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Projecting future heat-related hospital admissions in Berlin

RESEARCH WORKSHOP III

„CLIMATE CHANGE IN CITIES. MITIGATION, ADAPTATION“ FU BERLIN 28.03.2017

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CLIMATOLOGY
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Outline

Introduction

- Urban climate, human health and climate change
- Projecting health impacts under a changing climate

Future heat-related hospital admissions in Berlin

- Objectives and data
- Methods
- Results

Conclusions

Discussion and outlook

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Urban climate, human health and climate change

- Urban populations increase worldwide
- Urban environment substantially determines living conditions
- Urban Heat Island (UHI) and heat waves cause heat stress
- Heat stress causes impacts on human health
- Due to climate change more frequent heat waves, leading to enhanced heat stress

- IPCC 5th AR: risks of mortality and morbidity during periods of extreme heat, particularly for vulnerable urban populations, are identified with high confidence

- Challenges in public health care:
  - Demographic change
  - Increase of chronic diseases

→ In terms of mitigation and adaptation in public health care and urban development heat-related health impact projections are mandatory to develop appropriate short- and long-term strategies

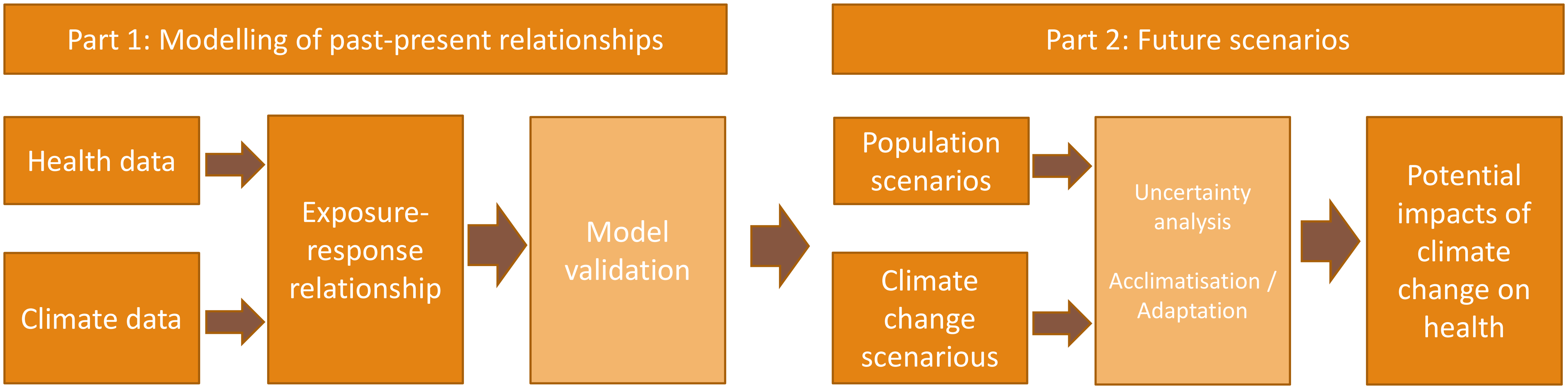
Projecting health impacts under a changing climate

Limitations / Challenges

- Access to data
- Uncertainties in climate and population projections
- Modelling exposure-response relationship

Assumptions

- No changes in morbidity / mortality rates in the future
- Exposure-response relationships remain constant over time
- No acclimatisation / adaptation



Schematic study concept adapted from Dessai 2002 and Gosling et al. 2007

Future heat-related hospital admissions in Berlin

Extract from PhD thesis: Scherber, 2014

Projecting future heat-related hospital admissions in Berlin

Objectives:

- Impacts of daily maximum air temperature on hospital admissions and in-hospital deaths in Berlin during summer months (2001-2010; 2021-2030)
- Diagnosis: **Respiratory system diseases** (RD)
- Comparing **morbidity** (inpatient hospital admissions; HA) and **mortality** (in-hospital deaths; IHD)
- Comparing **all ages** and **65+** (HA)

Data:

Air temperature

Daily T_{max} 2001-2010 (June-September)
Station: Tempelhof
German Meteorological Service (DWD)
Projections (PIK):
Daily T_{max} 2021-2030 (June-September)
Station: Tempelhof
STAR2; 2K-scenario, realisation 50
Potsdam Institute for Climate Impact Research (PIK)

Health data

Daily inpatient hospital admissions and in-hospital deaths
2001-2010 (June-September)
Respiratory system diseases (RD)
All ages and 65+
Research Data Centre of the Federal Statistical Office (FDZ)

Population data

Annual population data 2001-2010
Population projections 2021-2030 (medium variant; on basis 2011)
EU standard population (WHO, 1990)
Statistical Office Berlin,

First:

Modelling exposure-response relationship for reference period
HA (all ages, 65+), IHD (all ages)

Output:

Exposure-response curves for hospital admissions and in-hospital deaths

Second:

Estimation of the impacts of daily maximum air temperature on hospital admissions and in-hospital deaths
HA (all ages, 65+), IHD (all ages)

Output:

Percentage changes and relative risks for hospital admissions and in-hospital deaths for 1 °C increase above T_{max} 25° C

Third:

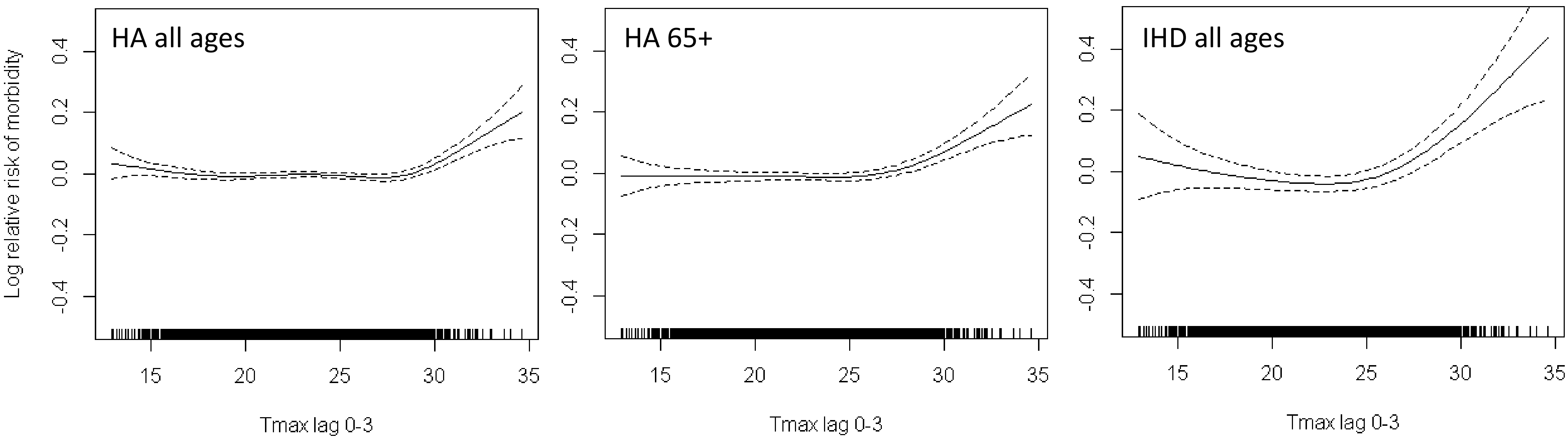
On the basis of morbidity and mortality rates, relative risks, temperature and population projections, estimation of future heat-related hospital admissions and in-hospital deaths
HA (all ages, 65+), IHD (all ages)

Output:

Expected number of daily hospital admissions and in-hospital deaths for future period 2021-2030

Methodology according to Almeida et al., 2010; Armstrong et al., 2011; Aström et al., 2013; Michelozzi et al. 2009

Exposure-response curves for hospital admissions (HA) and in-hospital deaths (IHD) in Berlin 2001-2010 Respiratory system diseases (RD)



log(RR) = 0.1
RR = exp (0.1)
RR = 1.10
→ 10 % more admissions per day

Exposure-response curves and 95% confidence intervals (dashed lines) between maximum air temperature (T_{max} lag 0-3) and daily hospital admissions (HA) and in-hospital deaths (IHD), all ages and 65+.
Models adjusted for year, month, day of the week and holidays (only HA).

	% Change (CI)
RD HA	0.7** (0.2 to 1.3)
RD HA 65+	1.8** (0.85 to 2.7)
RD IHD	4.8*** (2.4 to 7.2)

Percentage change (95 % confidence interval) in hospital admissions (HA) and in-hospital deaths (IHD) for 1°C increase above T_{max} lag 0-3 = 25°C.
Levels of significance:
*** 0.001; ** 0.01; * 0.05

Future heat-related hospital admissions in Berlin

Temperature and population projections

Population dynamics Berlin (Data basis 2011):

Year	Total	65+	% 65+
2001	3.388.434	508.779	15
2010	3.460.725	661.082	19
2021	3.709.134	753.194	20
2030	3.755.558	857.836	23

M**aximum air temperature Berlin** during summer months (June – September; n = 1220).

Period	Data basis	Station	Min	Mean	Max	n T_{max} ≥ 25 °C
2001-2010	observed	THF	10.3	22.8	37.5	395
2021-2030	STAR2, 2K	THF	10.8	23.6	36.3	466

Future heat-related hospital admissions in Berlin

Mean daily expected cases

for hospital admissions (HA) and in-hospital deaths (IHD) for respiratory system diseases (RD) for all ages and > 64-year-olds (65+), reference (observed and modelled) and future period.

Diagnosis	2001-2010 observed	2001-2010 modelled	2021-2030 modelled	Difference
RD HA	98	98	108	+10 (+10 %)
RD HA 65+	37	41	55	+14 (+34 %)
RD IHD	6	6	7	+1 (+16 %)

$$E[C]_t = RR^{(T_t - BP)} \times \quad Pop_t \quad \times \quad MR$$

$E[C]_t$	Expected number of cases at time t
RR	Relative risk
$(T_t\text{-BP})$	Difference between air temperature T at time t and breakpoint BP if T_t is greater than BP, otherwise 0
Pop t	Population at time t
MR	Mean morbidity or mortality rate

Methodology according to Aström et al., 2013

Conclusions

- **Increased risks** for hospital admissions and in-hospital deaths for respiratory system diseases at T_{max} above 25°C
- Stronger impacts of daily T_{max} on **mortality** (in-hospital deaths) than **morbidity** (hospital admissions)
- Stronger impacts of daily T_{max} on hospital admissions **65+** than **all ages**

- Due to population growth and climate change **increased** hospital admissions and in-hospital deaths expected **in near future** (2021-2030)
- Biggest increment for persons **65+** due to demographic change

Findings corresponding to:
Aström et al. 2011, Aström et al. 2013, Hajat et al. 2014, Lin et al. 2009, Michelozzi et al. 2009, Monteiro et al. 2013, Morabito et al. 2012

Discussion and outlook

Limitations

- Population studies do not provide impact assessment on individual level
- Restricted availability of data (no age stratification for in-hospital deaths)
- Uncertainties in climate and population projections
- No acclimatization / adaptation

Outlook – work in progress

- New climate projections (RCP scenarios)
- New population projections (update 2015)
- Model validation
- Urban – rural comparison (Berlin – Brandenburg)
- Acclimatisation / adaptation scenarios

Application of findings in

- Public health care
- Urban development

→ short- and long term mitigation and adaptation strategies

Thank you for your attention

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