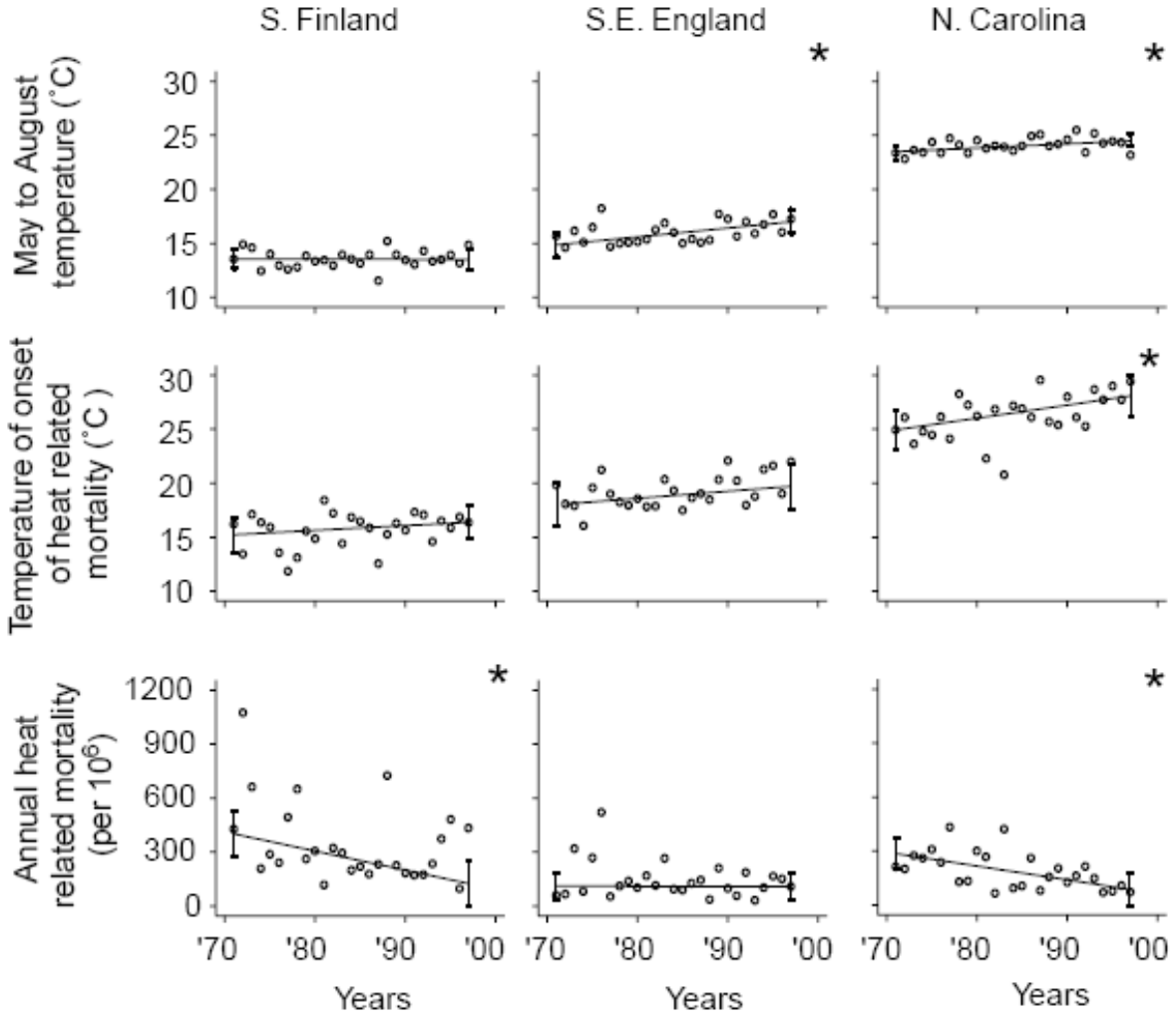
Haddon matrix and heat-wave related mortality

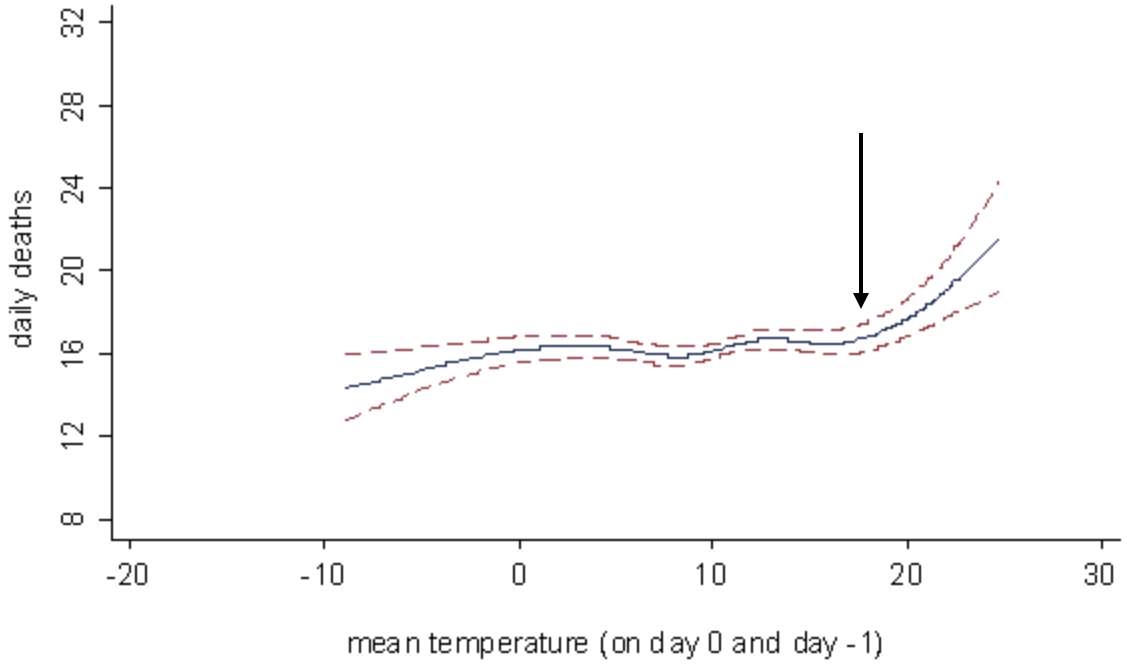
Influencing factors				
Phase	**Host**	**Agent/vehicle**	**Physical environment**	**Social environment**
Pre-event	Cardiovascular disease Anti-cholinergic medications	Climate	Urban heat island Indoor heat retention	Forecast quality, confidence Social cohesion
Event	Awareness of over-heating Protective behaviour	Degree, duration of heat episode	Neighbourhood temperature Indoor temperature	Heat warning diffusion Working « buddy system »
Post-event	Physical reserves		Rapid cooling capacity	Emergency Network Rehabilitation services

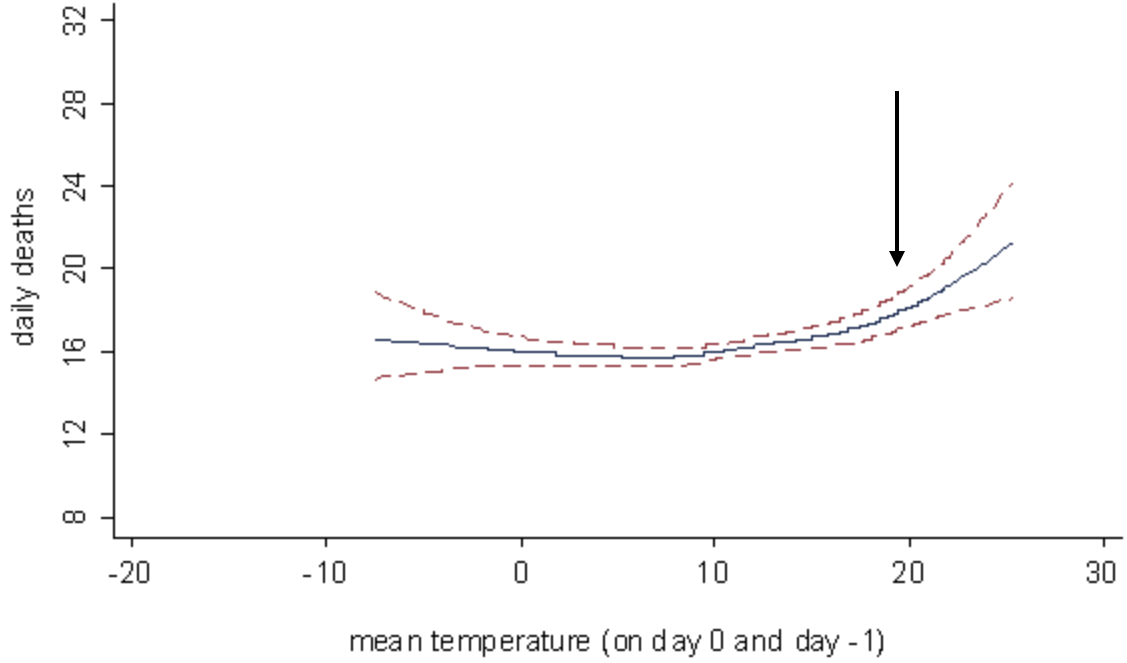
Work in progress!!

changes in mean summer temperature (May-August), temperatures of onset, and size of heat-related mortality. Heat-related mortality per million men and women aged 55+ between 1971 and 1997. Median regression lines. Bars are 95% confidence limits. *Slope, $P<0.05$ (Keatinge and Donaldson, 2003



daily deaths (all ages, all cause) for Vancouver North Metropolitan area associated with temperature at Vancouver Airport, **1986-1996**





1997-2008

thank you

BC Centre for Disease Control
An agency of the Provincial Health Services Authority

tom.kosatsky@bccdc.ca