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Sanitaria Locale Roma E

Dipartimento di Epidemiologia
del Servizio Sanitario Regionale
Regione Lazio

Health Effects of climate change

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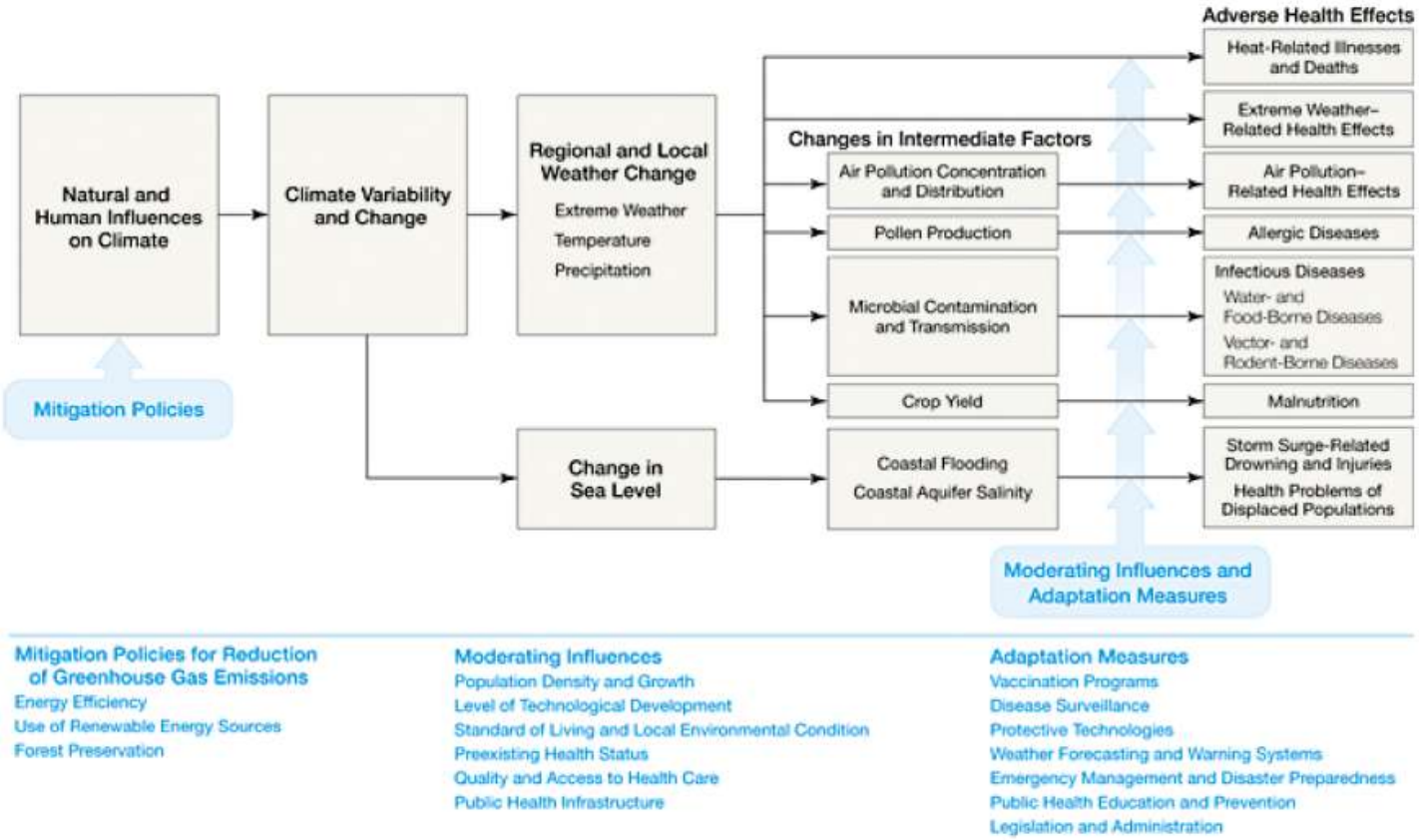
Paris, 26th November 2009

Temperatures change observed and projections

Observed change	Projections (without mitigation strategies)
At global level	
0.76°C increase over the past 100 yrs	Best estimated increase 1.8–4.0 °C during this century (range 1.1–6.4 °C)
In Europe	
1.1°C over the past 100 yrs	Mean increase 2.1–4.4 °C up to 2100 (range 2.0–6.3°C) with larger increases in southern and north-eastern Europe

Source: modified from EEA Technical report n° 2/2007 - Climate change and water adaptation issues

Potential health effects of climate change



Haines and Patz, JAMA 2004

Global direction and trends in extreme weather events and health

Phenomenon and trend	Projections for the 21st century	Benefits or risk to human health
Warmer days and nights, more hot days and nights and fewer cold days and nights	*Virtually certain*	Reduced mortality from decreased cold exposure
Increase in frequency of warm spells/heat-waves	*Very likely*	Increased risk of heat-related mortality, especially for the elderly, chronically ill, very young and socially isolated
Increase in frequency of heavy precipitation events	*Very likely*	Increase risk of death, injuries, infectious diseases, and mental health problems
Increase droughts areas	*Likely*	Increase risk of food and water shortages, malnutrition and water- and foodborne diseases
Increased incidence of extremes high sea levels	*Likely*	Increases risk of deaths and injuries from drowning and of negative migration-related health effects

Adapted from Climate Change 2007. Synthesis report IPCC

Estimating the impact of heat and heat waves on health

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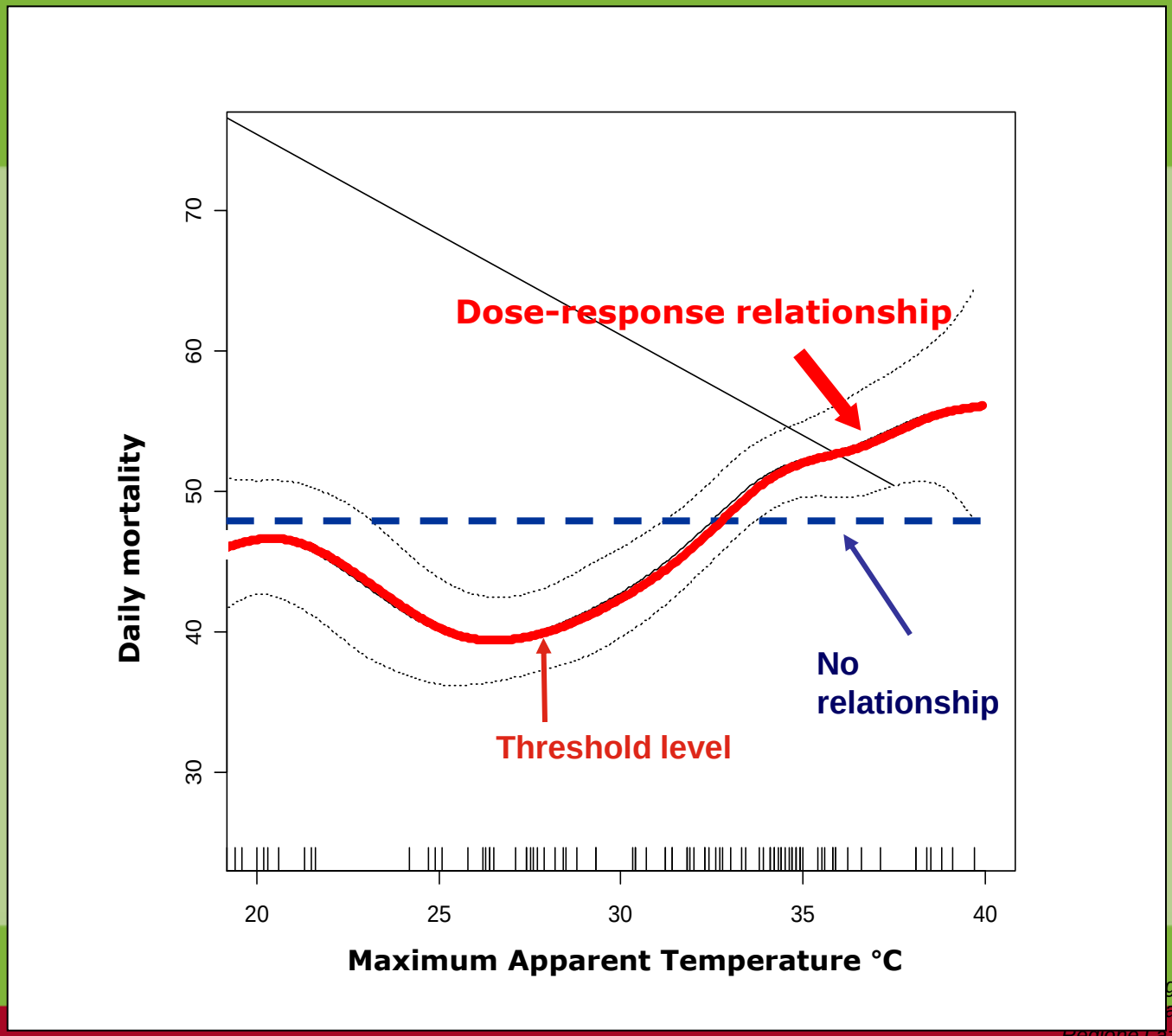
Temperature-mortality relationship



Two EU-funded multicenter projects **(PHEWE, EuroHEAT)** have investigated the effect of temperature and heat waves on mortality and hospital admissions in European cities.

Michelozzi P, et al. Environ Health 2007;6:12.

Baccini M, et al. Epidemiology 2008;19(5):711-9.

Analitis A, et al. Am J Epidemiol 2008;168(12):1397-1408.

Michelozzi P, et al. Am J Respir Crit Care Med. 2009 Mar 1;179(5):383-9.

D'Ippoliti D, et al. Am J Epidemiol (submitted).

PHEWE and EuroHEAT projects: cities involved

- Phewe cities period: 1990-2000
- Euro-Heat cities period: 1990-2004

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Methods

	PHEWE	EuroHEAT
Study design	Time series analysis	Episode analysis
Exposure	Maximum apparent temperature (T_{appmax}) (lag 0-3)	Heat wave: two or more days with: -T_{appmax} >90° pctile OR -T_{min}>90° pctile & T_{appmax}>median
Outcome	Mortality & hospital admissions	Mortality

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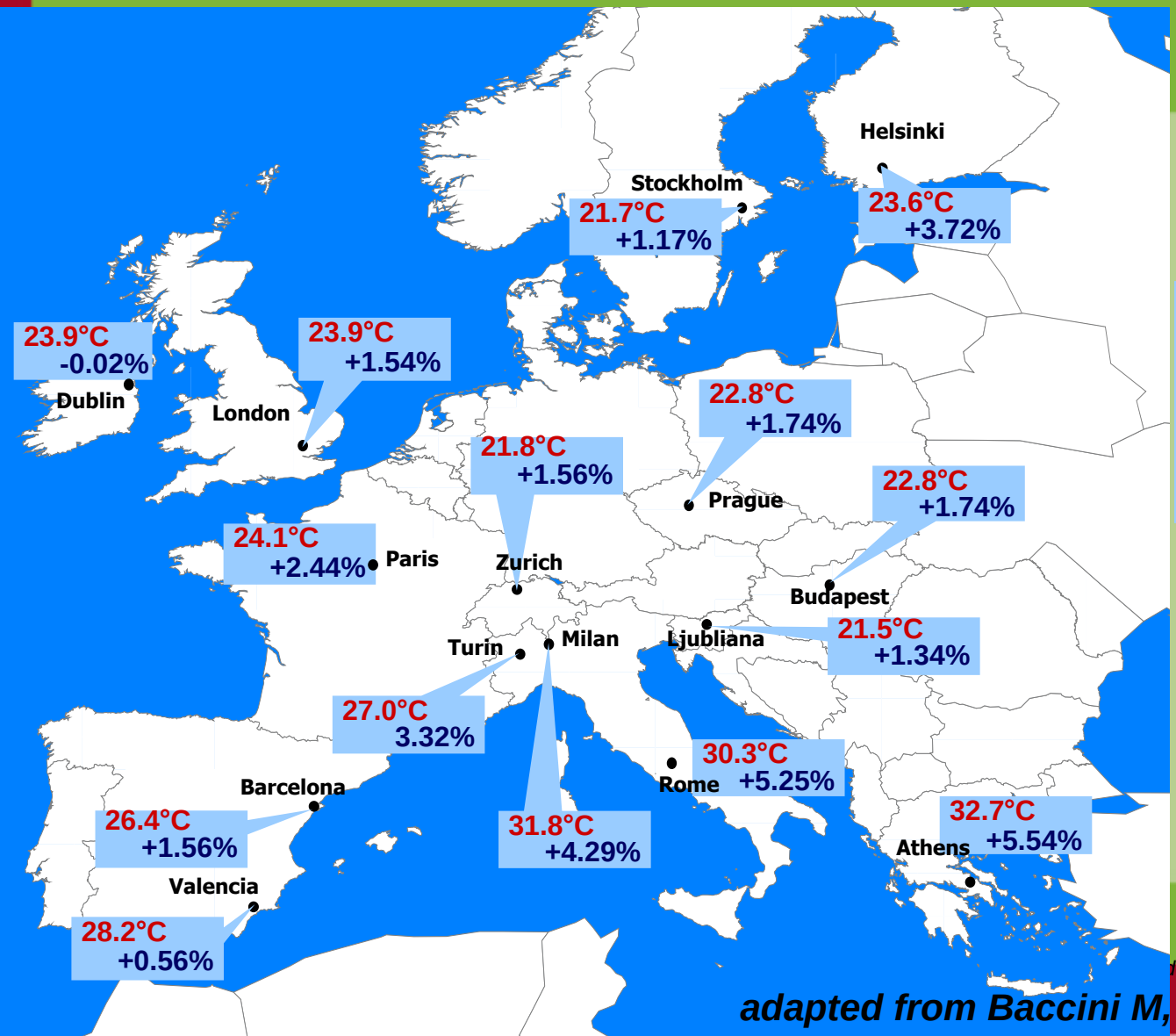
City-specific effect:

Relationship between maximum apparent temperature and mortality



threshold value

% change for 1°C increase

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adapted from Baccini M, et al. Epidemiology 2008

Cause-specific mortality:

Relationship between maximum apparent temperature and mortality

	Mediterranean cities			North-Continental cities		
Natural mortality						
	% change	95% CrI		% change	95% CrI	
All ages	3.12	0.60	5.73	1.84	0.06	3.64
15-64 yrs	0.92	-1.29	3.13	1.31	-0.94	3.72
65-74 yrs	2.13	-0.42	4.74	1.65	-0.51	3.87
75+ yrs	4.22	1.33	7.20	2.07	0.24	3.89
Cardiovascular mortality						
	% change	95% CrI		% change	95% CrI	
All ages	3.70	0.36	7.04	2.44	-0.09	5.32
15-64 yrs	0.57	-2.47	3.83	1.04	-2.20	4.92
65-74 yrs	1.92	-1.49	5.35	1.50	-1.12	4.62
75+ yrs	4.66	1.13	8.18	2.55	-0.24	5.51
Respiratory mortality						
	% change	95% CrI		% change	95% CrI	
All ages	6.71	2.43	11.26	6.10	2.46	11.08
15-64 yrs	1.54	-3.68	7.22	3.02	-1.55	7.42
65-74 yrs	3.37	-1.46	8.22	3.90	-0.16	8.92
75+ yrs	8.10	3.24	13.37	6.62	3.04	11.42

Baccini M, et al. Epidemiology 2008

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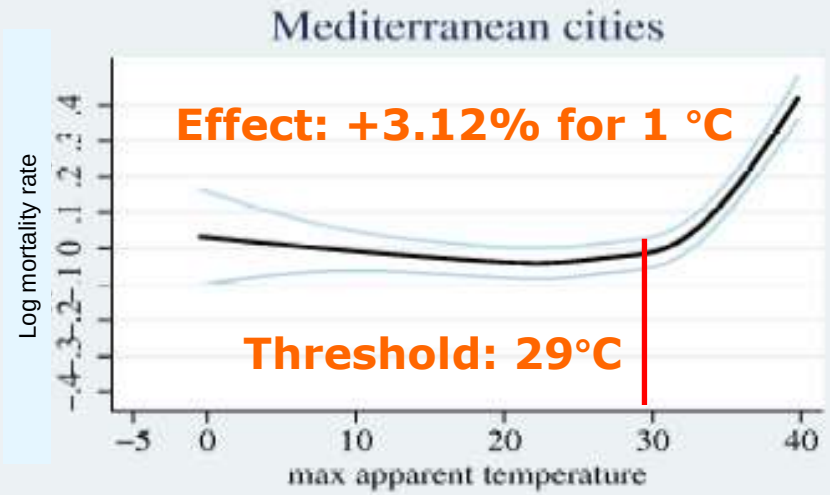
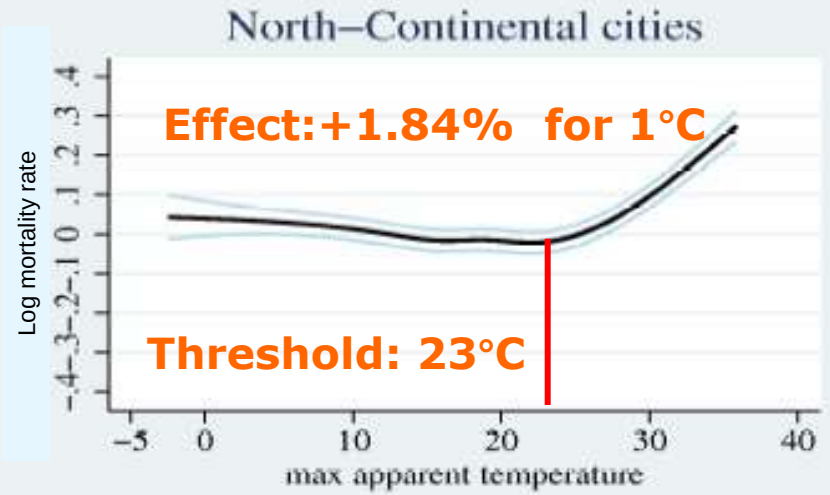
Pooled effect:

Relationship between maximum apparent temperature and mortality





Baccini M, et al. Epidemiology 2008

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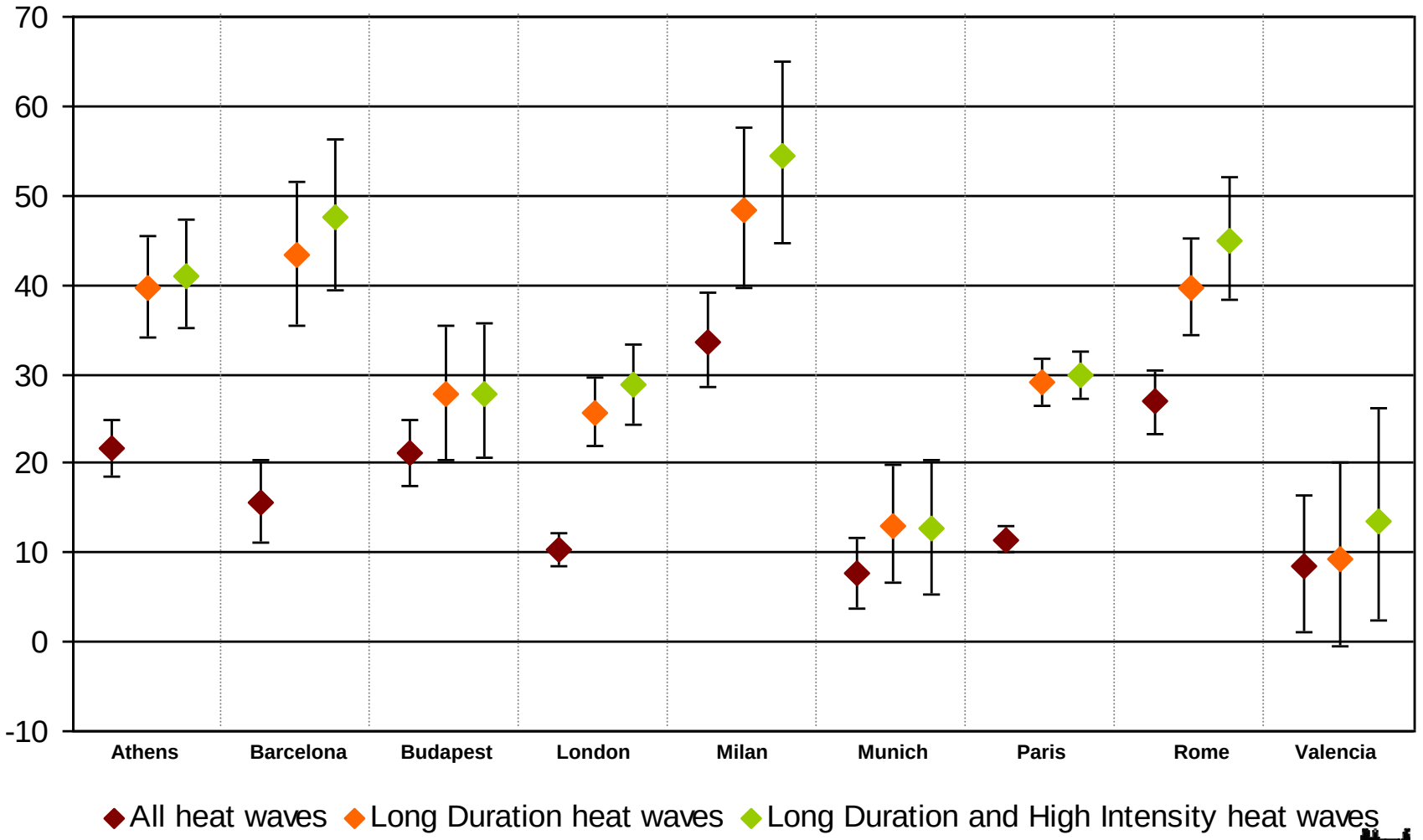
Hospital admissions:

Effect of maximum apparent temperature on hospital admissions above the 90° percentile by cause and age group *Michelozzi P, et al. AJRCCM 2009*

	% change (95%CI)†			
	Mediterranean cities		North-Continental cities	
Cardiovascular causes				
all ages	-0.6	(-1.8; 0.5)	-0.6	(-1.2; 0.1)
65-74 age group	-0.5	(-2.7; 1.7)	-1.1	(-2.3; 0.1)
75+ age group	-1.1	(-2.5; 0.3)	-0.6	(-1.4; 0.3)
Cerebrovascular causes				
all ages	-0.7	(-3.0; 1.6)	-1.1	(-2.5; 0.2)
65-74 age group	0.4	(-3.1; 4.0)	-1.6	(-4.2; 1.1)
75+ age group	-1.9	(-4.2; 0.5)	-1.3	(-3.1; 0.6)
Respiratory causes				
all ages	2.1	(0.6; 3.6)	1.2	(0.1; 2.2)
65-74 age group	-0.3	(-4.1; 3.6)	2.7	(-0.3; 6.0)
75+ age group	4.5	(1.9; 7.3)	3.1	(0.8; 5.5)

Heat wave characteristics:

Effect of heat waves on mortality by duration and intensity



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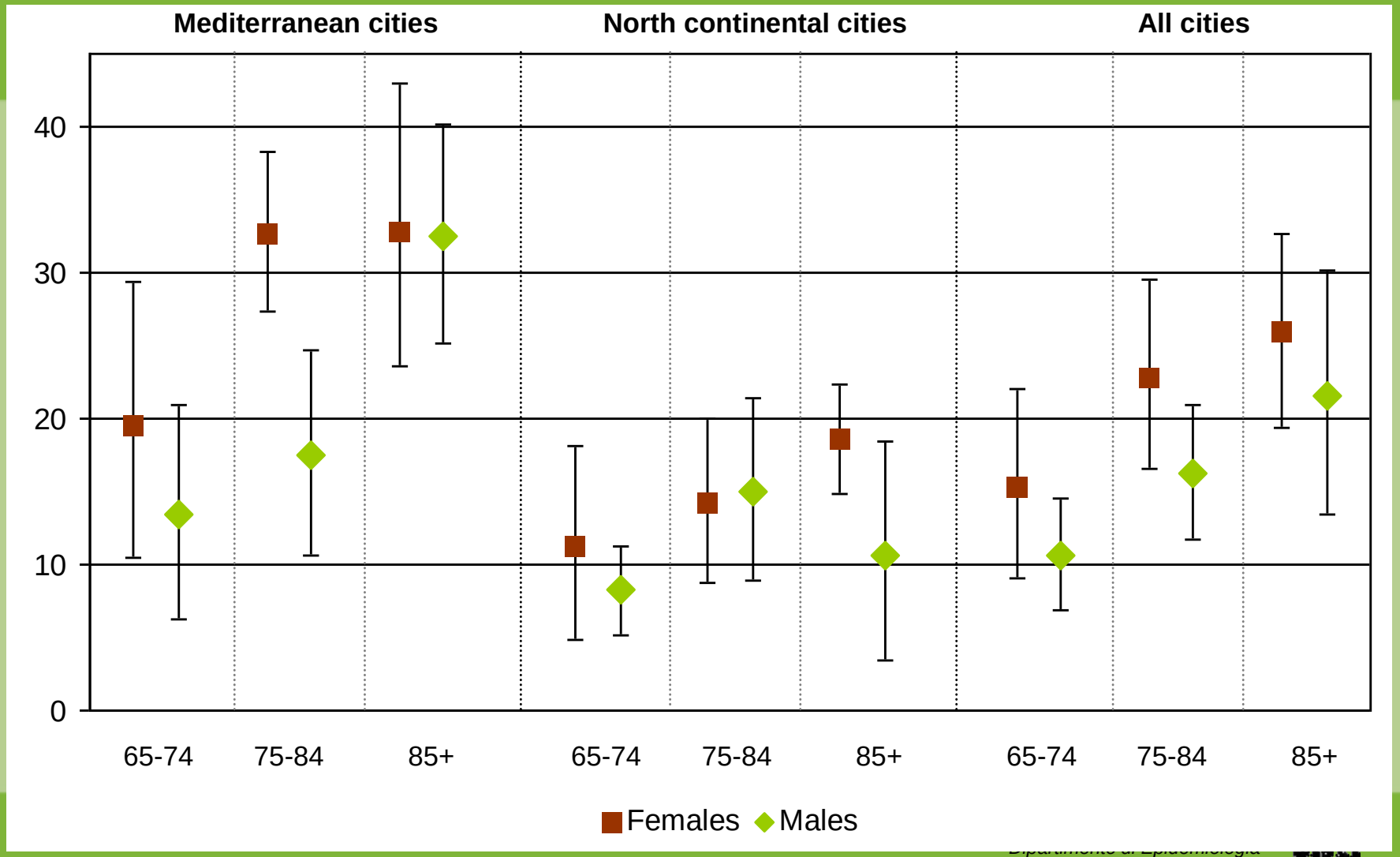
D'Ippoliti D, et al. Am J Epidemiol (submitted)

Age and gender:

Effect of heat waves on mortality by age group and gender



D'Ippoliti D, et al. Am J Epidemiol (submitted)

Cause-specific mortality:

Effect of heat waves on mortality by cause and gender

	Mediterranean		North Continental	
	Increase in daily mortality		Increase in daily mortality	
	%	90% CI	%	90% CI
Respiratory causes				
female	57.0	32.7 - 85.7	24.9	18.5 - 31.5
male	48.9	37.4 - 61.3	15.6	10.4 - 21.2
Cardiovascular causes				
female	38.0	30.3 - 46.1	16.1	10.1 - 22.3
male	22.6	17.8 - 27.8	9.6	4.8 - 14.6
Cerebrovascular causes				
female	39.8	29.2 - 51.3	19.5	12.9 - 26.4
male	22.6	17.8 - 27.8	9.6	4.8 - 14.6

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D'Ippoliti D, et al. Am J Epidemiol (submitted)

ERJ Express. Published on February 27, 2009 as doi: 10.1183/09031936.00003409

Climate change and respiratory disease: a position statement

Ayres JG[1], Forsberg B[2], Annesi-Maesano I[3], Dey R[4], Ebi KL[5], Helms PJ[6], Medina-Ramón M[7], Menne B[8], Windt M[9], and Forastiere F[10] on behalf of the Environment & Human Health Committee of the European Respiratory Society (ERS)

Attributable deaths under different weather scenarios

	Number of attributable deaths*			
	Observed series 1990-2000	B1 Low emission scenario 2030 ΔT**=0.54	A1B Middle emission scenario 2030 ΔT**=0.84	A2 High emission scenario 2030 ΔT**=1.02
Athens	230	316	376	415
Barcelona	290	319	338	350
Budapest	399	457	490	511
Dublin	0	0	1	1
Helsinki	11	14	17	18
Ljubljana	13	13	15	15
London	142	183	206	220
Milan	95	116	130	139
Paris	423	500	546	574
Prague	72	84	93	98
Rome	388	470	520	552
Stockholm	21	19	21	22
Turin	121	136	148	156
Valencia	72	56	59	61
Zurich	29	32	35	37

Baccini M, et al. J Epidemiol Comm Health (in press)

Results. Public health implications

- Effect of heat on mortality greater in cities with higher exposure levels (Mediterranean cities)
- Higher susceptibility/lower adaptive capacity of populations living in North-Continental cities (lower threshold, higher impact of unusual heat waves)
- Hospital admissions for respiratory diseases is a good indicator of heat effect in European cities
- The impact of extreme heat events on chronic respiratory diseases is expected to increase in European cities as result of global warming and progressive population aging

(ERS Position Statement, Eur Respir J 2009)

Identifying subgroups of general population more susceptible to heat and heat waves

Vulnerability = *f (Hazard, Susceptibility, Adaptation)*

Heat hazard:

function of intensity and duration of a period of anomalous heat

Susceptibility:

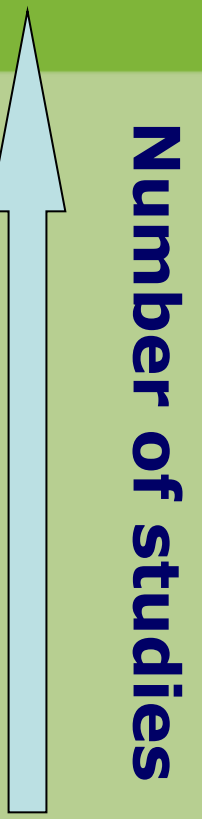
physiological and behavioural response to anomalous heat, individual/population level

Adaptation capacity:

perception, awareness of heat hazard and of the need to adapt, availability of resources

Susceptible population subgroups

- **Age**
  - ≥65 anni
- **Chronic illnesses**
  - cardiovascular
  - respiratory
  - psychosis
- **Gender**
  - female
- **Poor social condition**
  - socio-economic status
  - living alone
  - limited social contacts
- **Individual preventive measures**
  - air conditioning
  - changes in behaviour



Number of studies

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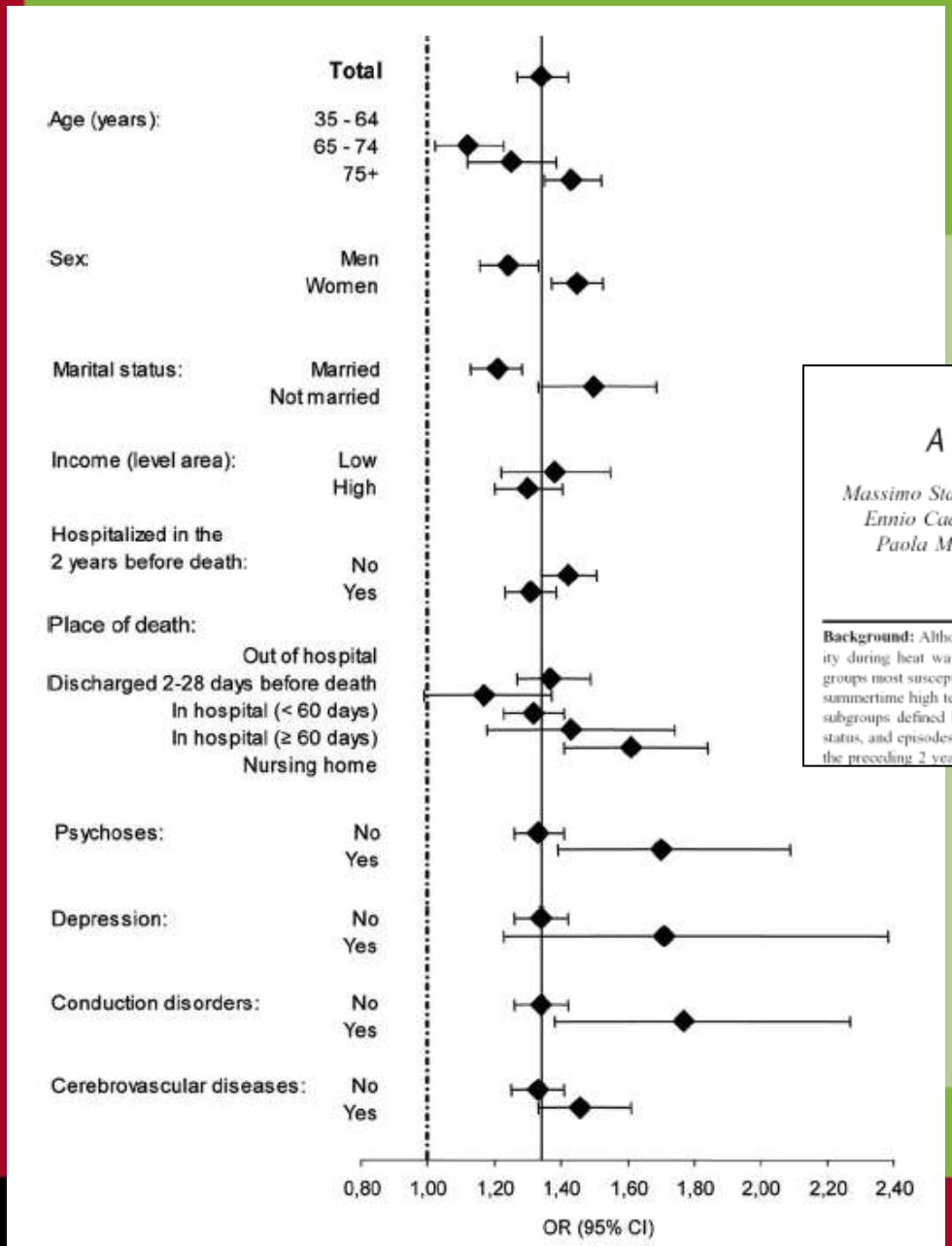


Vulnerability to Heat-Related Mortality

A Multicity, Population-Based, Case-Crossover Analysis

Massimo Stafoggia, Francesco Forastiere,* Daniele Agostini,† Annibale Biggeri,‡ Luigi Bisanti,§ Ennio Cadum,‖ Nicola Caranci,¶ Francesca de'Donato,* Sara De Lisio,† Moreno De Maria,‖ Paola Michelozzi,* Rossella Miglio,** Paolo Pandolfi,† Sally Picciotto,* Magda Rognoni,§ Antonio Russo,§ Corrado Scarnato,† and Carlo A. Perucci**

Background: Although studies have documented increased mortality during heat waves, little information is available on the subgroups most susceptible to these effects. We evaluated the effects of summertime high temperature on daily mortality among population subgroups defined by demographic characteristics, socioeconomic status, and episodes of hospitalization for various conditions during the preceding 2 years.

Conclusions: Subsets of the population that are particularly vulnerable to high summer temperatures include the elderly, women, widows and widowers, those with selected medical conditions, and those staying in nursing homes and healthcare facilities.

(*Epidemiology* 2006;17: 315–323)

Environmental Health

BioMed Central

Susceptibility to heat wave-related mortality: a follow-up study of a cohort of elderly in Rome

Environmental Health

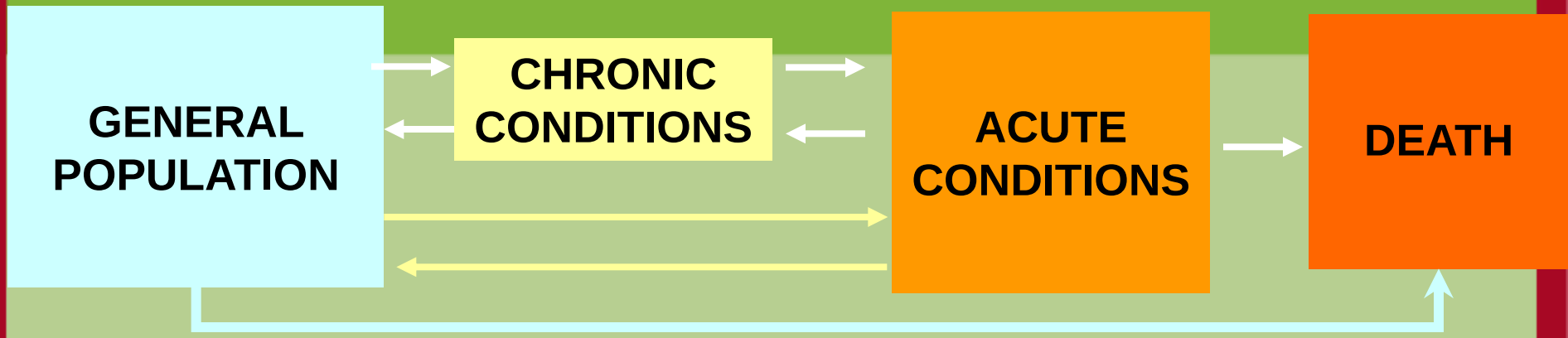
BioMed Central

Susceptibility to heat wave-related mortality: a follow-up study of a cohort of elderly in Rome

(Schifano et al., Env. Health, 2009)

Age groups strata		65-74			75+		
Factors		RR	CI 95% inf	CI 95% sup	RR	CI 95% inf	CI 95% sup
Gender		1.48	1.27	1.72	1.26	1.15	1.37
Age							
	85-94 vs 75-84	-	-	-	2.45	2.26	2.65
	95+ vs 75-84	-	-	-	4.46	3.91	5.08
Civil Status	*single vs not single*	1.37	1.17	1.61	1.27	1.16	1.38
Malignant neoplasm		14.66	12.68	16.95	3.86	3.49	4.27
Acute and chronic liver diseases		2.56	1.88	3.47	1.82	1.44	2.30
Renal failure		2.63	1.96	3.53	1.82	1.58	2.10
Psychiatric disorders		2.18	1.54	3.09	1.46	1.23	1.74
Diabetes mellitus		1.25	1.00	1.58	1.54	1.37	1.74
Other Disorders of the CNS		3.24	2.45	4.29	1.03	0.90	1.17
Cardiac dysrhythmias		1.57	1.20	2.06	1.94	1.69	2.24
Heart failure		2.58	1.85	3.60	1.28	1.13	1.45
Cerebrovascular diseases		1.74	1.35	2.24	1.98	1.72	2.28
Chronic pulmonary diseases		1.99	1.58	2.51	1.54	1.38	1.73
Income level	*low vs high*	1.24	1.06	1.46	1.34	1.18	1.52
Number of previous hospitalizations							
	0-1	1.24	0.89	1.74	0.63	0.49	0.81
	>1	2.86	1.61	5.07	1.20	1.09	1.31

SUSCEPTIBILITY MODEL



SUSCEPTIBILITY

Exposure level and adaptive/mitigation mechanisms (vulnerabiltiy)

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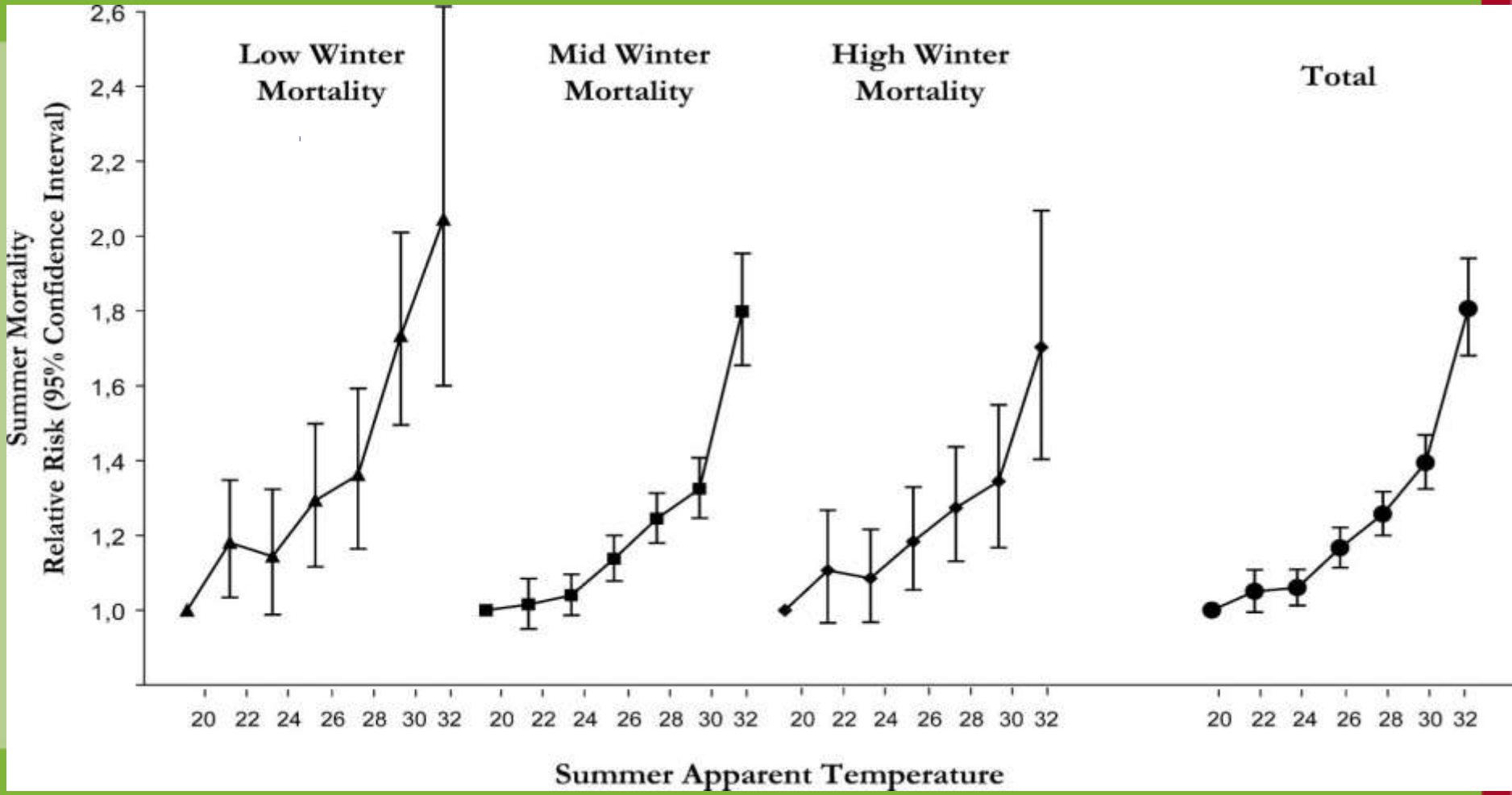
Effect modification by previous winter mortality



Stafoggia M. et al. Epidemiology • Volume 20, Number 3, May 2009

Prevention

of heat-health effects

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Italian Prevention Programme

- City-specific Heat Health Watch Warning Systems (HHWWS) and local network for the distribution of the warning bulletin
- To identify susceptible (at-risk) subgroups of the population
- To define local prevention plan

National Programm Summer 2009

Coverage: 93% of elderly population (age >65) living in urban areas

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Example of HHWWS daily bulletin

<< City >>

Warning System for Prevention of the health effects of heat waves

Forecast

Date	06-14-2009	06-15-2009	06-16-2009
	Level 0	**Level 2**	**Level 3**
Temperature 8:00 a.m.	23.5	24.8	25.1
Temperature 14:00 p.m.	30.1	31.5	32.7
Maximum Apparent Temperature	31.4	32.8	33.6

Legend

Level 0	Meteorological conditions with no risk for population's health
Level 1	Meteorological conditions with no risk for population's health that may anticipate level 2 conditions.
Level 2	High temperatures and meteorological conditions with adverse health effects on at risk population subgroups*
Level 3	Heat wave episode (adverse meteorological conditions prolonged for three or more days). Prevention activities targeted to at risk population subgroups are needed.

*See on this website the document "Heat Prevention: informations for general population"

National Department for Civil Protection

On behalf of
the National Coordination Center

Dipartimento di Epidemiologia
Struttura regionale di riferimento per l'epidemiologia
ASL RME

Prevention activities in Italian cities

Preventive measure	Level of implementation	
Define a Local prevention plan	29/34	+++
Social interventions		
Educational campaign	32/43	+++
Telephone help-line	28/34	+++
Social support services	31/34	+++
Availability of air-conditioned places	22/34	++
Educational programmes for social and health workers	25/34	++
Health care interventions		
Health surveillance of at-risk individuals	11/34	++
Local register of susceptible individuals	24/34	++
Emergency protocols	15/34	+

Conclusions

- A reduction in the impact of heat waves has been observed in the Italian cities which have had operational HHWWS and heat programs since 2004.
- Preliminary results suggest that the active surveillance of high risk subgroups may reduce the impact on mortality.
- Considering future predictions of climate change, the implementation of effective prevention programs, targeted to high risk subjects, are a priority in the public health agenda