Spatial distribution of pollen-induced symptoms within a large metropolitan area – a pilot study

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Introduction:

Although cities, especially large cities, are a diverse mixture of urban environments and environmental conditions, often only a single pollen trap provides information about airborne pollen in the entire urban area. Notable differences in spatial distribution of three allergologically relevant pollen types for Central Europe (birch [Fig. 1], grass [Fig. 2] and mugwort [Fig. 3]) have been present in a novel survey focusing on pollen monitoring at 14 sites (at street level height) within a large metropolitan area – Berlin, Germany – during the pollen season 2014 (Werchan et al. 2017).

Results:

Higher amounts of monitored birch (Fig. 7) and grass (Fig. 8) pollen in the peripheral areas of Berlin were reflected in stronger symptoms of users located within the suburbs than those located in the city centre. A statistically-based relationship between the varying presence of mugwort pollen in the air and the severity of symptoms could not be found, mainly due to low number of user entries. Given the low number of user entries no detailed statistical evaluation is possible between the pollen data of a single trap and the symptom data of the associated users.

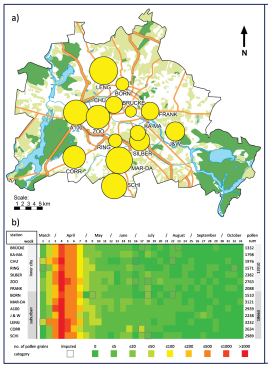

Fig. 1 Higher seasonal sedimentations of **birch** pollen were observed in pollen traps situated nearer the outside of Berlin, whereas lower depositions in traps were observed near the inner city.

a) Total sum of birch pollen during the whole investigation period from 11 March until 28 October 2014; the circle size corresponds to the observed pollen sum.
b) Graphic illustration of weekly birch pollen sedimentations; traps are ordered by their distance from the geographical center of the city (N 52° 30.092 E 13° 24.137); imputed = imputed model data in weeks with lost slides.

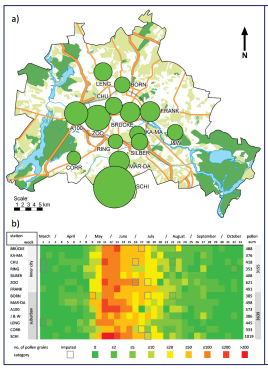

Fig. 2 By far the highest seasonal sedimentation of **grass** pollen was found in the south of Berlin – in the trap coded "SCHI". Higher pollen sedimentations were observed in suburban area of Berlin in comparision to inner city.

a) Total sum of Poaceae pollen during the whole investigation period from 11 March until 28 October 2014; the circle size corresponds to the observed pollen sum.
b) Graphic illustration of weekly grass pollen sedimentations; traps are ordered by their distance from the geographical center of the city (N 52° 30.092 E 13° 24.137); imputed = imputed model data in weeks with lost slides.

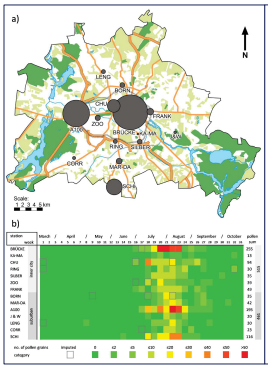

Fig. 3 Apparent spatial distribution of **mugwort** pollen have occurred throughout the city of Berlin following the direct influence of abundant local sources (Werchan et al. 2017).

a) Total sum of mugwort pollen during the whole investigation period from 11 March until 28 October 2014; the circle size corresponds to the observed pollen sum.
b) Graphic illustration of weekly mugwort pollen sedimentations; traps are ordered by their distance from the geographical center of the city (N 52° 30.092 E 13° 24.137);); imputed = imputed model data in weeks with lost slides.

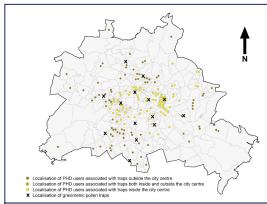

Fig. 4 Distribution of 162 active PHD users during **birch** pollen season (11.03. to 05.05.2014) within the city of Berlin. The sum of entries in the map is 170; 10 users are associated with two different pollen traps at the same time; 8 users are associated with two different pollen traps during the course of the season.
The light yellow dots indicate the users associated with traps located inside the city centre (7 pollen traps: BRÜCKE, KA-MA, CHU, RING, SILBER, ZOO, FRANK). The darker brown dots indicate the users associated with traps located outside of the city centre (7 pollen traps: BORN, MAR-DA, A100, J&W, LENG, CORR, SCHI).

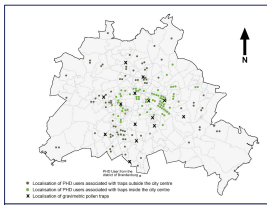

Fig. 5 Distribution of 149 active PHD users during **grass** pollen season (15.04. to 05.08.2014) within the city of Berlin. The sum of entries in the map is 159; 9 users are associated with two different pollen traps at the same time; 8 users are associated with two or three different pollen traps during the course of the season.
The light green dots indicate the users associated with traps located inside the city centre (7 pollen traps: BRÜCKE, KA-MA, CHU, RING, SILBER, ZOO, FRANK). The dark green dots indicate the users associated with traps located outside the city centre (7 pollen traps: BORN, MAR-DA, A100, J&W, LENG, CORR, SCHI).

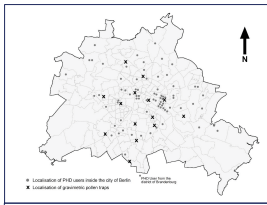

Fig. 6 Distribution of 69 active PHD users during the mugwort pollen season (24.06. to 16.09.2014) within the city of Berlin. The sum of entries in the map is 76; 3 users are associated with two different pollen traps at the same time; 6 users are associated with two different pollen traps during the course of the season.

Objectives:

Under these different exposure conditions, it is assumed that persons affected by pollen allergy could develop pollen-induced symptoms to different degrees within one city. An examination of the hypothesis is the main purpose of the study. Birch, grass and mugwort pollen data were collected with usage of gravimetric pollen traps on a weekly base*. Anonymously reported daily pollen-induced symptom data of users (Fig. 4, Fig. 5 and Fig. 6) from Berlin metropolitan area were extracted from the online-based self-documentation tool "Patient´s Hay-fever Diary" (PHD; www.pollendiary.com). The user overall total symptoms "OTS" (eyes + nose + airways) entries were associated with the nearest of 14 pollen monitoring sites on the basis of postal codes assigned by the users for every of their entries. From the resulting 14 user groups the weekly user symptom data were statistically compared with weekly pollen data of the corresponding monitoring sites using Kendall´s Tau B.

* The definition of pollen season follows the recommendations of the European Aeroallergen Network (https://ean.polleninfo.eu/Ean/), which define the beginning with 1% and ending with 95% of the yearly sum of a pollen count.

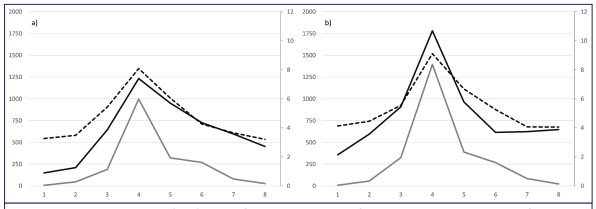

Fig. 7 Overall Total Symptoms (OTS) score of users and amount of **birch** pollen over the course of the entire birch pollen season (8 weeks, 11.03.-05.05.2014). Left hand axis indicates the number of birch pollen, right hand axis indicates the OTS score.
Grey solid line = weekly amount of birch pollen; **black solid line** = weekly OTS score of significant positive correlated users, **black dashed line** = weekly OTS score of significant positive + positive correlated users.
Together 170 users = 90 users "city centre" + 81 users "outside the city centre" (One user is counted into "city centre" and also into "outside the city centre".).
a) "city centre" – 9 significant positive users, 41 positive + significant positive users
b) "outside the city centre" – 6 significant positive users, 42 positive + significant positive users

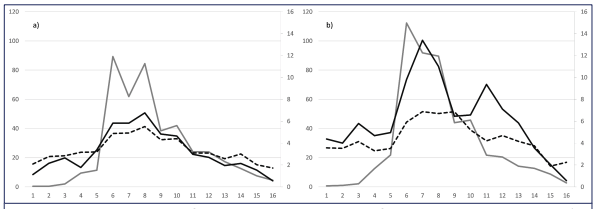

Fig. 8 OTS score and amount of **grass** pollen over the course of the entire grass pollen season (16 weeks,15.04.-05.08.2014). Left hand axis indicates the number of grass pollen, right hand axis indicates the OTS score.
Grey solid line = weekly amount of grass pollen; **black solid line** = weekly OTS score of significant positive correlated users, **black dashed line** = weekly OTS score of significant positive + positive correlated users.
Together 159 users = 79 users "city centre" + 80 users "outside the city centre".
a) "city centre" – 11 significant positive users, 35 positive + significant positive users
b) "outside the city centre" – 4 significant positive users, 29 positive + significant positive users

Conclusion:

Grass and birch pollen data from a single inner city trap may not serve as an adequate source of information and as an appropriate explanation of pollen-induced symptoms of allergy sufferers living within the suburbs and vice versa. In order to provide more detailed and reliable information about the exposure to allergenic pollen, **pollen monitoring should be based on more than one pollen trap per city**. Furthermore, the occurrence of higher quantities of mugwort pollen in the air is a local phenomenon, strongly associated with the presence/absence of those plants in the immediate vicinity (Werchan et al. 2017), and cannot be adequately expressed in symptom data at a postal-code scale. An appropriate placement of two or more pollen monitoring traps within cities or/and in case of pollen types with local occurrence the usage of personal pollen samplers (Werchan et al. 2016) would render more realistic data.

In realation to this presentation, I declare that there are no conflicts of interest.

References:

Werchan, B., Werchan, M., Mücke, H.-G., Gauger, U., Simoleit, A., Zuberbier, T. & Bergmann, K.-C. (2017). Spatial distribution of allergenic pollen through a large metropolitan area. Environmental Monitoring and Assessment, 189(169). DOI: 10.1007/s10661-017-587

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