

DACH 2025

The risk of hospitalization associated with foehn winds and heat in the mountainous region of Switzerland

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Under review at *Environmental Epidemiology*

June 24th 2025, Bern

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Background - foehn winds and health

Tab 1: Evidence of the health effects of foehn winds.

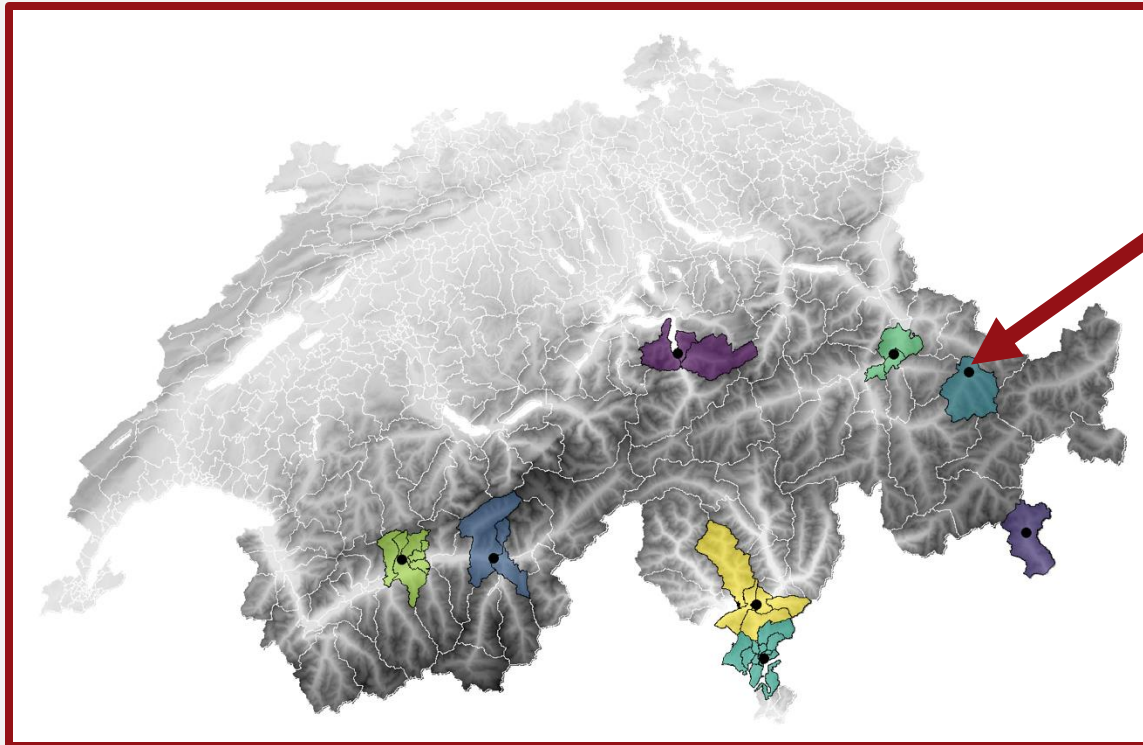
Foehn winds affect :	Foehn winds do not affect :
Fatigue, headaches, dizziness 	Acute coronary syndromes 
Mental health hospitalization 	Cardiovascular hospitalization 
Risk of migraines 	Suicide risk 
	Trauma-related hospitalization 
	Heat-related hospitalization 

Introduction – research questions

- ① Do foehn winds increase the risk of hospitalization and is this effect independent from temperature?
- ② Do foehn winds increase the risk of hospitalizations associated with heat?
- ③ Are certain subpopulations more vulnerable to both effects than others?

Methodology – study population and data

- 1998 - 2019
- Emergency admissions by Medstat region (stratified)



- Daily mean temperature
- 10-minute foehn wind data



- ① Daily foehn wind intensity
- ② Binary index

Fig 1: Elevation map of Switzerland with the included foehn measuring meteorological stations displayed as black dots and their Medstat-regions in color around them. The shading indicates elevation from 0 m above sea level (white) to 4500 m above sea level (black).

Methodology – statistical analysis

- Case-time series analysis for small-area assessments

① Direct effect of foehn winds

Model 1: daily hospitalizations ~ foehn winds intensity

Model 2: daily hospitalizations ~ foehn winds intensity + temperature

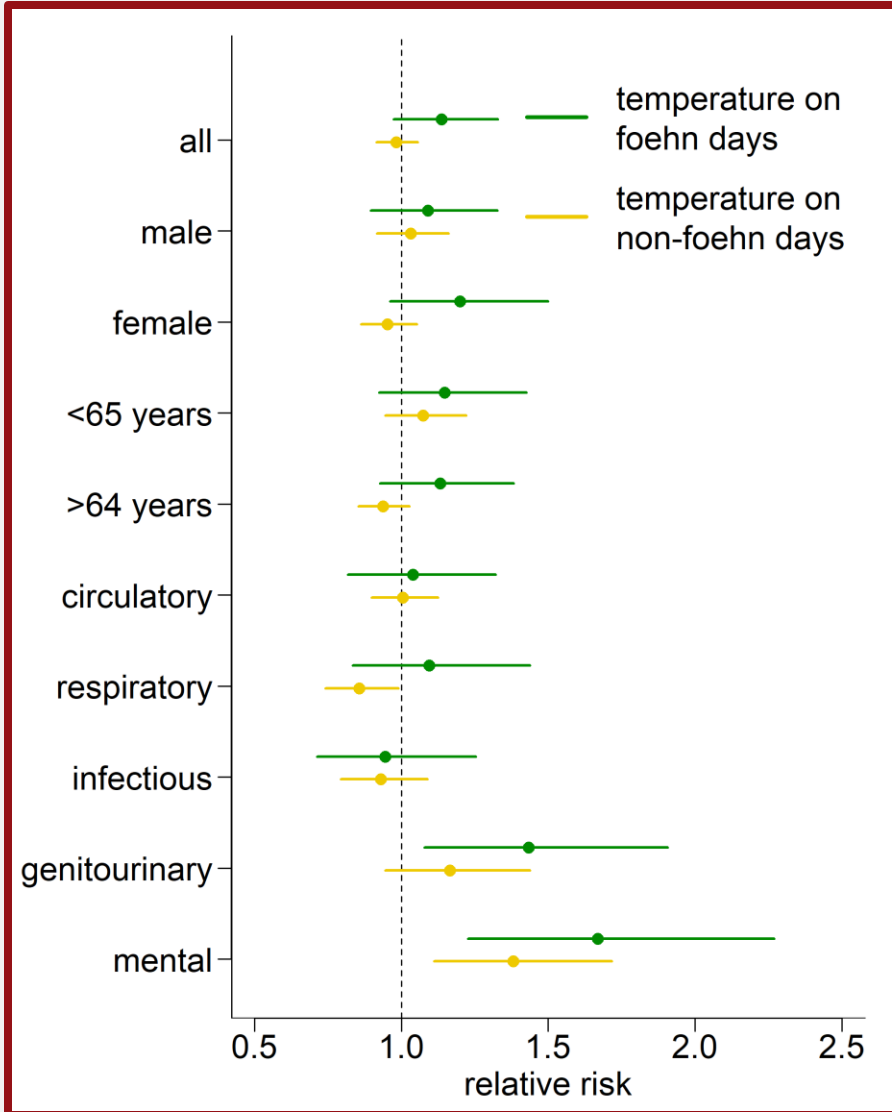
② Foehn winds as a modifier of temperature

Model 3: daily hospitalizations ~ temperature + foehn wind interaction

Results – ①③ direct effect of foehn winds

No evidence of an association between daily foehn winds intensity and hospitalizations!

Results – ② ③ foehn wind as a modifier of temperature



Foehn wind presence increases the risk of heat-related hospitalization for:

- all
- females
- older individuals
- respiratory cause hospitalizations
- mental health hospitalizations

Fig 2: Cumulative relative risk (**Model 3**) for subgroups at 24.7 °C (95% CI).

Discussion

- **Novel approach** on the effects of foehn wind intensity
- **Novel study** on foehn wind's role modifying temperatures association
- Heat and foehn winds **affect females and older people**
- The increase in risk is hospitalization **cause specific**:
 - Respiratory causes
 - Mental health admissions

Discussion – limitations

1. Equal **exposure across all residents**
2. Equal **intensities** with the same foehn wind intensity **between stations**.

Outlook

More extensive warning systems.

Repeating this study design in other mountainous areas

Conclusion

- Foehn winds intensify the risk of heat-related hospitalizations.
- Especially for **females, older adults, respiratory** diseases and **mental** health admissions.

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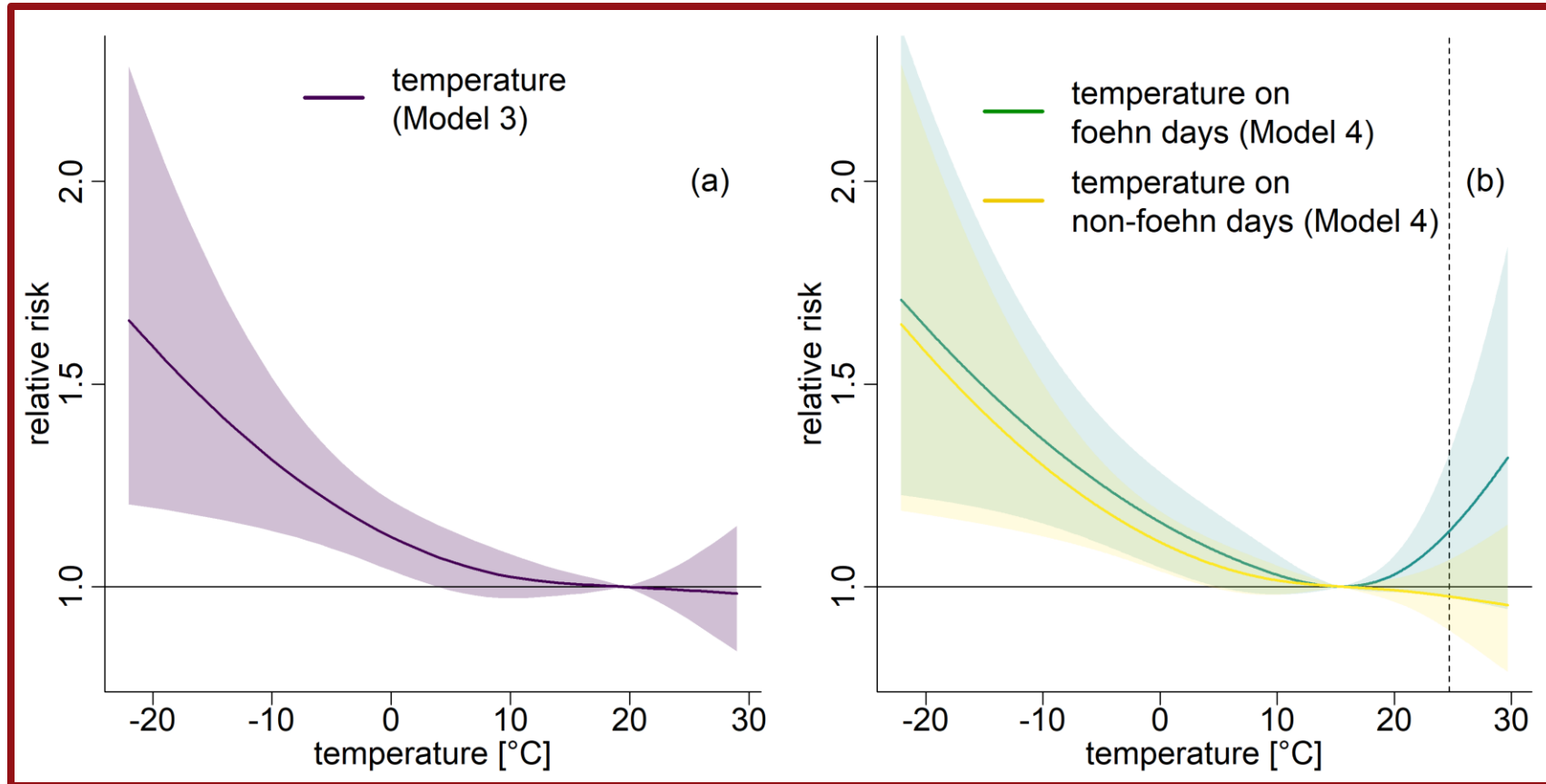
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Appendix – ② foehn wind as a modifier of temperature



At higher temperatures, we have **increased relative risk on foehn days.**

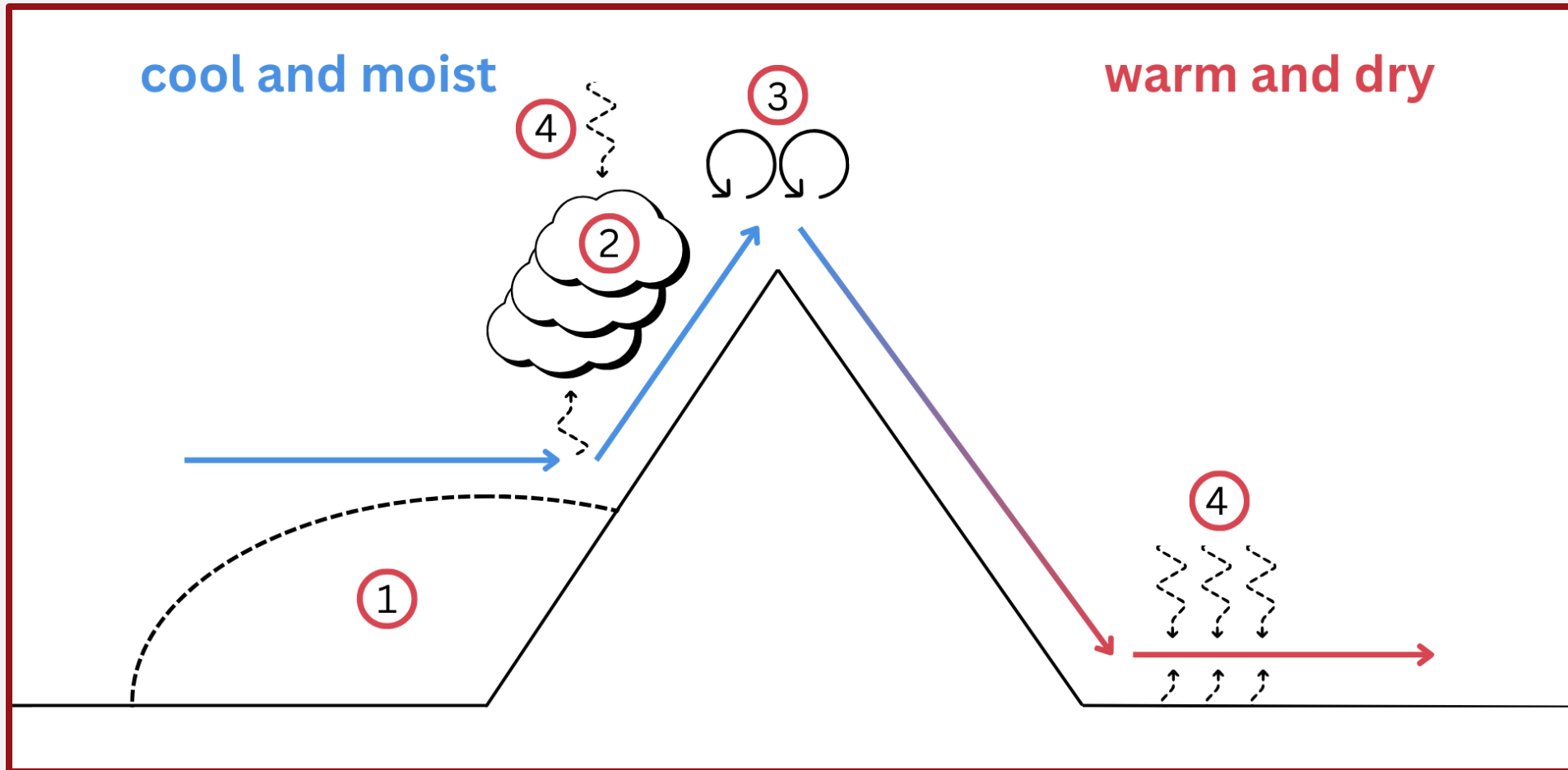
sFig 1:

(a) Cumulative relative risk from temperature exposure (**Model 3**) for all-cause hospitalizations (95% CI),

(b) cumulative relative risk from temperature exposure (**Model 4**) for all-cause hospitalizations (95% CI) on foehn and non foehn days.

The dotted line indicates the temperature corresponding to the 99th percentile of the temperature distribution (24.7 °C).

Appendix - foehn wind processes

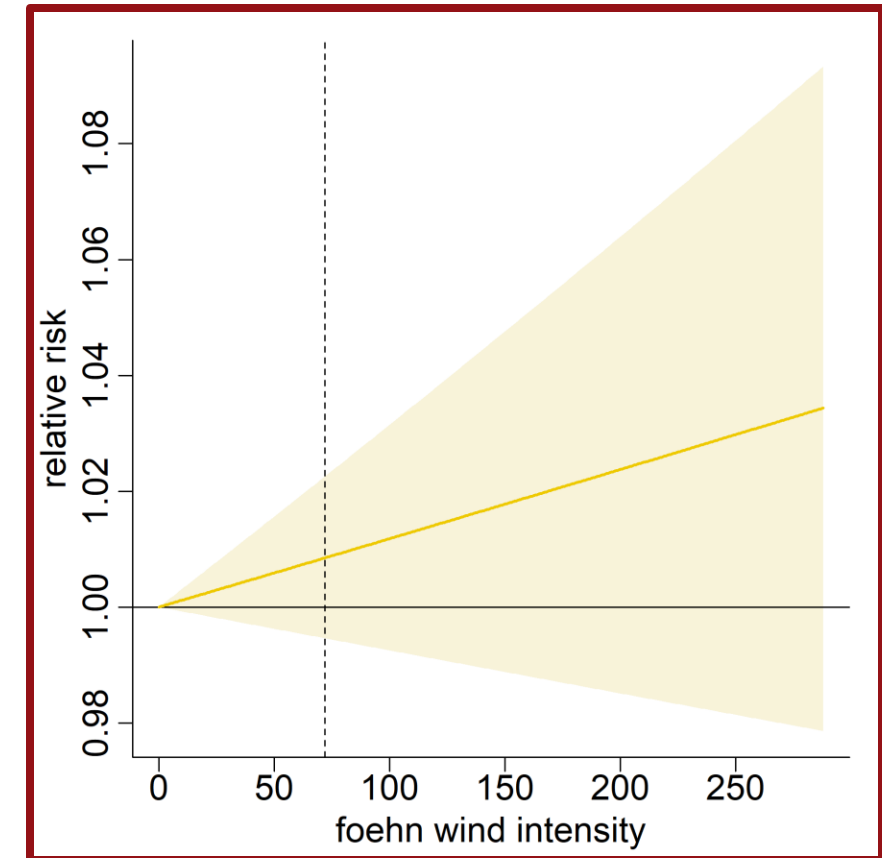


sFig 2: Processes that lead to foehn wind warming in the lee of mountains: (1) isentropic drawdown due to near surface blocking; (2) latent heat release; (3) mechanical mixing; (4) radiative heating (adapted from Elvidge and Renfrew (2016) ⁸).

Appendix – ①③ direct effect of foehn winds

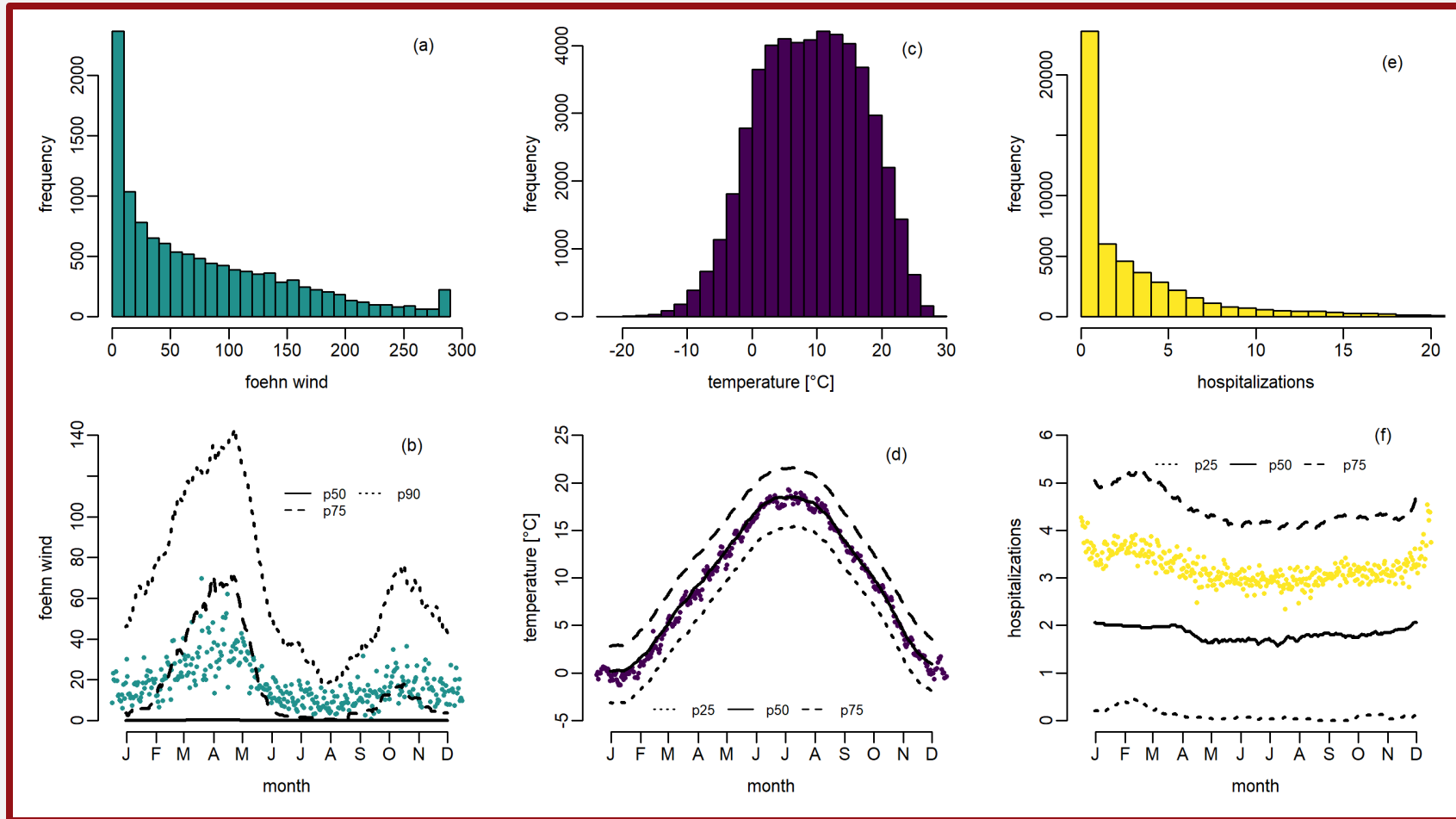
sTab 1: Cumulative relative risk for hospitalizations by cause for an exposure of 72 [95% CI].

Subgroup	Model 1	Model 2
all	1.008 [0.995-1.023]	1.004 [0.989-1.018]
male	1.007 [0.990-1.026]	1.002 [0.984-1.021]
female	1.010 [0.990-1.029]	1.005 [0.985-1.025]
<65 years	1.004 [0.986-1.024]	0.998 [0.979-1.018]
>64 years	1.012 [0.994-1.031]	1.009 [0.990-1.028]
circulatory	1.000 [0.978-1.022]	1.002 [0.980-1.025]
respiratory	1.015 [0.990-1.041]	1.003 [0.978-1.030]
infectious	1.028 [0.996-1.060]	1.030 [0.997-1.064]
genitourinary	1.000 [0.971-1.029]	0.989 [0.959-1.019]
mental	1.010 [0.983-1.038]	0.997 [0.969-1.026]



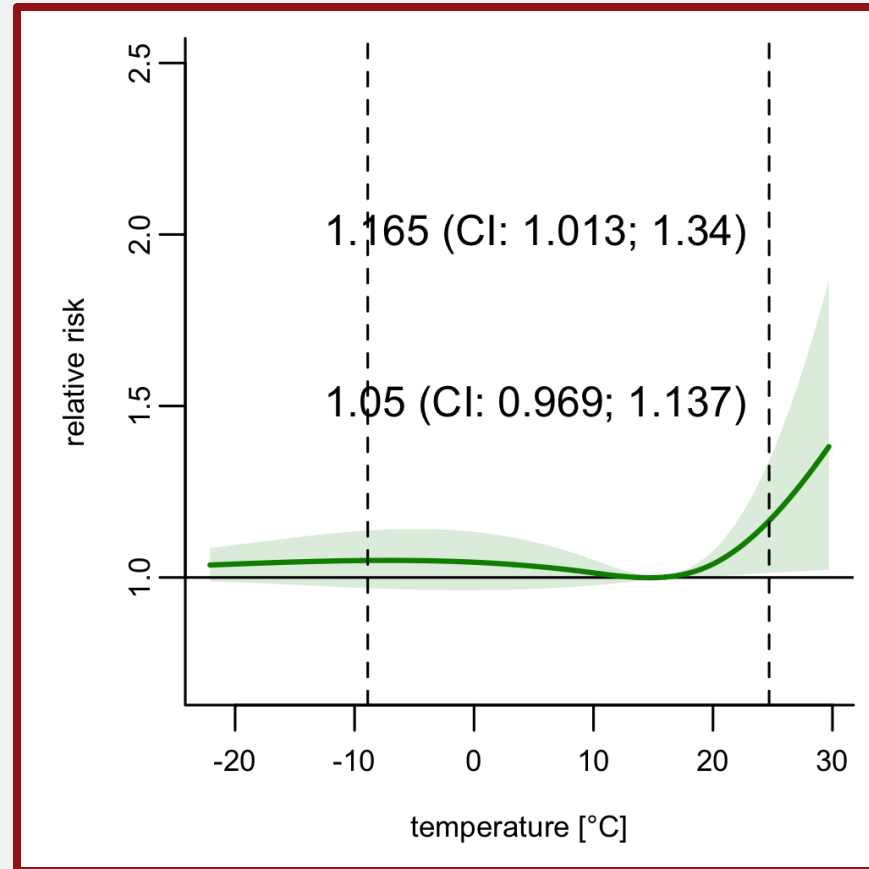
sFig 3: Cumulative relative risk from foehn wind intensity exposure (**Model 1**) for **all-cause** hospitalizations (95% CI).

Appendix – distribution



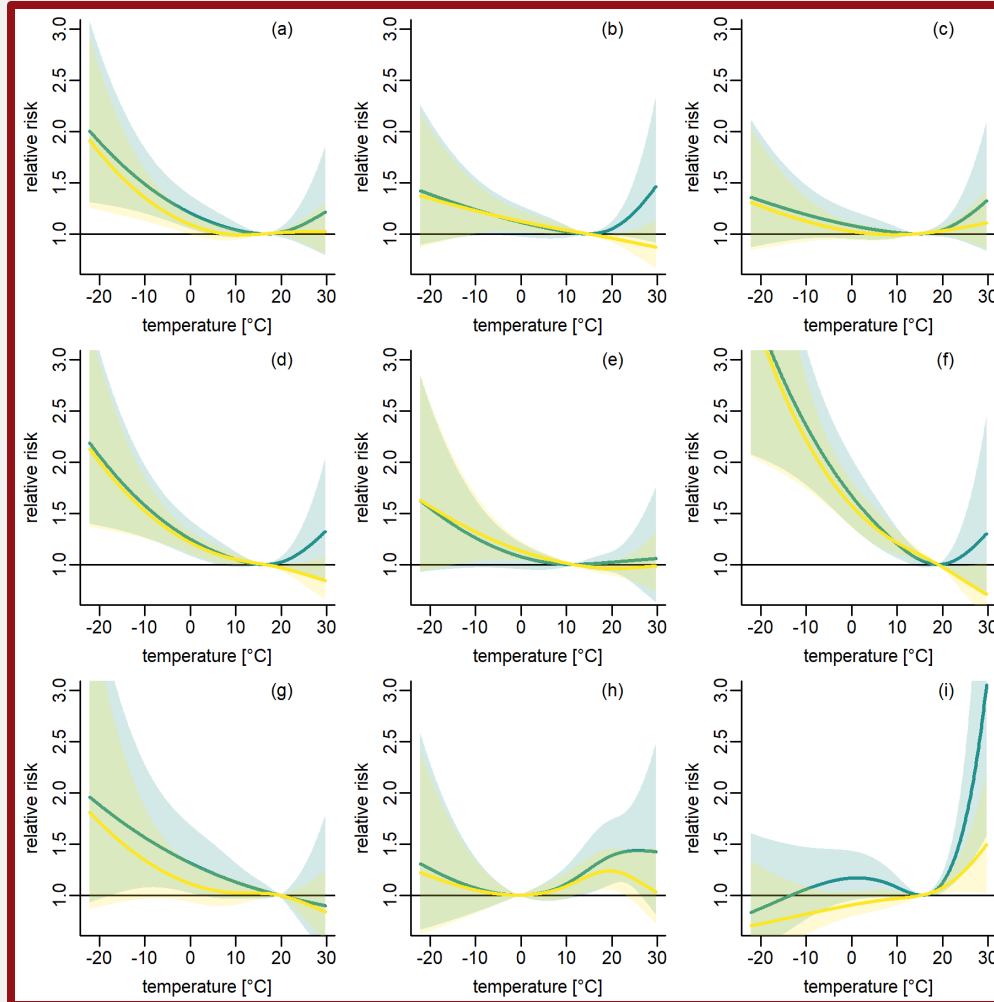
sFig 4: a) daily foehn wind intensity score distribution excluding 0-foehn wind days, (b) daily mean foehn wind intensity, (c) daily mean temperature distribution, (d) daily averages of daily mean temperature, (e) daily all-cause hospitalization distribution, (f) daily mean all-cause hospitalizations. Black lines indicate 30-day moving averages of percentiles.

Appendix – interaction all-cause hospitalization

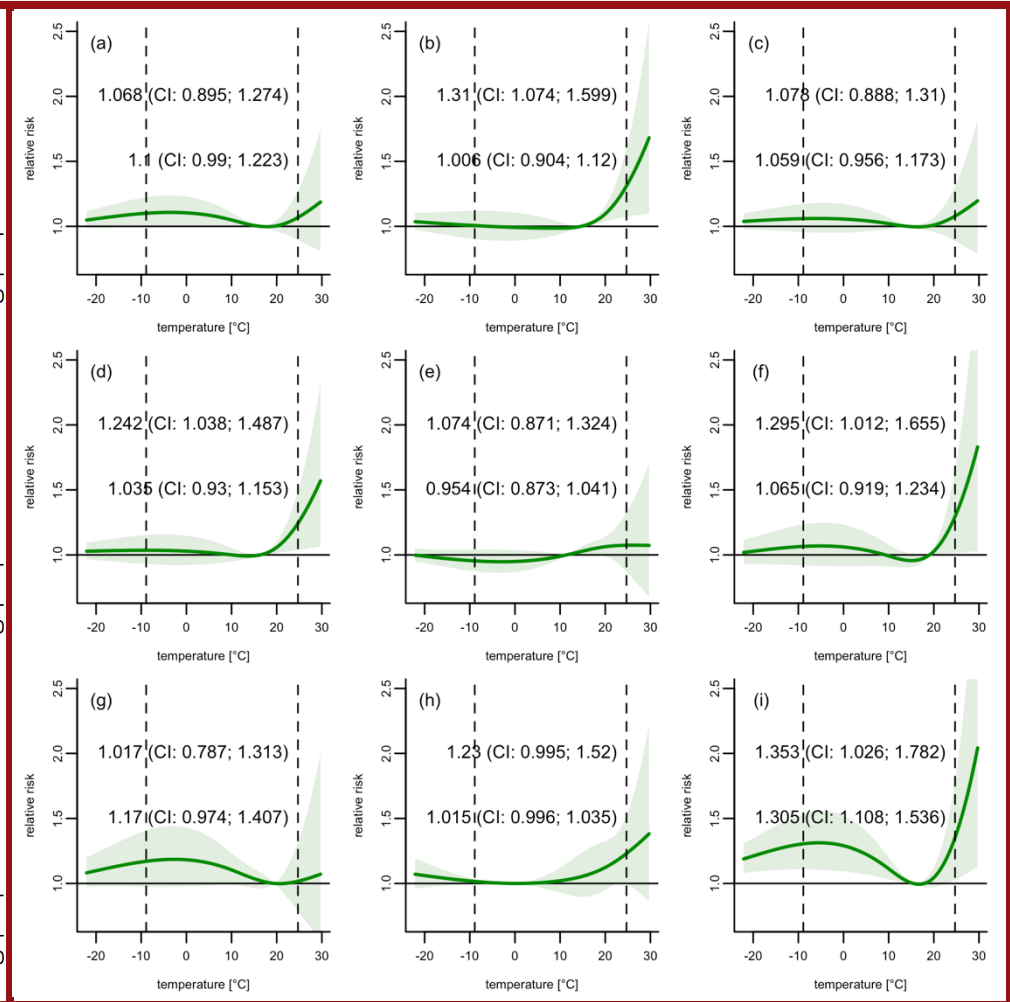


sFig 5: Cumulative relative risk of the interaction between foehn and temperature with 95% confidence interval for all-cause hospitalizations.

Appendix – interaction subpopulations



sFig 6: Cumulative relative risk [95% CI] for (a) male, (b) female, (c) 64 years and younger, (d) older than 64 years, (e) circulatory, (f) respiratory, (g) infectious, (h) genitourinary, (i) mental hospitalization with a binary foehn wind threshold value of 72.



sFig 7: Cumulative relative risk of the interaction between foehn wind and temperature [95% CI] for (a) male, (b) female, (c) 64 years and younger, (d) older than 64, (e) circulatory, (f) respiratory, (g) infectious, (h) genitourinary, (i) mental hospitalizations.