Health-relevant influences of air substances and meteorological conditions

An investigation of the effects of ozone, nitrogen dioxide and temperature extremes using health data from the area of Augsburg.

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For a long time it has been known that exceptionally strong and long-lasting heat waves have negative health effects on the population, which is expressed in an intensification of existing diseases and over-mortality of certain risk groups. Often associated with heat are stagnant airflow conditions that cause a large increase in the concentration of certain air substances. Many of these air substances have a strong adverse effect on the human organism.

The aim of the project is to investigate the actual hazard potential of health-relevant air pollution- and climatological variables by quantifying the effects on human health of increased exposure to air constituents and meteorological extremes. Different multivariate statistical methods such as correlation analysis and regression models, extreme value analysis and individual case studies are used.
Research Questions and Goal

Research Topic
„Health-relevant influences of air substances and meteorological conditions“

Initial Question:
Are air hygiene and meteorological stress situations evident in the medical records?

What characteristics and significance do the relationships have?

Which factor can be assigned the greatest hazard potential?

Which weather conditions carry an above average high emergency room risk?

What are the most common environmental emergency cases?

What are the health risks of climate change?

Weather forecast → increased likelihood of certain diseases
High concentrations of certain air constituents are created according to an effect chain. Air pollution often arise in the context of certain air pressure constellations that favor the formation and accumulation of air pollutants in the troposphere through heat or low-exchange conditions.

**Air Substances**
- Focus on O$_3$, NO$_2$, PM$_{10}$, PM$_{2.5}$
- Measured at various stations in Augsburg
- Provided: Bayerisches Landesamt für Umwelt

**Climate**
- Numerous meteorological parameters used
- Provided: Deutscher Wetterdienst

**Synoptic Situations**
- Responsible for current weather events
- Major role in the formation, decomposition process and the distribution of pollutants
- Provided: ECMWF ERA5
Health effects spectrum of air pollutants

- Increased risk of stroke, dementia, Alzheimer's
- Increased mortality from respiratory diseases
- Increased mortality from cardiovascular diseases
- Increased risk of type 1/2 diabetes and gestational diabetes
- Increased risk of pregnancy complications
- Accelerated skin aging and irritation of eyes, nose, throat and skin

Risk groups:
- Babies, toddlers, children
- Pregnant women
- Seniors
- People with pre-existing conditions
- Intense outdoor activities
Methodological approach

- Extreme Value Analysis
- Multivariate Statistics
- Case Studies
- Correlation Analysis
- Regression Analysis
- Subdivision of Data

### Air substances and Meteorology
- Waves
  - Exceeding official limit values for at least three days [e.g. Ozone-Wave = 3 days of > 100 µg/m³ Ozone] [WHO]

### Conditions
- Focusing on days that are on the bottom or top end of official scales (e.g. wind-speeds – Beaufort scale)

### Patient
- Age-Group
- Gender
- Rural/Urban Residence

### Analysis
- Correlation Analysis
- Regression Analysis
First results: Correlations(1)

Legend
red = neg. corr, green = pos. corr, x = not significant (p-value > 0.05)

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Illnesses
- J Diseases of the respiratory system
  - J00 Acute nasopharyngitis (common cold)
  - J02 Acute pharyngitis
  - J03 Acute tonsillitis
  - J04 Acute laryngitis and tracheitis
  - J05 Acute obstructive laryngitis (croup) and epiglottitis
  - J06 Acute upper respiratory infections of multiple and unspecified sites
  - J18 Pneumonia, organism unspecified
  - J20 Other acute lower respiratory infections
  - J21 Acute bronchiolitis
  - J22 Unspecified acute lower respiratory infection
  - J38 Diseases of vocal cords and larynx, not elsewhere classified
  - J40 Bronchitis, not specified as acute or chronic
  - J44 Other chronic obstructive pulmonary disease
  - J45 Asthma
  - J69 Pneumonitis due to solids and liquids
  - J96 Respiratory failure, not elsewhere classified
  - J98 Other respiratory disorders
  - J00-J06 Acute upper respiratory infections
  - J09-J18 Influenza and pneumonia
  - J20-J22 Other acute lower respiratory infections
  - J30-J39 Other diseases of upper respiratory tract
  - J40-J47 Chronic lower respiratory diseases
  - J90-J94 Other diseases of the pleura
  - J95-J99 Other diseases of the respiratory system
  - R05 Cough
  - R06 Abnormalities of breathing

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Air substances, Meteorology and Synoptic Data
- Air substances = daily maximum of NO₂, O₃, PM₁₀, PM₂.₅ in Augsburg
- Meteorology = FX: wind max, FM = wind mean, RSK = precipitation, NM: cloud cover, VPM = vapor pressure, PM: local air pressure, TMK: temperature mean (in 2m), UPM: relative humidity, TXK: temperature max (in 2m), TNK: temperature min (in 2m), TGK: temperature min (on ground)
- PC = Circulation Patterns after Principal Component Analysis of Air Pressure

Tab.: Correlations between Diseases of the respiratory system and air quality, meteorology and synoptic (data: 2017-2018)
First results: Correlations (2)

Possible explanations

- All infection related respiratory issues show much stronger correlations → spread of infections is related to weather conditions
- Temperature shows major neg. impact → respiratory issues seem to be more likely in cold weather
- Cloud cover → associated with temperature
- Relative humidity show pos. correlations
- Vapor pressure has neg. influence
- Circulation patterns: PC2 stands out with negative correlations → west winds with mild and humid air from the Atlantic Ocean in Germany

Fig.: PC2 Circulation Pattern


References


