Clinical Climate Impact Research – The Lungs as Portal Organ of Climate Change

- From the Epidemiology to the Clinical Practice of Physicians and Patients- Closing the gap -

Impacts World 2017 Conference, 11.-12. October 2017, Potsdam, Germany

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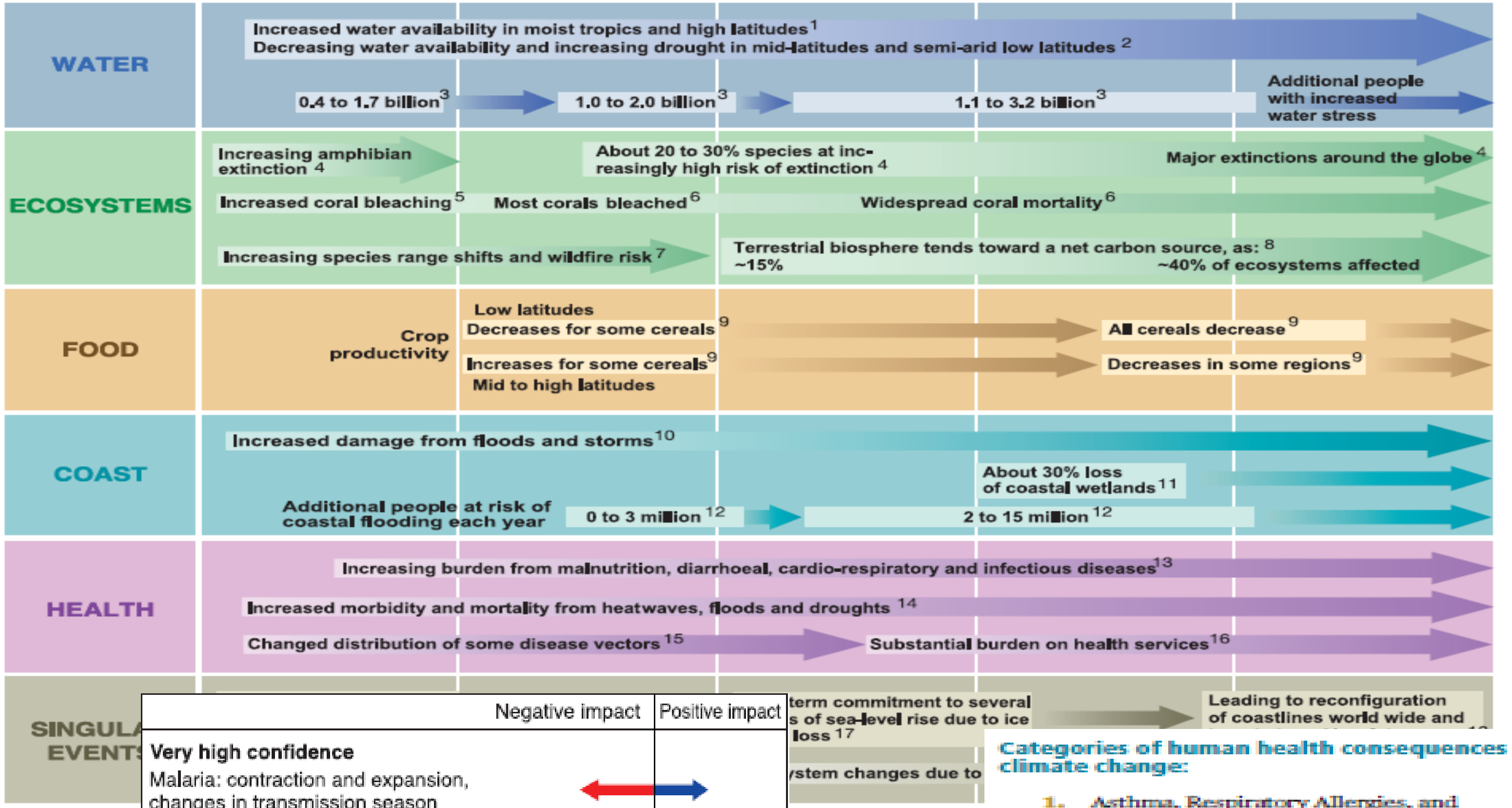
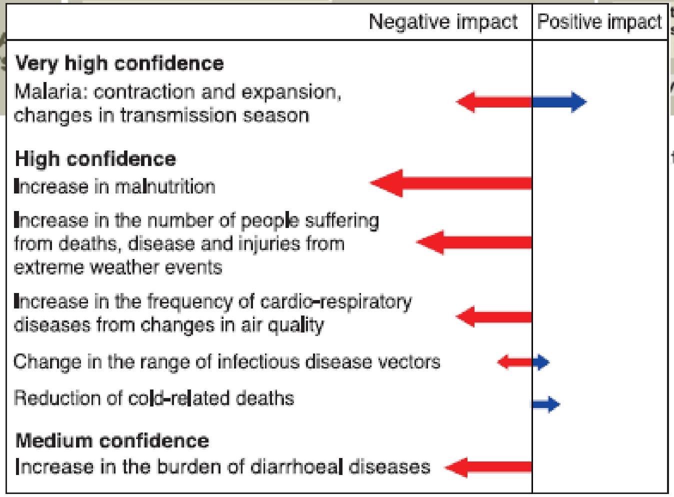
Disclosures:
Presentations, Adboards, Education Honoraries, Suiveys,
Expert Opinion from Astra-Zeneca, GSK, MSD, BMS, Berlin-Chemie, Uptake-Medicals, BMG, DFG,BMBF
No conflicts of any interests with that

Impact of Climate Change / Health impact, IPCC 2007





http://www.ipcc.ch/activity/uncertaintyguidancenote.pdf

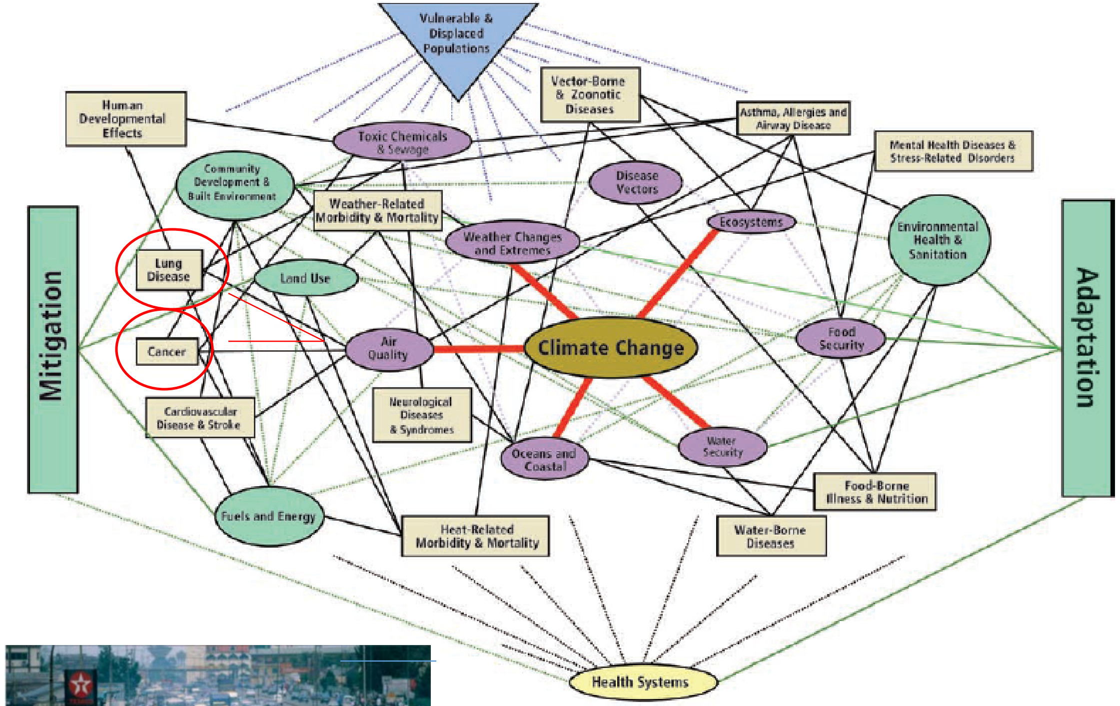
Categories of human health consequences of climate change:

1. Asthma, Respiratory Allergies, and Airway Diseases
2. Cancer
3. Cardiovascular Disease and Stroke
4. Foodborne Diseases and Nutrition
5. Heat-Related Morbidity and Mortality
6. Human Developmental Effects
7. Mental Health and Stress-Related Disorders
8. Neurological Diseases and Disorders
9. Vectorborne and Zoonotic Diseases
10. Waterborne Diseases
11. Weather-Related Morbidity and Mortality

NIEHS 2010

Lungs - Portal Organ of Climate Change

- **Lung Cancer**



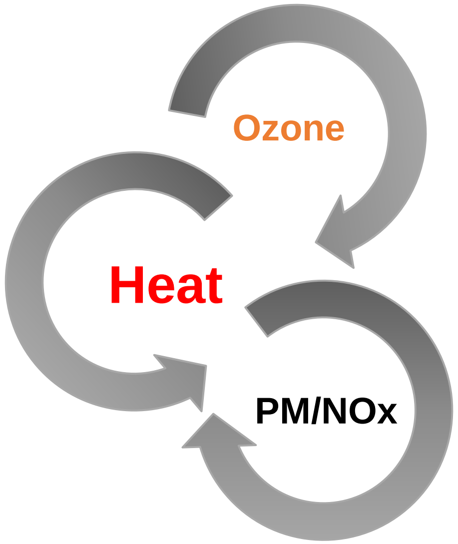
www.niehs.nih.gov/climatereport

„Urban Lung Cancer Screening“ ?

- **Obstructive Lung Disease (COPD/Asthma)**

- **Allergic Diseases**

Pathophysiology of Heat Stress in the Lungs



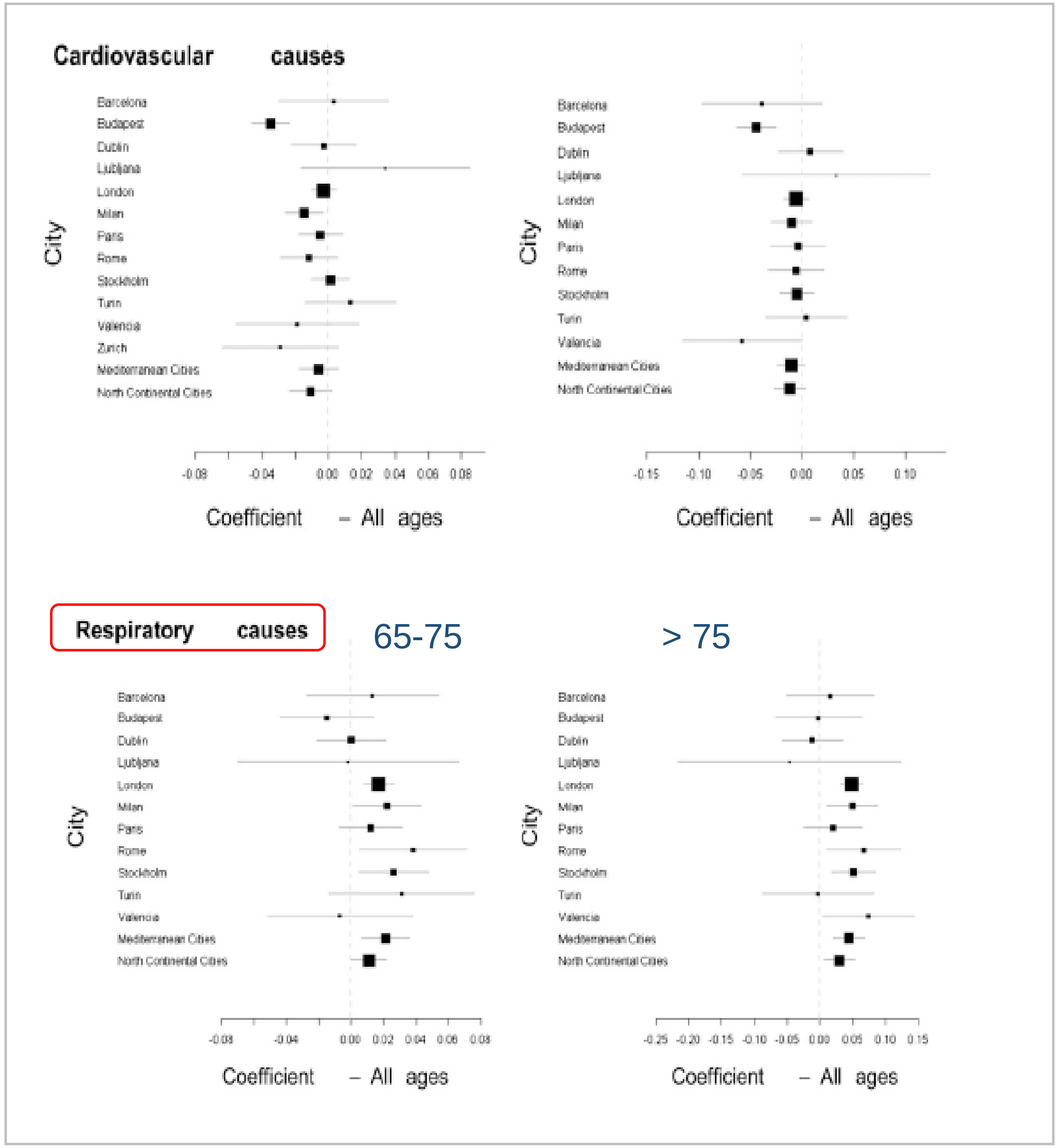
↑ Temperature
- \>Worsening of air quality (NO_2)

↑ PM , ↑ Ozon
↑ Allergens

Heath Risks Concentration problems ↑
Morbidity ↑ Mortality ↑

- Hyperventilation
- Lung fluid loss
- Lung perfusion ↓
- ↑ Airway resistance by stimulating **c-fiber nerves**
- Lower broncho-constructive threshold
- ↑ Inflammation of bronchial musosa
- Imbalance of defence mechanisms

Heat stress and Emergency Visits in European Cities



Michelozzi et. al. AJRCCM 2009

Increased mortality rate at a temperature rise of 1 °C in 15 European Cities

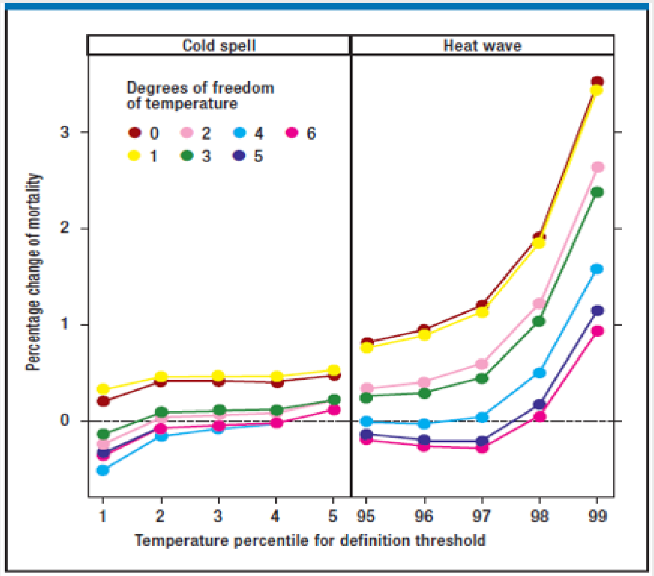
TABLE 3. Overall Meta-Analytic Percent Changes (95% Credibility Intervals) in Mortality for All Natural, Cardiovascular, and Respiratory Causes, in All Ages and by Age Group, Associated With a 1°C Increase in Maximum Apparent Temperature Above the City-Specific Threshold

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

Baccini et al. Epidemiology. 19(5):711-719, September 2008.

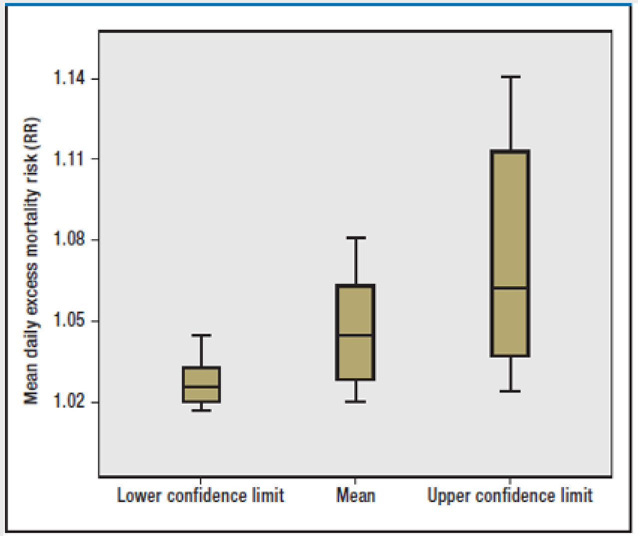
Temperature influences Mortality and Morbidity in COPD

Mortality increase per 1°C in cold spells and heat waves



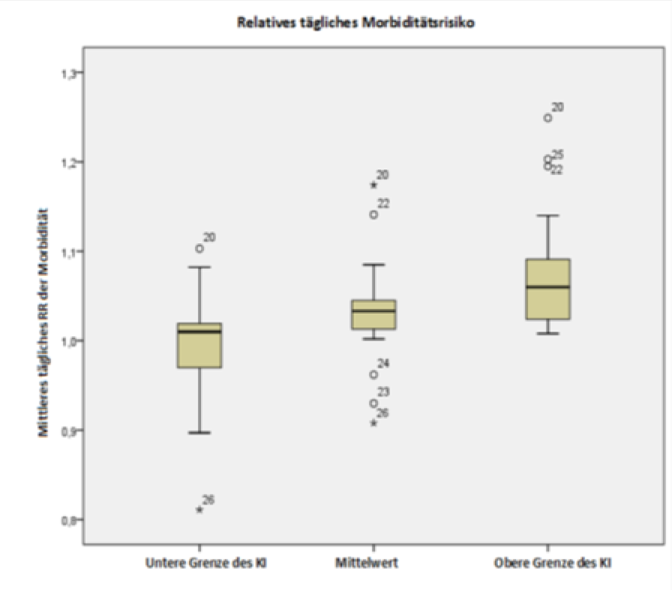
adapted Semenza JC, Rubin CH, Falter KH, et al.

Mean Daily Excess Mortality during heat waves up to 14 %



Boxplot comparison: confidence intervals (CI) [90 to 95] of mean relative heatwave-related daily excess mortality risk (as rate ratio [RR]) for patients with chronic lung disease

Mean Daily Excess Morbidity increase during heat waves up to 9%



Meta-Analysis of Mortality and Morbidity for Repiratory Diseases due to Heat Waves (1995-2014 >100 Mio. Patients)

Deutsches Ärzteblatt (2015) 112; 878-883

UCaHS - Urban Climate and Heat Stress

in mid-latitude cities in view of climate change

CHARITÉ UNIVERSITÄTSMEDIZIN BERLIN · PIK · TU berlin · UCaHS · DFG

Why Berlin ?

- not significantly influenced by oceans, mountain ranges or other geographical features
- Heat stress is a common phenomenon, since air conditioning of buildings is not applied.

Goals

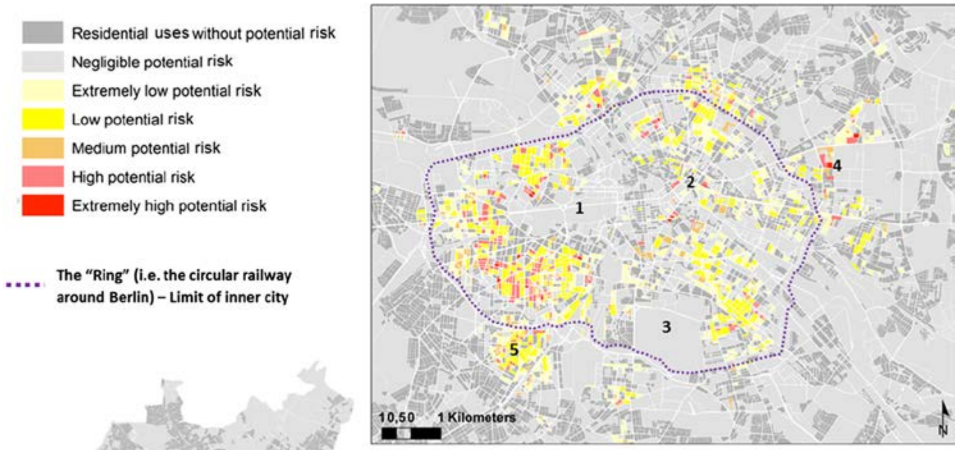
- Quantification of heat-stress hazards and risks (identification of vulnerable groups)
- Efficiency of technical and non-technical actions (adaptation strategies for patients care)
- Options for implementation

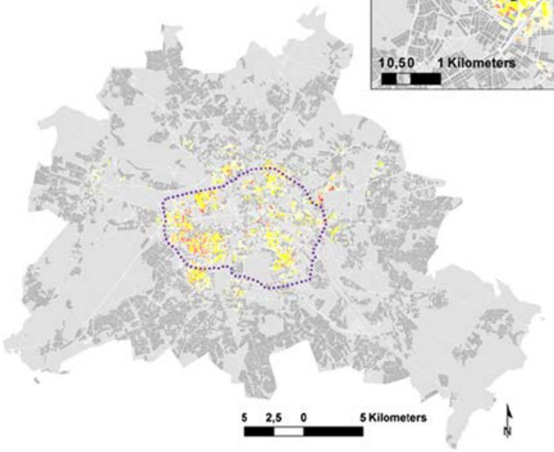
Berlin – Heat stress distribution and mortality (2006/2010)

Land use patterns, temperature distribution, and potential heat stress risk – The case study Berlin, Germany

Pierre-Adrien Dugord [a], Steffen Lauf [a,*], Christian Schuster [b], Birgit Kleinschmit [a]

[a] Technische Universität Berlin, Dept. of Landscape Architecture and Environmental Planning, Geoinformation in Environmental Planning Lab, Berlin, Germany
[b] Humboldt Universität zu Berlin, Dept. of Geography, Geoinformation Science Lab, Berlin, Germany





Risk Map
potential heat-stress risk
in view of climate change

Computers, Environment and Urban Systems 48 (2014) 86–98

Heat mortality in Berlin – Spatial variability at the neighborhood scale

Christian Schuster [a,*], Katrin Burkart [b], Tobia Lakes [a]

[a] Geoinformation Science Lab, Geography Department, Humboldt-Universität zu Berlin, Germany
[b] Climatology and Vegetation Geography, Geography Department, Humboldt-Universität zu Berlin, Germany

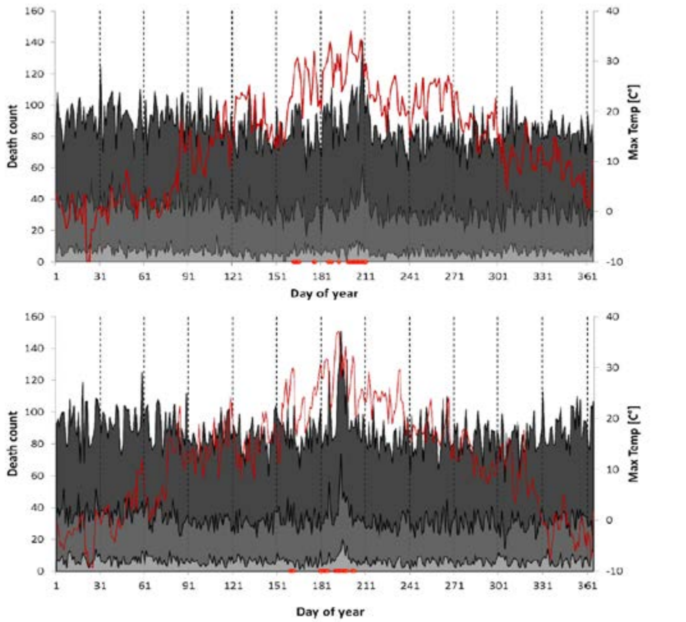


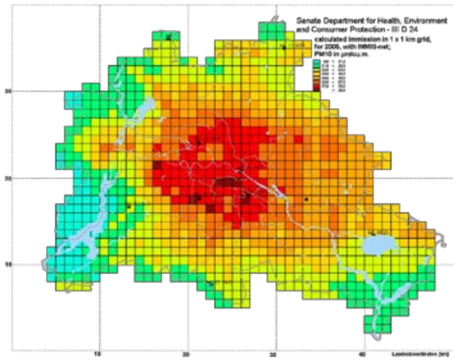
Fig. 2. Daily maximum temperature (red line), days of heat warnings (orange dots), and daily death count (dark gray: all-cause, medium gray: cardiovascular, light gray: respiratory) for the years 2006 (upper) and 2010 (lower). Dotted lines indicate monthly separation. Particularly high death counts occurred during heat events in July.

Urban Climate 10 (2014) 134–147

Topics of Clinical Climate Impact Research

Heat related disease exacerbation ?

Heat as a disease-promoting factor?



PM10 pollution (annual mean) in the Berlin, Atlas Senatsverwaltung

COPD Patient (GOLD II-IV)

↓

Heat Stress / Air pollution

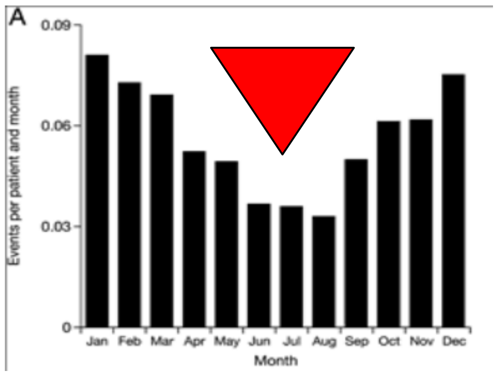
↓ ← Vulnerability

Heat related Exacerbation

Morbidity

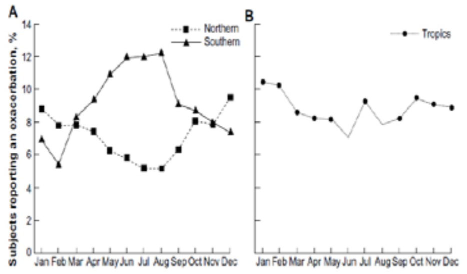
↓ ← Vulnerability

Mortality



Rabe, CHEST 2013; 143(3):711–719

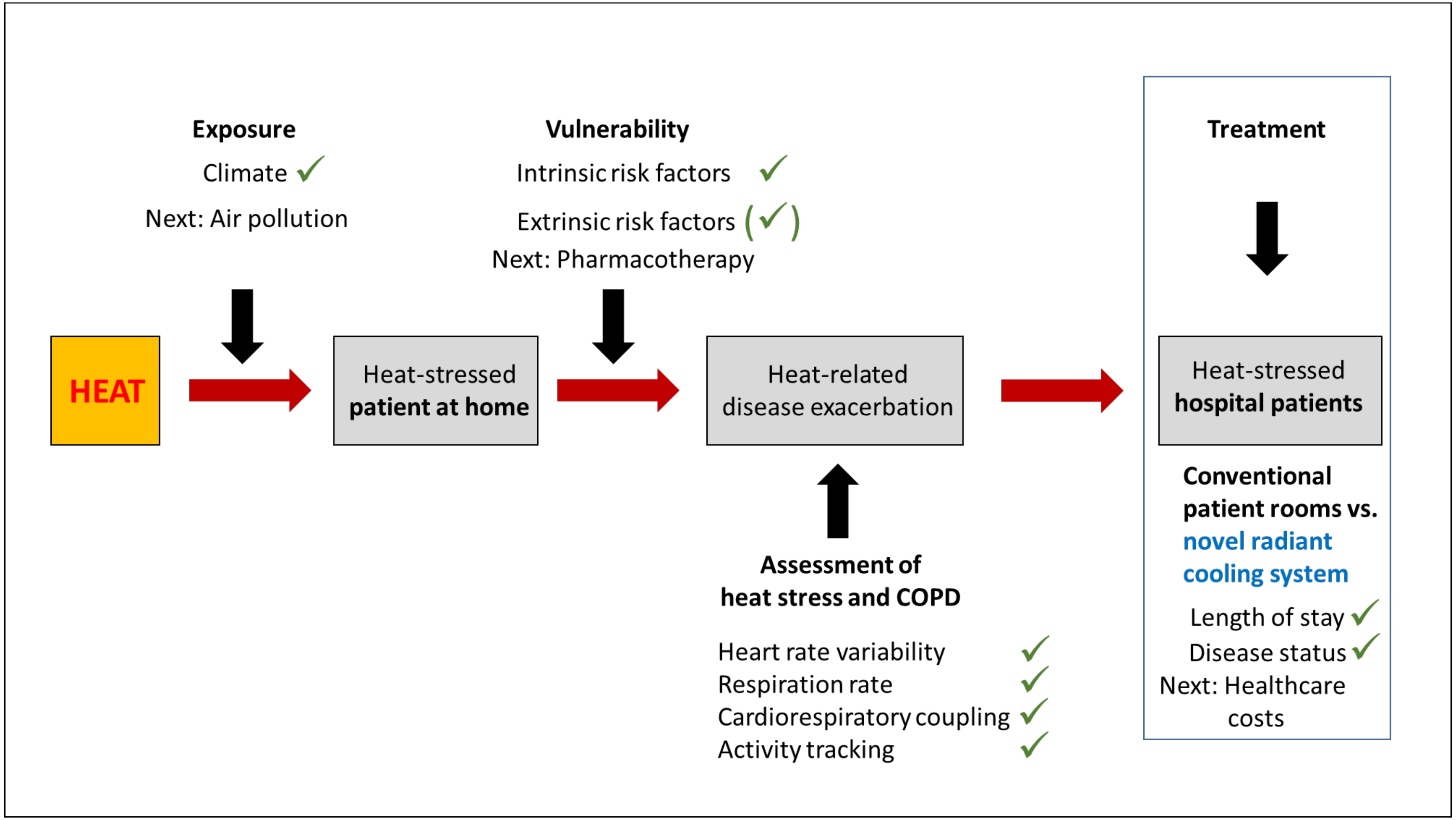
- Who is vulnerable to heat stress?
- Is there a COPD-phenotype ?
- Does air conditioning support reconvalescence from AECOPD ?



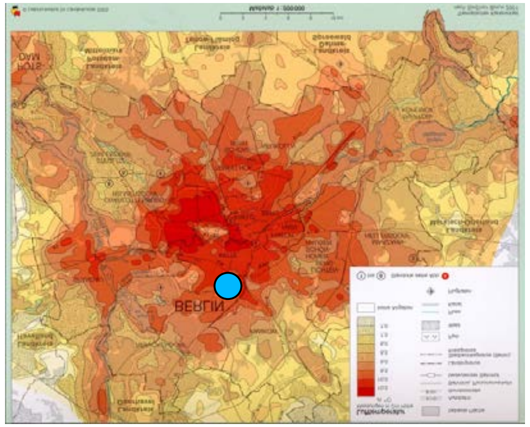
Gavin C Donaldson, Jadwiga A Wedzicha

Research Approach

Vulnerability leads to Hospitalisation of Patients with COPD

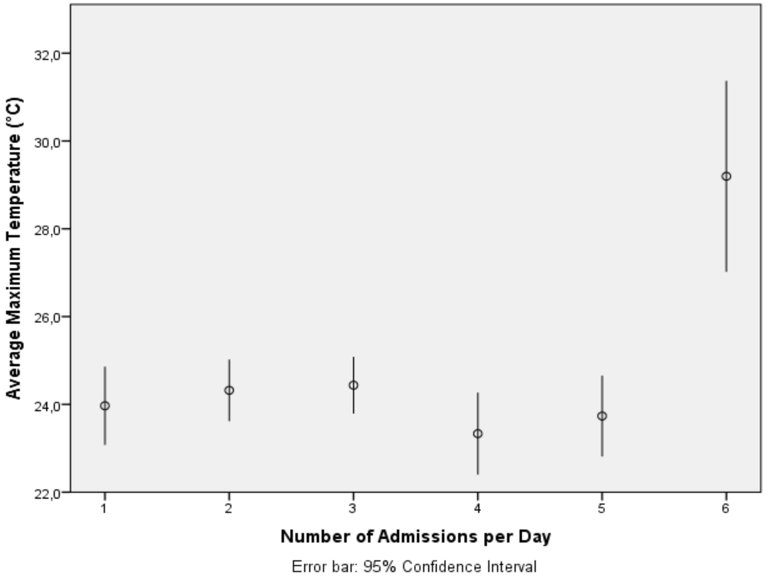


Hospital Admisssion due to Heat related Exacerbation during several Summer periods

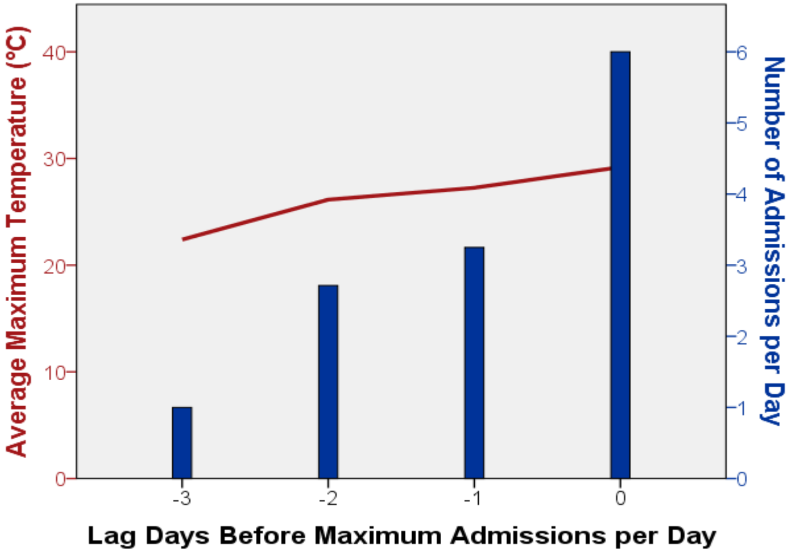


- Analysis of
  n = 563 patients admitted to the urban hospital via emergency unit due to AECOPD (Vivantes Klinikum Berlin- Neukölln)
- Investigated period Mai 15 – August 31
  Years: **2006**, **2010**, **2011**, and **2012**
- Climate data from the German Service (DWD)
  $Temp_{max/min/Ø}$

High summer temperatures induce more admissions due to AECOPD in urban hospitalls ($p < 0.05$)



The lag effect: The daily maximum temperature and the number of admissions rises continuously during the 3 days preceding the day with maximum admissions ($p < 0.05$)

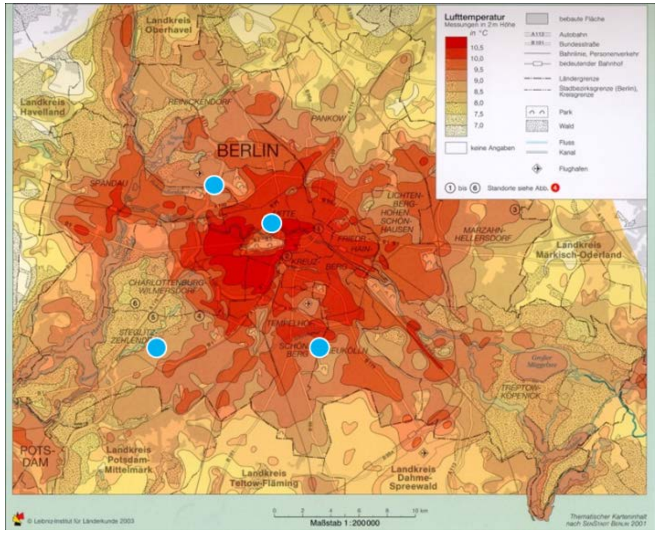


Hospital admissions due to AECOPD on days with urban heat stress in Berlin

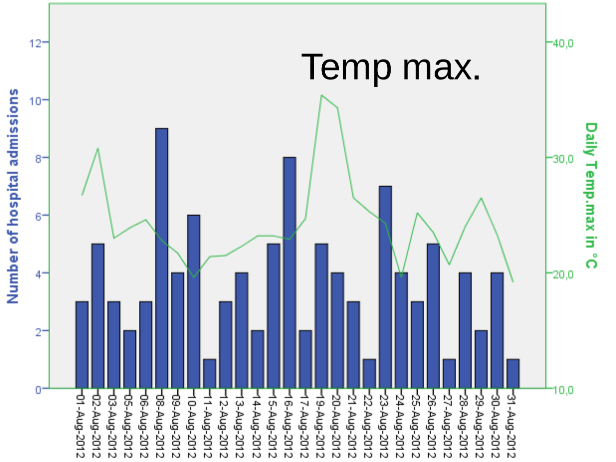
- Retrospective analysis of
- **n = 335** patients admitted to hospital due to exacerbation of COPD (COPD Guidelines, 2013)
- Investigation period: **May 15 – August 31, 2012**

- Clinical data from **4 large urban hospitals/ermergency units**
  - Charité University Hospital and
  - Vivantes Clinic Neukölln

- Climate data from the German Meteorological Service (DWD)
- $Temp_{max/min/Ø}$
- Air pressure
- Ozone pollution



Map of Berlin showing hospitals included into UCaHS trial



Days of admission

Daily max. temperature and emergency hospital admissions due to COPD (Summer 2012)

GOLD	Non heat-related Admission (N=250)	Heat-related Admission (N=85)
II	39 (15.6%)	17 (19.8%)
III	71 (28.4%)	31 (36.0%)
IV	92 (36.8%)	20 (23.3%)
unknown	48 (19.2%)	17 (20.9%)
Note: Differences in GOLD status distribution are significant on p < 0.05		

Differantiation of severity of COPD between heat related and not heat related admissions

Phenotype of heat related exacerbator?

Heat-related Emergency Hospitalizations for Respiratory Diseases in the Medicare Population

G. Brooke Anderson[1], Francesca Dominici[2], Yun Wang[2], Meredith C. McCormack[3,4], Michelle L. Bell[5], and Roger D. Peng[1]

Overall, each 10°F increase in daily temperature was associated with a 4.3% increase in same-day emergency hospitalizations for respiratory diseases (95% posterior interval, 3.8, 4.8%). C

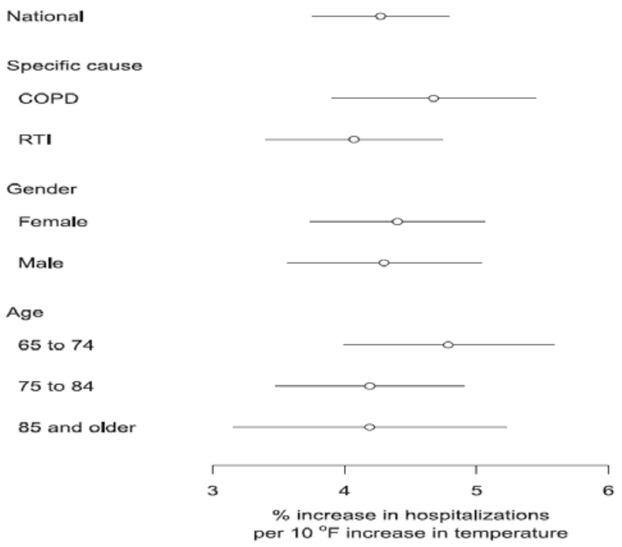
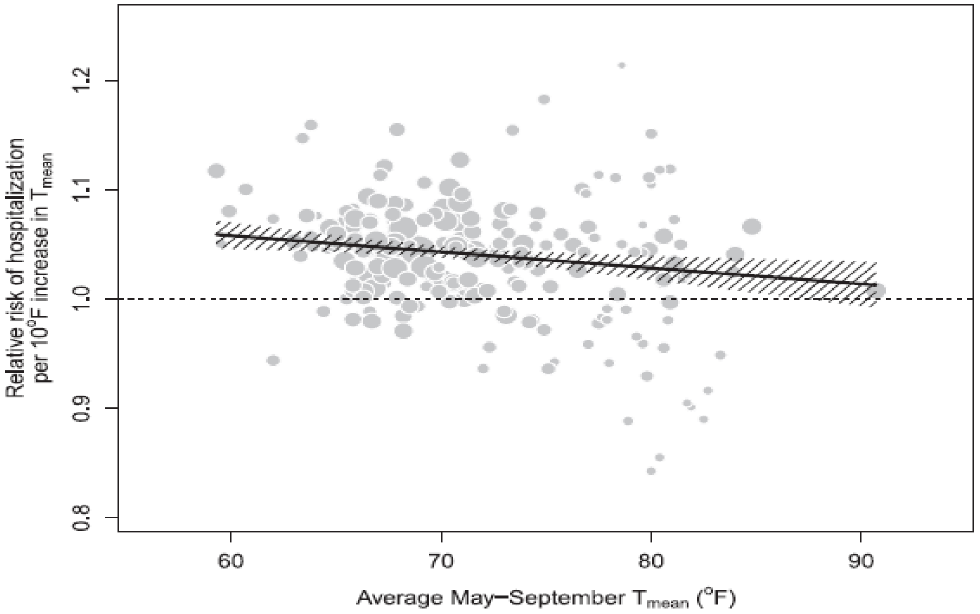


Figure 2. Percent increase in respiratory hospitalizations for each 10°F daily outdoor heat increase, 1999 to 2008 (lag 0). Estimates are pooled across all 213 study counties; outdoor heat is measured as daily mean temperature, May to September. *Horizontal lines* show 95% posterior intervals. COPD = chronic obstructive pulmonary disease; RTI = respiratory tract infections.



The Effect of Weather on Respiratory and Cardiovascular Deaths in 12 U.S. Cities

Alfésio L. F. Braga,[1, 2] Antonella Zanobetti,[1] and Joel Schwartz[1]

[1]Environmental Epidemiology Program, Harvard School of Public Health, Boston, Massachusetts, USA; [2]Environmental Pediatrics Program, University of Santo Amaro School of Medicine, and Laboratory of Experimental Air Pollution, Department of Pathology, University of São Paulo School of Medicine, São Paulo, Brazil

Table 2. Percentage increase in cause-specific deaths at 30°C and at –10°C for the difference between the 90th and 10th percentiles in air conditioning, variance of summer temperature, and variance of winter temperature.

	Summer effect		Winter effect	
	Percent	95% CI	Percent	95% CI
CVD				
Air conditioning	–1.15	−14.72–14.60		
Variance summertime temperature	0.93	−9.67–12.77		
Variance wintertime temperature			2.20	−1.19–5.71
MI				
Air conditioning	–16.99	−35.64–7.06		
Variance summertime temperature	15.67	−7.54–44.71		
Variance wintertime temperature			–3.63	−11.62–5.08
COPD				
Air conditioning	–13.44	−45.89–38.49		
Variance summertime temperature	42.76	4.54–94.94		
Variance wintertime temperature			25.86	−1.12–60.20
Pneumonia				
Air conditioning	–8.31	−30.79–21.47		
Variance summertime temperature	28.01	3.96–57.63		
Variance wintertime temperature			12.57	2.87–23.19

Novel climatization model in the hospital for heat-stress related lung disease exacerbation treatment

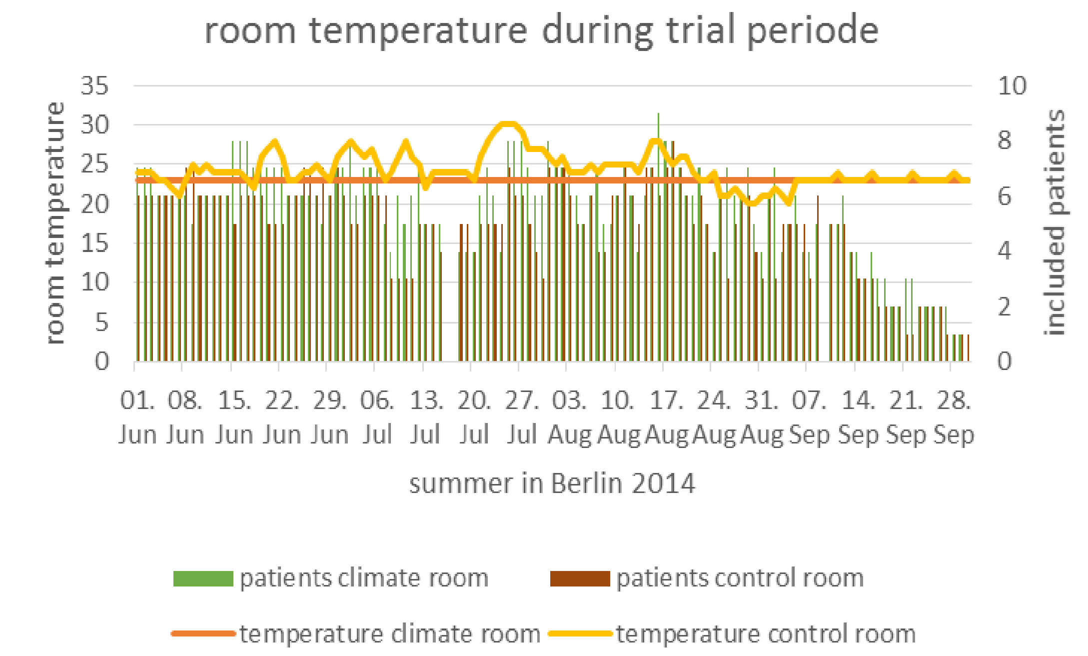
Prospective Randomized Controlled Trial (RCT)

(**DRKS 00004931**, http//apps.who.int/trialsearch/)

Cooling System:

Convection free radiant cooling system using capillary tube mats

(by Clina Cooling, UK Inc., setpoint T 23°C).

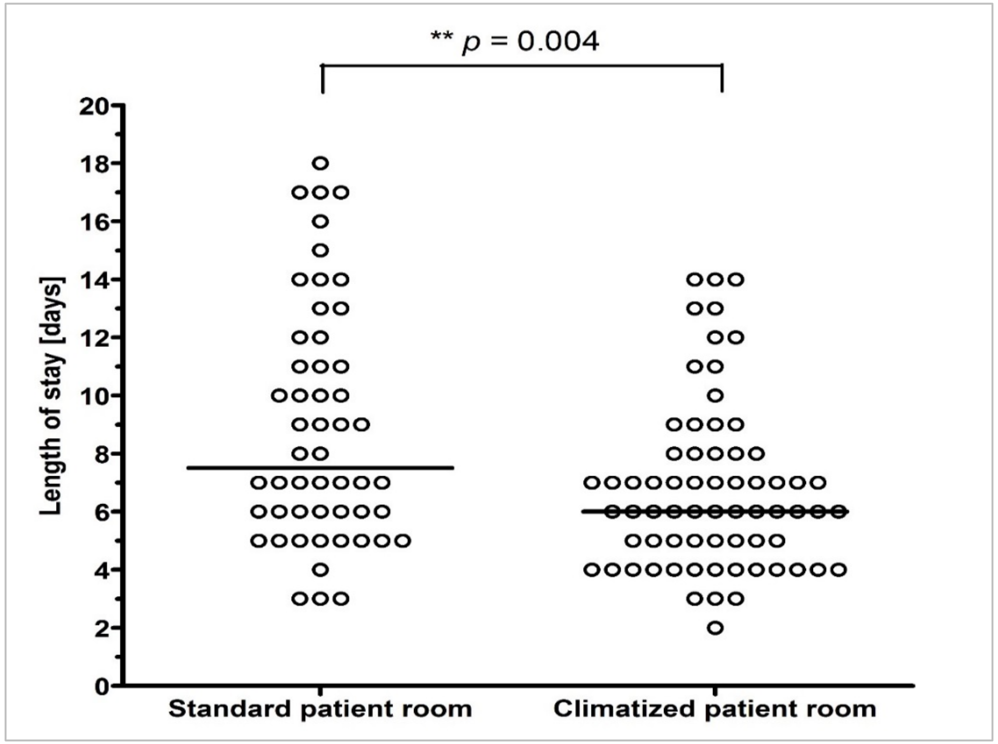


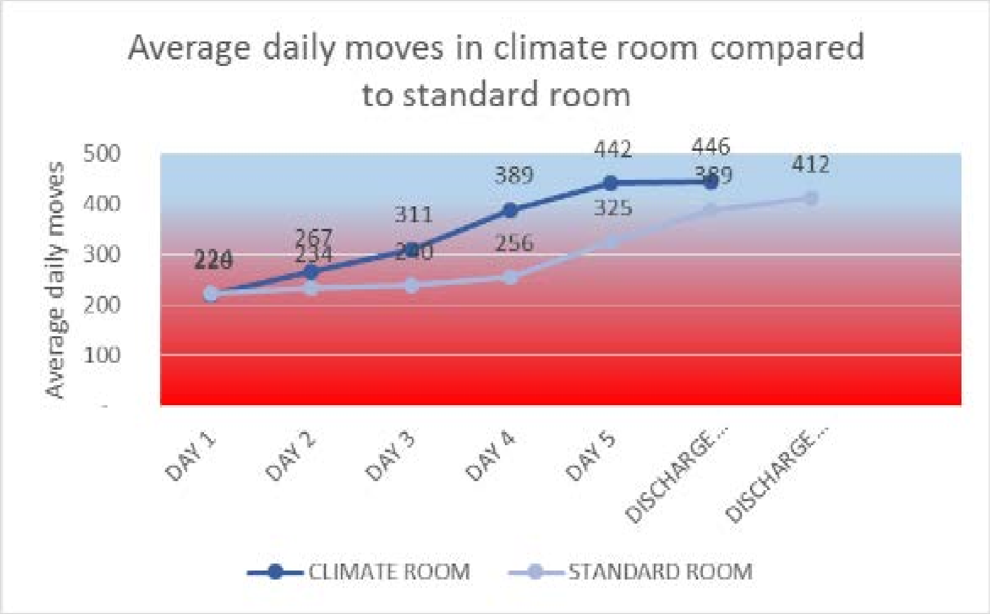
Climatized room 23°C **Conventional room** until **30.5°C,**

Parameter	Patient room w/o climatization	Patient room with climatization	Total
Patients, n (%)	52 (43%)	68 (57%)	120
Age, median (range)	68 years (43 – 84)	66 years (32 – 90)	
Gender, n			
Female	32	15	47
Male	20	53	73
CAT at admission, median (range)	27 (6 – 39)	26 (8 – 40)	

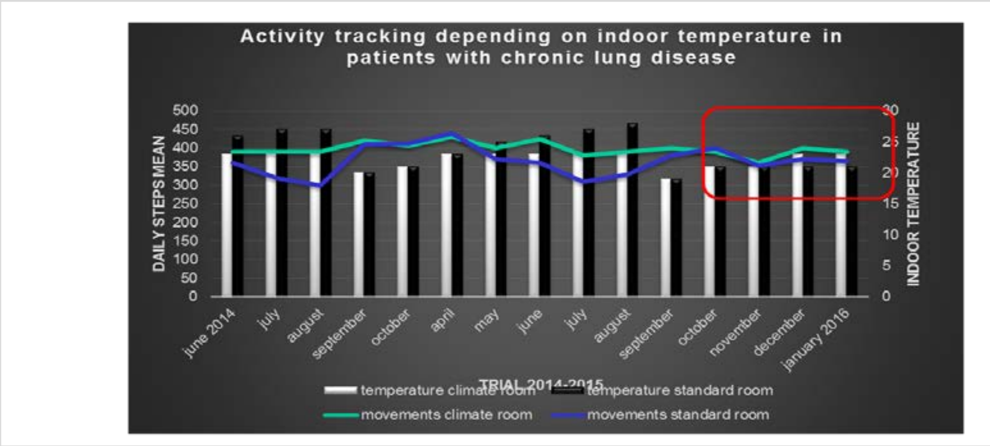
CAT: COPD Assessment Test

Climate controlled patients rooms improves the activity and support the early mobilization in urban heat-stress related COPD exacerbation (RCT, n= 120)





Parameter	Patient room w/o climatization	Patient room with climatization	P value
CAT at discharge, median (range)	23 (12 – 36)	23 (6 – 36)	0.456
Length of stay, median (range)	7.5 days (3 – 18)	6 days (2 – 14) ⇩	0.004**



Schubert, Witt et al ATS 2016

Lung Health- Public Health: Prevention Early detection Protection

Bed rest and fresh air were important parts in the treatment of tuberculosis.

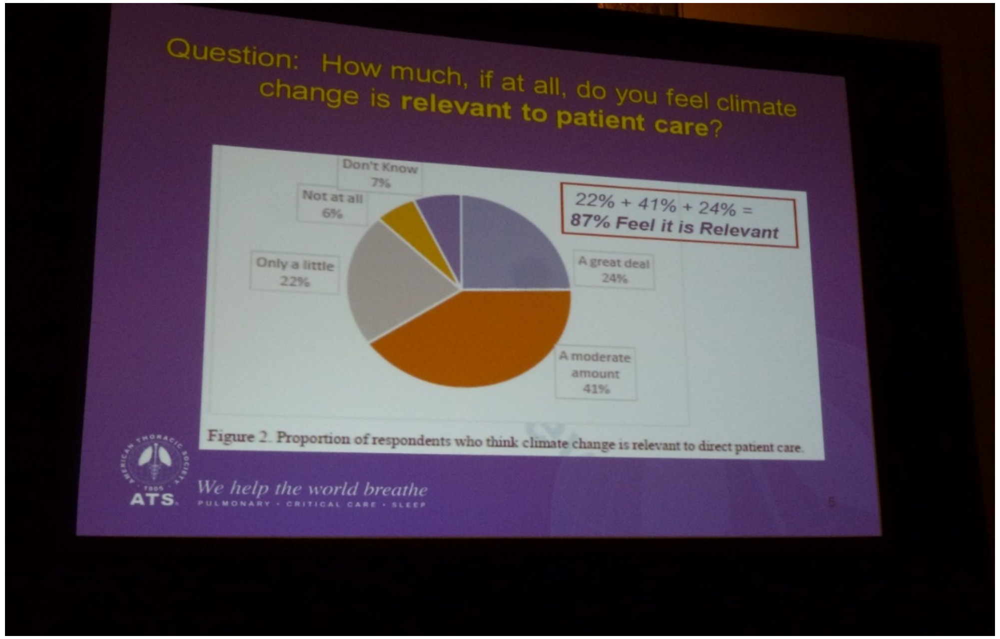
X-Ray Truck, 1957

Mortality
1900: 300 Tbc - Deaths /100.000
1950: 40 Tbc - Deaths/100.000
2008: 50 Lung cancer - Deaths/100.000

Clinical Climate Impact Research !

Impressions about the U.S. Alliance for Climate and Health

Physicians understood the importance of the Climate Change for the health of their Patients



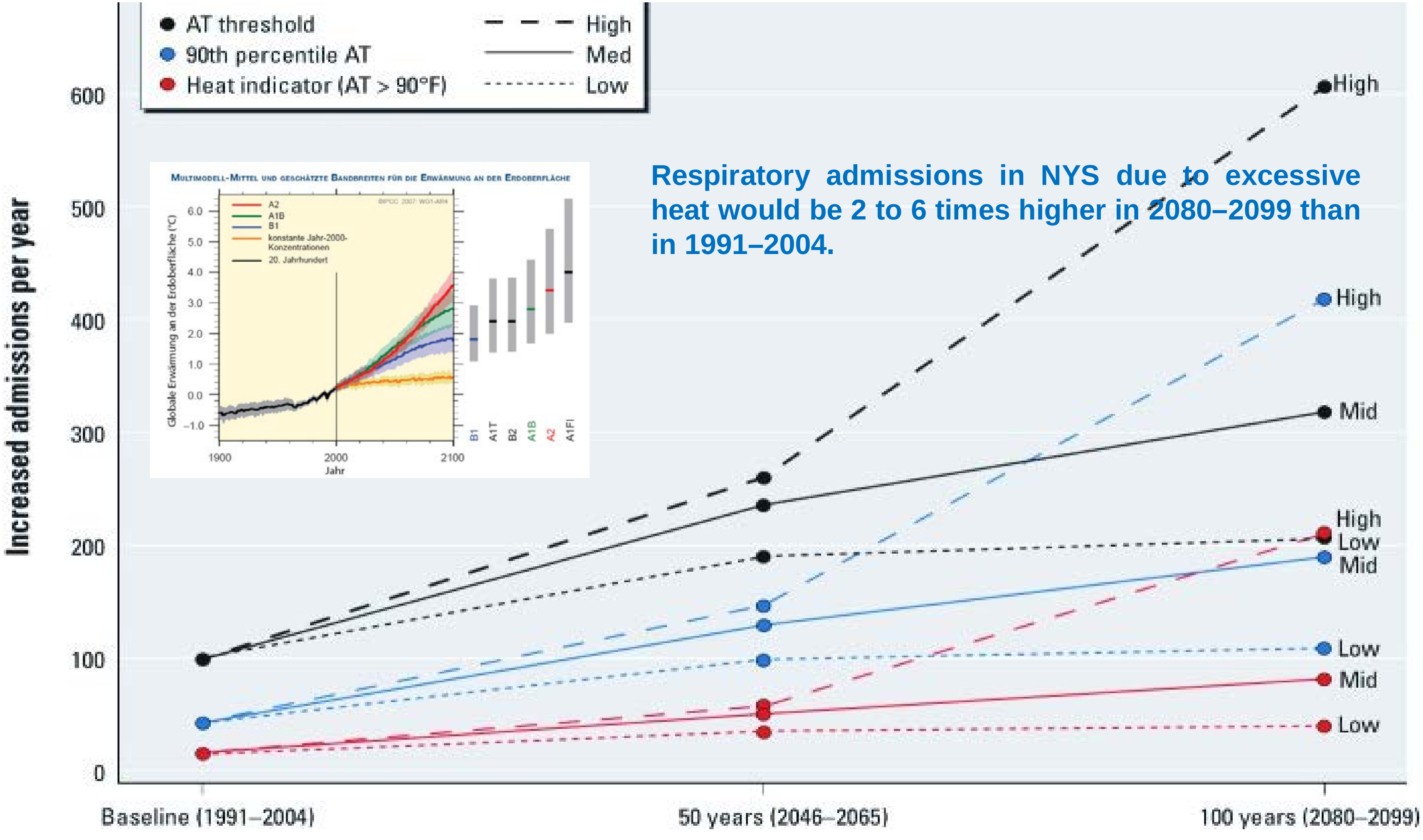
Patients understood the importance of Climate Change for themselves

ATS – Meeting 2015, Denver, CO

Excessive Heat and Respiratory Hospitalizations in New York State: Estimating Current and Future Public Health Burden Related to Climate Change

Shao Lin,[1,2] Wan-Hsiang Hsu,[1,2] Alissa R. Van Zutphen,[1,2] Shubhayu Saha,[3] George Luber,[3] and Syni-An Hwang[1,2]

[1]Center for Environmental Health, New York State Department of Health, Albany, New York, USA; [2]Department of Epidemiology and Biostatistics, University at Albany School of Public Health, Rensselaer, New York, USA; [3]National Center for Environmental Health, Centers for Disease Control and Prevention, Atlanta, Georgia, USA



Respiratory admissions in NYS due to excessive heat would be 2 to 6 times higher in 2080–2099 than in 1991–2004.

Time

Lin et al. Environ Health Perspect. 2012 November; 120(11): 1571–1577

Concept, expected impacts, linkages to other research and innovation and the overall methodologies

TR 6

Demonstrator 3.1 Oasis+Health
The objective is to help the health insurance sector to understand much more precisely the relation between the air quality, climate extremes and health conditions in a given population.

→

The health insurance sector will gain accurate information on air quality and climate impacts on health. This will foster new innovations which will allow a better adaptation to new climatic conditions.

⇄

German Association of Private Insurers (PKV). Health insurers active in the OASIS program.

- A demonstrator will be implemented for the **City of Berlin**.
- Fine resolution **air quality and climate models (temperature)** will be used to set up the event set, representing chronic as well as extreme conditions.
- The **health damage function** will be defined on the basis of the **exposure of the population**, especially the most sensitive ones, considering as well data on **affected people**, just after the extremes and after exposure thresholds are exceeded

Urban Heat Stress
Global Warming

Vulnerability to Lung health risks ↑

(Exacerbation, Allergy, Infection and Cancer)

(Temp. ↑ of Water - Surface)

Trigger-Mechanisms ↑

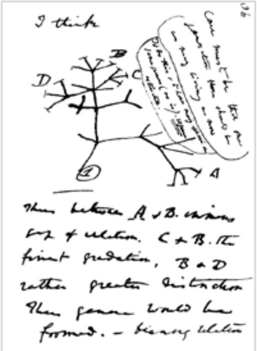
Microbiome-Change

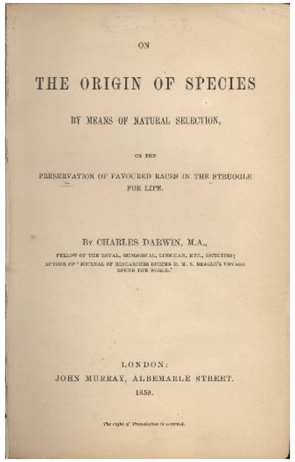
Mitigation

Adaptation

Evolution

- Identification of vulnerable groups
- Reduce Riks, Prevent Risks,
- Adaptation (climate- adaptive treatments, Innovative indoor climatisation





Towards More Comprehensive Projections of Urban Heat-Related Mortality: Estimates for New York City under Multiple Population, Adaptation, and Climate Scenarios

Elisaveta P. Petkova,[1] Jan K. Vink,[2] Radley M. Horton,[3] Antonio Gasparrini,[4,5] Daniel A. Bader,[3] Joe D. Francis,[2] and Patrick L. Kinney[6]

CONCLUSIONS: These findings provide a more complete picture of the range of potential future heat-related mortality risks across the 21st century in New York City, and they highlight the importance of both demographic change and adaptation responses in modifying future risks.

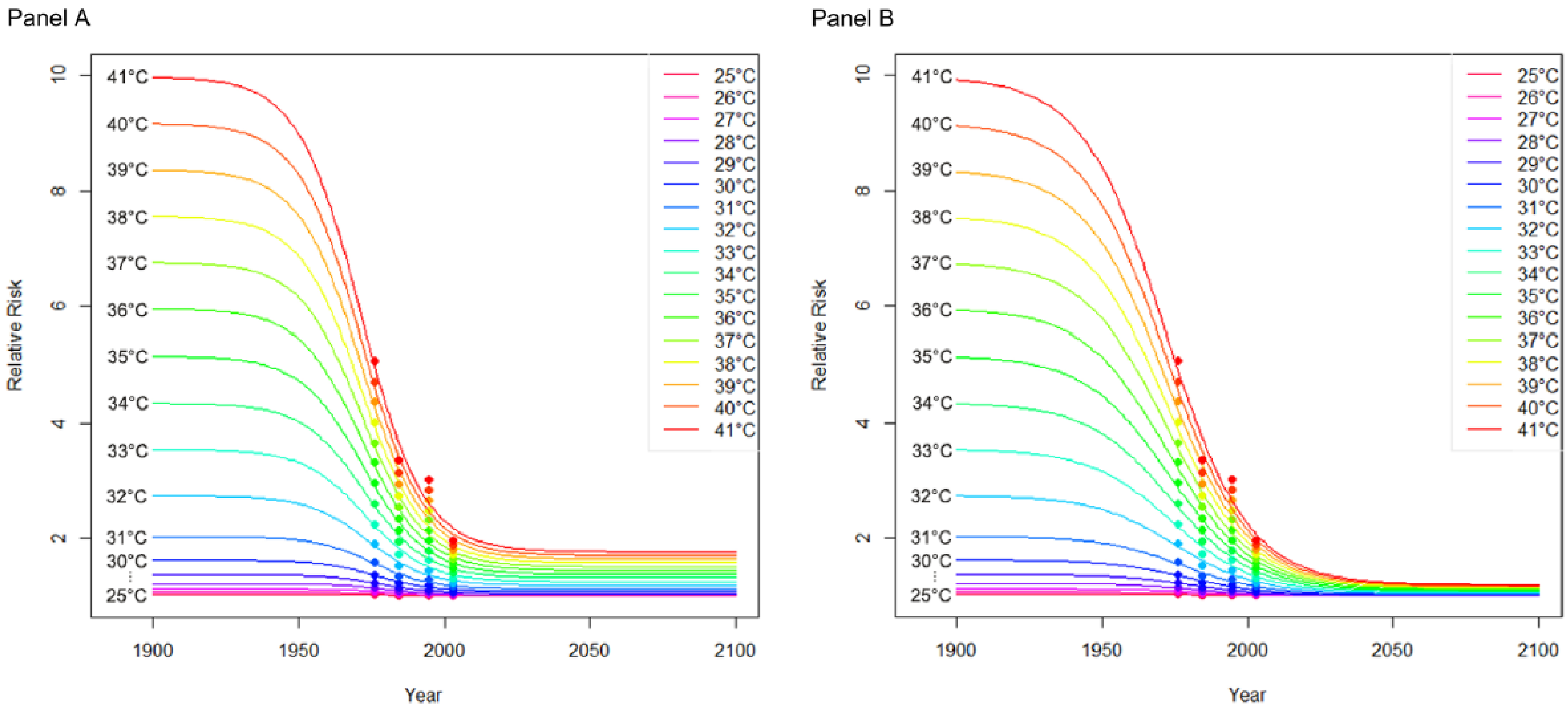


Figure 1. Temperature-specific mortality curves for New York City, 1900–2100. (*A*) Adaptation model assumes that temperature-specific relative risks will decrease by an additional 20% ("low adaptation") between 2010 and 2100 compared with the 2000s. (*B*) Adaptation model assumes that temperature-specific relative risks will decrease by an additional 80% ("high adaptation") between 2010 and 2100 compared with the 2000s. Points represent the relative risks (RRs) calculated using the distributed lag non-linear model (DLNM) for each temperature for the 1970s (1973–1979), 1980s (1980–1989), 1990s (1990–1999), and 2000s (2000–2006). RRs were calculated for June–September using a model with a quadratic spline with 4 degrees of freedom and 22°C as a reference temperature.

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INKA BB
KLIMAWANDEL UND INNOVATION

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