LMU LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN

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MASTER- UND PHD-PROGRAMME

The impact of climate and weather and the epidemiological situation on regional distribution of Lyme borreliosis in Bavaria, Germany: 2013-2019

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BACKGROUND

- **Lyme Borreliosis (LB)** is the most common vector-borne infectious disease in Germany and is caused by various genospecies of spirochete bacteria belonging to the ***Borrelia burgdorferi* sensu lato** complex. LB is mainly transmitted by **ticks** of the ***Ixodes ricinus*** complex.
  - Reservoir: small mammals and birds
- LB is a complex multi-systemic disease which can affect skin, nervous system, muscles, joints and heart
- Most common manifestations of LB are **erythema migrans (EM),** acute neuroborreliosis and Lyme arthritis
  - **Notification is mandatory** in Bavaria since 03/2013

OBJECTIVES

- **Objective 1**: To identify periods, populations, and regions with an amplified risk for LB in Bavaria, Germany.
- **Objective 2**: To examine to which extent the weekly variation of LB cases in Bavaria can be related to changing weather condition.

METHODS

- We analyzed all notified cases of EM in Bavaria which were notified between 1st March 2013 – 18th November 2019 and fulfilled the case definition for EM.
- Meteorological data were collected from weather stations that were closest to the geographical center of the county (radius of 500 meters).
- Incidences (cases/100,000 inhabitants) were calculated and analyzed by time, person, region
- We used **a quasi-Poisson analysis** with weekly lagged meteorological variables (lag 1-4 weeks)
  - Independent variables: average weekly temperature, precipitation, relative humidity
  - Dependent variable: weekly reported EM cases
    - We controlled for region and season
    - Log annual (regional) population was set as an offset
  - Model was built using feature selection with cross-validation

RESULTS

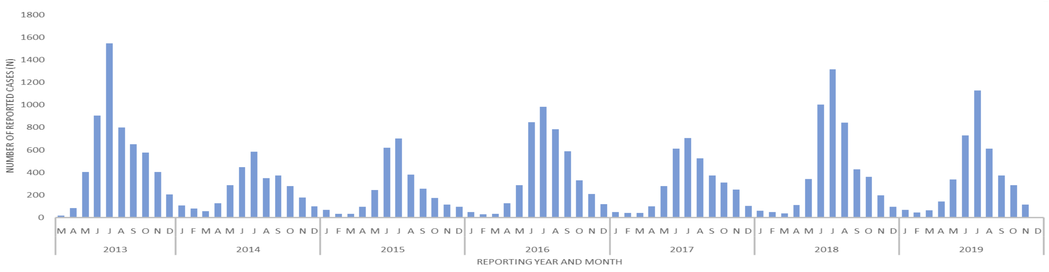

Fig. 1. EM cases reported in Bavaria by month and year, 2013–2019 (n=27.957).

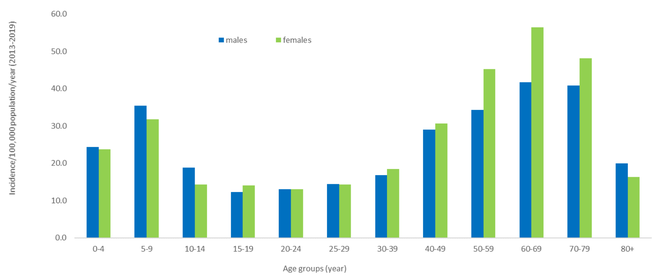

Fig. 2. Mean incidence of EM cases by age group and sex in Bavaria, 2013–2019 (n=26,723). Reported ages ranged from <1 – 100 years.

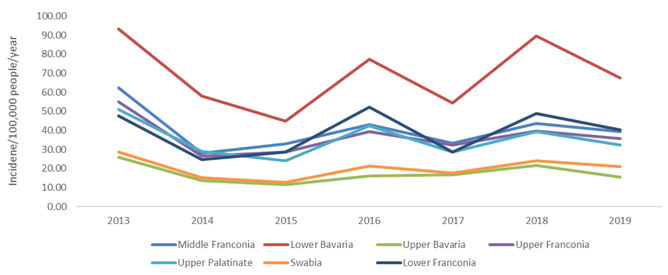

Fig. 3. Annual incidence of EM cases/100,000 people/year in Bavaria 2013–2019, by reporting region (n=27,897).

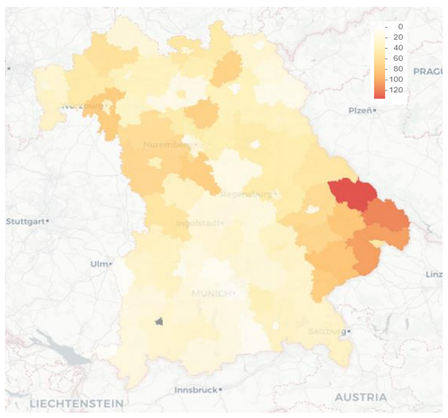

Figure 4. Map of counties in Bavaria, with code based on notified mean annual incidence of EM/100,000 population, 2013–2019 (n=27,958).

Table 1. Quasi-Poisson model. Variables included in the quasi-Poisson model that influenced EM incidence rates in Bavaria, 2013-2019. Reference region is Middle Franconia. Reference season is spring. (Coef. Coefficients, IRR Incidence Rate Ratio, CI Confidence interval)

EM cases	Coef.	IRR	95%-CI	p
(Intercept)		0	0.00 – 0.00	**<0.001**
lag_temperature_01	0.010	**1.01*** **	1.01 – 1.02	**<0.001**
lag_precepitation_01	-0.010	**0.99***	0.99 – 1.00	**0.017**
lag_precepitation_03	0.020	**1.02*** **	1.01 – 1.03	**<0.001**
lag_humidity_03	0.000	**1***	0.99 – 1.00	**0.033**
lag_humidity_04	0.000	**1*** **	1.00 – 1.01	**<0.001**
region [Lower Bavaria]	0.425	**1.53*** **	1.46 – 1.60	**<0.001**
region [Upper Bavaria]	-0.511	**0.6*** **	0.57 – 0.63	**<0.001**
region [Upper Franconia]	0.588	**1.8*** **	1.70 – 1.91	**<0.001**
region [Upper Palatinate]	0.351	**1.42*** **	1.34 – 1.50	**<0.001**
region [Swabia]	0.000	1	0.94 – 1.06	0.959
region [Lower Franconia]	0.405	**1.5*** **	1.42 – 1.58	**<0.001**
seasonw [summer]	0.095	**1.1*** **	1.06 – 1.15	**<0.001**
seasonw [autumn]	0.020	1.02	0.97 – 1.08	0.429
seasonw [winter]	-0.0619	0.94	0.85 – 1.03	0.201
Observations	2201			
R2 Nagelkerke	0.901			
Deviance	2753.39			

DISSCUSSION

- Future climate change with warmer and more extreme weather events may alter the spatiotemporal distributions of LB
- Meteorological factors alone do not fully explain the weekly variation of LB incidence → geographic location, ecological characteristics, local abundance of ticks and their hosts, and human outdoor behavior should also be considered
- Potential bias due to underreporting of cases and short study period
- Further studies are needed to understand the impact of weather factors and climate on LB incidence

CONCLUSION

- High-risk **season, populations,** and **regions** with increased incidence of LB were identified.
- The impact of **weather factors** on LB in Bavaria was described for the first time. We found a significant association between EM incidence and weather.
- In the absence of vaccination: avoiding tick bites, removing ticks as soon as possible, treating LB early and adequately and increasing public awareness in high-risk areas in Bavaria.