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Annoyance due to noise from sports facilities

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ABSTRACT

To enable and facilitate access to sports facilities, they are oftentimes integrated into residential areas. This, however, can lead to conflicts, e.g. with respect to noise exposure. Therefore, the impact of noise from such sources needs particular consideration. In a project funded by the German Environment Agency, the amendment of the sports facilities noise regulation was evaluated. The evaluation was done via stakeholder interviews, qualitative and quantitative population surveys as well as a legal assessment. Six sports facilities across Germany were selected with varying sport activities (e.g. soccer, tennis, athletics). The quantitative survey was conducted in two survey waves in 2021 and 2022, respectively. Adults (≥ 18 years) living in the proximity of sports facilities were asked about various topics such as their living conditions, noise annoyance due to different sources (road traffic, neighbours, sports facilities as well as different types of sports facility noise and different days of the week), sports facilities noise related disturbances, personal and societal relevance of the local sports facility, coping strategies and sociodemographic characteristics. Participants had the option to fill in an online questionnaire or participate via telephone (CATI). The exposure was determined by calculation of individual noise levels for each participant and different time periods of the day. In total, the sample consists of 947 participants of which 241 participated in both survey waves. In this contribution, results of the study including exposure-response curves for annoyance due to sports grounds for different days of the week are presented and discussed.

Keywords (3-6): Noise, Annoyance, Sports facilities

INTRODUCTION

To promote sporting activities close to home, sport facilities are increasingly found in residential areas. This has the advantage that children, adolescents as well as adults can pursue sport activities within a close range of their homes. However, this can pose major

challenges as noise conflicts can arise. In recent years, noise conflicts between residents and sport facilities have increased especially in urban areas due to redensification.

Noise from sports facilities mainly occurs at times when the neighbouring residents have a need for restoration (e.g. evening hours, Saturdays and Sundays). Additionally, the prevailing characteristics of noise from sports facilities can differ greatly: depending on the type of sports, the noise can be of high impulse (e.g. whistles, bouncing balls) and can contain information (e.g. voices from athletes, coaches). According to Guski and colleagues¹, noise annoyance is a complex, psychological response to sounds that comprises three elements: disturbance of activities, affective and evaluative reaction, and a cognitive reaction¹.

Not many studies can be found in the literature with respect to the impact of noise from sports facilities. Guski and colleagues² compared the annoyance and disturbance due to sports noise from tennis and soccer to the annoyance and disturbance due to industrial and occupational noise.

The current study was funded by the German Environment Agency and aimed at evaluating the amendment of the Sports Facilities Noise Regulation and its effects. The evaluation was done via stakeholder interviews, a qualitative and a quantitative survey examining the impact of noise annoyance from sports facilities as well as a legal assessment. This paper presents and discusses the results of the quantitative survey.

MATERIALS AND METHODS

Study Design

To quantitatively determine the noise impact of sports facilities in residential areas, annoyance surveys were carried out at six selected sports facilities located in urban areas in Germany (Hamburg, Berlin, Munich, Voerde, Dortmund, Cologne). As the survey was conducted during the Covid-19 pandemic from September 2021 until November 2021 and restrictive measures were still in place at the time, a second survey wave was conducted in April and May 2022 to account for a potential difference in noise exposure. Random samples of the adult population living within a radius of 250m from each sports facility were drawn and contacted for participation. Participants could fill in an online questionnaire or participate via telephone (CATI). The total sample should consist of 600 people per survey wave. Participants from the first survey wave were contacted again and were asked to participate in the second survey wave as well.

Noise rating levels ($L_{r,A}$) for sports facilities noise exposure were calculated for the home address of each participant for different days of the week and different times of a day.

Questionnaire

Based on the qualitative telephone interviews, a questionnaire was developed for the quantitative survey. The questionnaire covered the following topics: residential satisfaction, living environment and conditions, noise annoyance (due to different sources, on different days of the week and time of day³, noise-induced activity disturbance, attitudes towards the local sports facility and sports facilities in general, coping strategies, and sociodemographics.

As both survey waves took place only six months apart, two different time frames were used for the noise annoyance and disturbance questions. For the first survey wave, the time frame participants were asked to think about were the last 12 months, and in the second survey wave this time frame was reduced to six months to avoid overlapping time periods.

RESULTS

Sample description

537 people participated in the first survey wave and 651 in the second survey wave. As 241 people took part in both survey waves, the total sample consists of 947 participants. 53% of participants were female, 47% male and 0.3% diverse. The average age was 53.9 years ($SD = 17.32$).

Exposure to noise from sports facilities

For the subsample that consisted of 241 participants, the exposure to sports facilities noise was tested for significant differences between the two survey waves. Results show a significant difference in noise exposure with differences in noise rating levels $L_{r,A}$ of up to 6 dB.

Living environment, sports facility and noise annoyance

Satisfaction with both the living environment (1st wave: $M = 4.33$, $SD = 0.79$; 2nd wave: $M = 4.35$, $SD = 0.78$) and the apartment/house (1st wave: $M = 4.27$, $SD = 0.82$; 2nd wave: $M = 4.25$, $SD = 0.78$) as well as the rating of the sojourn quality outdoors (1st wave: $M = 4.13$, $SD = 0.80$; 2nd wave: $M = 4.13$, $SD = 0.80$) was high in both survey waves. Further, questions were asked with respect to the societal and personal relevance of the sports facility. Societal relevance encompasses aspects such as “The sports facility is relevant for children and adolescents”, “The sports facility is a relevant meeting point for the neighbourhood”, or “The sports facility invigorates the residential area”. Personal relevance of the sports facility covers aspects such as “The sports facility is relevant for me personally” or “The sports facility serves as a nice green space”. The societal relevance is rated high in both survey ways (1st wave: $M = 4.26$, $SD = 0.77$; 2nd wave: $M = 4.35$, $SD = 0.75$). The personal relevance of the sports facility seems to be somewhat less relevant (1st wave: $M = 3.43$, $SD = 1.00$; 2nd wave: $M = 3.46$, $SD = 0.95$). Overall, the mean ratings for noise annoyance due to the different noise sources from sports facilities are rather low (see Table 1). For example, annoyance ratings for both road traffic (1st wave: $M = 2.53$, $SD = 1.24$; 2nd wave: $M = 2.37$, $SD = 1.21$) and neighbourhood noise (1st wave: $M = 1.98$, $SD = 1.09$; 2nd wave: $M = 1.82$, $SD = 1.00$) are higher than those ratings for sports facilities noise (12 months: 1st wave: $M = 1.48$, $SD = 0.98$; 2nd wave: $M = 1.40$, $SD = 0.84$). Looking at the ratings for noise annoyance due to sports facilities for different days of the week, noise annoyance during the weekend seems to be higher than during weekdays (e.g. 1st wave: weekdays $M = 1.29$, $SD = 0.77$; Sundays: $M = 1.56$, $SD = 1.04$). The difference between noise annoyance on weekdays and on weekends is significant.

Annoyance from sounds from sport activities (e.g. bouncing balls, athletes, coaches, audience) as well as from ambient sounds (e.g. music, door slamming on the parking lot) are rated lower as the overall noise annoyance due to sports facilities in both survey waves. In general, there are no differences between the two survey waves.

Table 1: Descriptives of relevant variables

	1 st wave			2 nd wave		
	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>
Living environment						
Satisfaction with living environment	536	4.33	0.79	651	4.35	0.78
Satisfaction with apartment/house	536	4.27	0.82	650	4.25	0.78
Sojourn quality outdoors	535	4.13	0.80	650	4.13	0.80
Noise annoyance						
Overall	536	1.85	1.15	651	1.82	1.05
Road traffic	536	2.53	1.24	651	2.37	1.21
Sports facilities (12 months)	535	1.48	0.98	651	1.40	0.84
Sport facilities (6 months)	-	-	-	651	1.38	0.88
Neighbourhood	536	1.98	1.09	651	1.82	1.00
Weekdays	536	1.29	0.77	651	1.26	0.71
Saturdays	536	1.48	0.96	651	1.40	0.89
Sundays	536	1.56	1.04	651	1.48	0.98
Sounds from sport activities	535	1.34	0.65	651	1.29	0.61
Ambient sounds	535	1.33	0.66	651	1.25	0.59
Relevance of the sports facility						
Societal relevance	534	4.26	0.77	410	4.35	0.75
Personal relevance	532	3.43	1.00	410	3.46	0.95

Correlations

Correlation analyses were conducted to investigate the relationship between noise annoyance from sports facilities and different noise rating levels of sports facility noise exposure. Table 2 shows the correlations for the 1st survey wave and Table 3 for the 2nd survey wave. Overall, the ratings of noise annoyance due to sports facilities correlate statistically significantly with all noise rating levels. The total noise annoyance from sports facilities correlates highest with the rating level for Sunday evenings (8 p.m. to 10 p.m.; 1st wave: $r = 0.403$, $p < 0.01$). The noise annoyance due to sports facilities on weekdays, Saturdays and Sundays are significantly correlated to almost all noise rating levels.

Satisfaction with the living environment and the sojourn quality outdoors are significantly negatively related to all ratings for noise annoyance due to sports facilities (see Table 2); i.e. the higher the noise annoyance due to sports facilities the less satisfied participants are with their living environment and the less they rate the sojourn quality outdoors.

Both societal and personal relevance of the sports facility correlate negatively with all noise annoyance ratings (e.g. societal relevance and noise annoyance due to sports facilities overall $r = -.508$, $p < 0.01$; personal relevance and noise annoyance due to sports facilities overall $r = -.378$, $p < 0.01$). Results of the correlation analyses for the second survey wave are similar.

Table 2: Correlations between relevant variables and noise exposure for the 1st survey wave

Correlation <i>r</i>	Noise annoyance due to sports facilities					
	Overall	Weekdays	Saturdays	Sundays	Sounds	Ambient
Sports facilities noise levels						
<i>L_{r,A}</i> weekdays 8-20h	.288**	.233**	.290**	.319**	.264**	.231**
<i>L_{r,A}</i> weekdays 20-22h	.294**	.234**	.299**	.336**	.300**	.239**
<i>L_{r,A}</i> Saturdays 8-20h	.252**	.204**	.252**	.281**	.232**	.203**
<i>L_{r,A}</i> Saturdays 20-22h	.299**	.262**	.219**	.261**	.237**	.204**
<i>L_{r,A}</i> Sundays 9-13 & 15-20h	.238**	.195**	.237**	.264**	.215**	.192**
<i>L_{r,A}</i> Sundays 13-15h	.277**	.214**	.278**	.312**	.264**	.223**
<i>L_{r,A}</i> Sundays 20-22h	.403**	.318**	.343**	.364**	.327**	.233**
Living environment						
Satisfaction with living environment	-.265**	-.289**	-.242**	-.240**	-.272**	-.304**
Satisfaction with apartment/house	-.103*	-.094*	-.088*	-.08	-.133**	-.142**
Sojourn quality outdoors	-.345**	-.336**	-.331**	-.327**	-.312**	-.260**
Relevance of the sports facility						
Societal relevance	-.508**	-.424**	-.435**	-.486**	-.504**	-.386**
Personal relevance	-.378**	-.334**	-.346**	-.366**	-.363**	-.295**

Table 3: Correlations between relevant variables and noise exposure for the 2nd survey wave

Correlation <i>r</i>	Noise annoyance due to sports facilities					
	Overall	Weekdays	Saturdays	Sundays	Sounds	Ambient
Sports facilities noise levels						
<i>L_{r,A}</i> weekdays 8-20h	.284**	.230**	.300**	.335**	.324**	.243**
<i>L_{r,A}</i> weekdays 20-22h	.303**	.233**	.306**	.344**	.323**	.262**
<i>L_{r,A}</i> Saturdays 8-20h	.298**	.243**	.310**	.343**	.334**	.250**
<i>L_{r,A}</i> Saturdays 20-22h	.207**	.104	.184**	.249**	.226**	.182**
<i>L_{r,A}</i> Sundays 9-13 & 15-20h	.287**	.232**	.303**	.336**	.325**	.245**
<i>L_{r,A}</i> Sundays 13-15h	.300**	.246**	.312**	.343**	.341**	.246**
<i>L_{r,A}</i> Sundays 20-22h	.285**	.159	.236**	.324**	.287**	.207**
Living environment						
Satisfaction with living environment	-.248**	-.223**	-.223**	-.223**	-.191**	-.203**
Satisfaction with apartment/house	-.147**	-.163**	-.151**	-.160**	-.111**	-.103**
Sojourn quality outdoors	-.303**	-.295**	-.306**	-.295**	-.269**	-.221**
Relevance of the sports facility						
Societal relevance	-.529**	-.518**	-.536**	-.536**	-.516**	-.413**
Personal relevance	-.413**	-.402**	-.404**	-.413**	-.371**	-.301**

Exposure-Response-Analyses

To examine the exposure-response-relationship between %HA_V and the noise rating levels of sports facilities, six logistic regression analyses were conducted for each survey wave. The

exposure-response-curves for the two survey ways are based on two different time frames regarding the annoyance ratings (12 vs 6 months).

First, simple logistic regressions were calculated to compare the different days of the week. Figure 1 and Figure 2 show the exposure-response-curves for weekdays, Saturdays and Sundays for each survey wave, respectively, with the corresponding $L_{r,A}$ to the day of the week and the time of day.

In general, all exposure-response curves are lower in the 2nd survey wave compared to the 1st survey wave. In the 2nd survey wave, the exposure-response-curve for weekdays is less steep than in the 1st survey wave and all three curves representing %HA_V for the weekends. At the same $L_{r,A}$ level, the %HA_V for weekends is higher than for weekdays. The three %HA_V curves shown for the weekend are quite similar to each other. The odds ratios (OR) for being highly annoyed vs. not being highly annoyed on Saturdays per 1-dB increase in $L_{r,A}$ for Saturdays 8-20h is 1.08 ($p < 0.01$) higher in the 1st survey wave and 1.13 ($p < 0.01$) higher in the second survey wave.

The World Health Organization (WHO) specifies a 10 %HA as the health-related relevance threshold for high noise annoyance⁴. With respect to sports facilities, this threshold is reached at approx. 56 dB for weekdays (8-20h), 46 dB for Saturdays (8-20h), 45 dB (9 a.m. - 1 p.m. / 3 p.m. - 8 p.m.) and 47 dB for Sundays (13 - 8 p.m.).

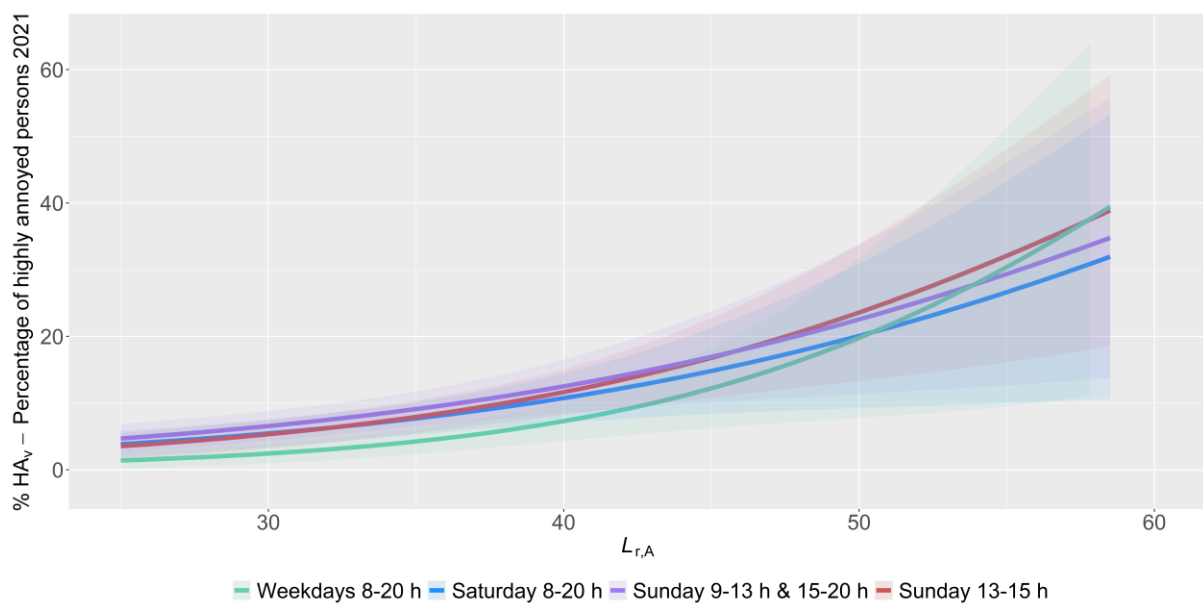


Figure 1: Exposure-response relationship for $L_{r,A}$ and %HA_V from sports facility noise for different days of the week and times of the day (1st survey wave, n = 537)

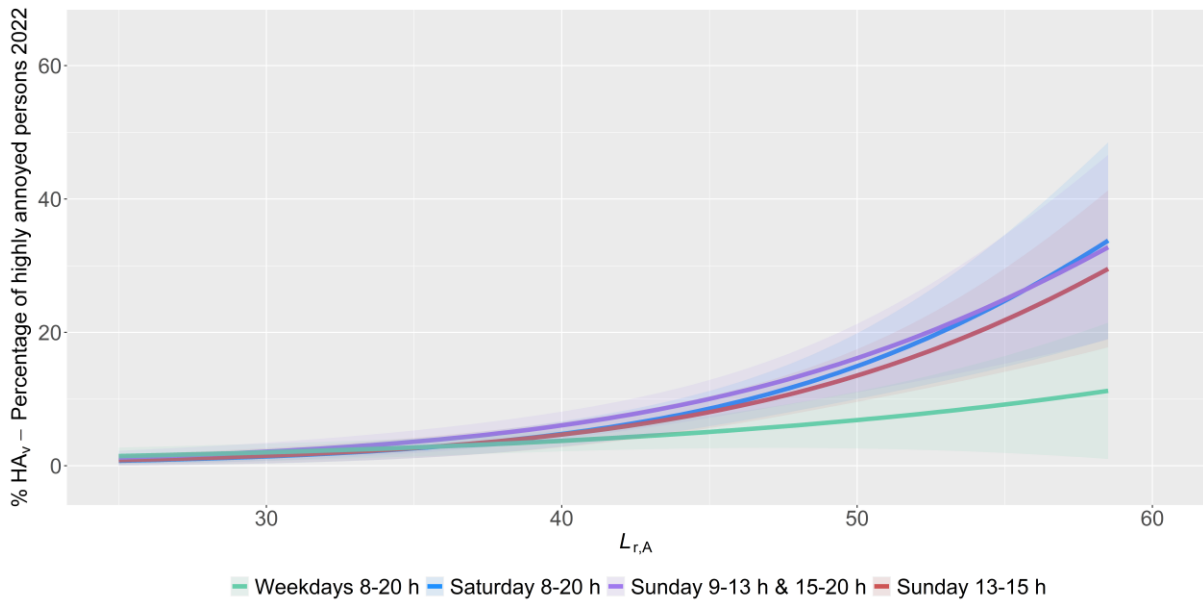


Figure 2: Exposure-response relationship for $L_{r,A}$ and % HA_V from sports facility noise for different days of the week and times of the day (2nd survey wave, n = 651)

The second set of simple logistic regressions was calculated for the comparison of noise annoyance due to sounds from sport activities, ambient sounds and sports facility noise overall. As Sundays seem to be of particular relevance for annoyance ratings, the $L_{r,A}$ for Sundays were chosen as exposure variables. The exposure-response-curves for both survey waves can be seen in Figure 3 and Figure 4. Again, all three exposure-response-curves are steeper in the 1st survey wave, i.e. the % HA_V is smaller in the 2nd survey wave than in the 1st survey wave at the same $L_{r,A}$. At 40 dB $L_{r,A}$ the % HA_V for annoyance due to sports facility noise overall is at approx. 10% in the 1st survey wave and approx. 4-5% in the 2nd survey wave.

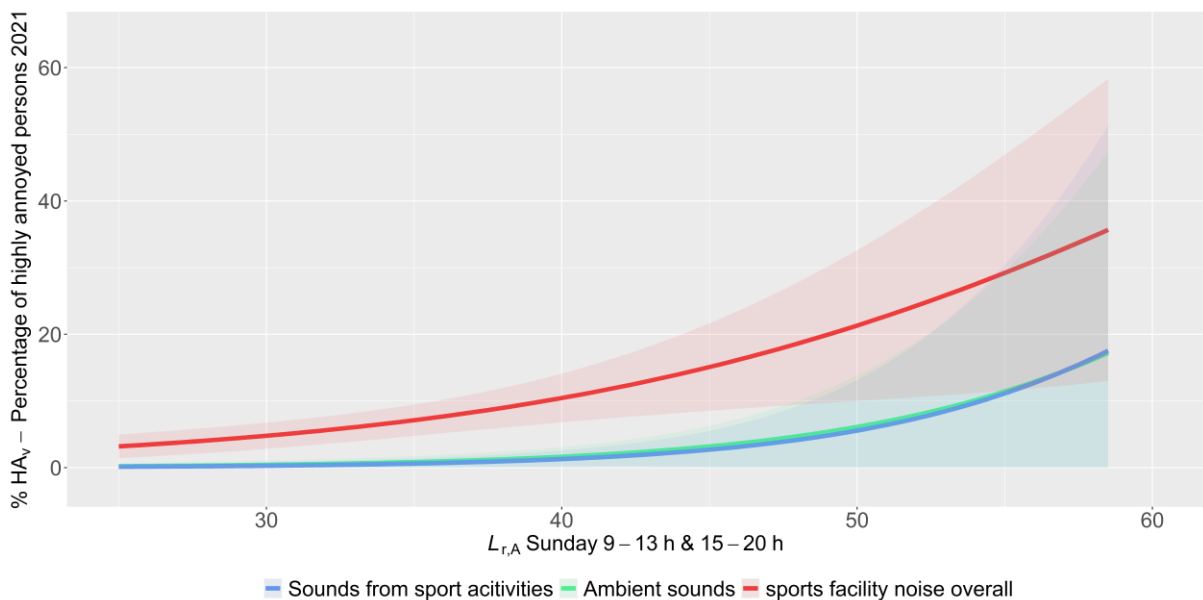


Figure 3: Exposure-response relationships for $L_{r,A}$ on Sundays from 9 a.m. to 1 p.m. and 3 p.m. to 8 p.m. and % HA_V from total sports noise, sports noise and background noise (1st survey wave, n = 537)

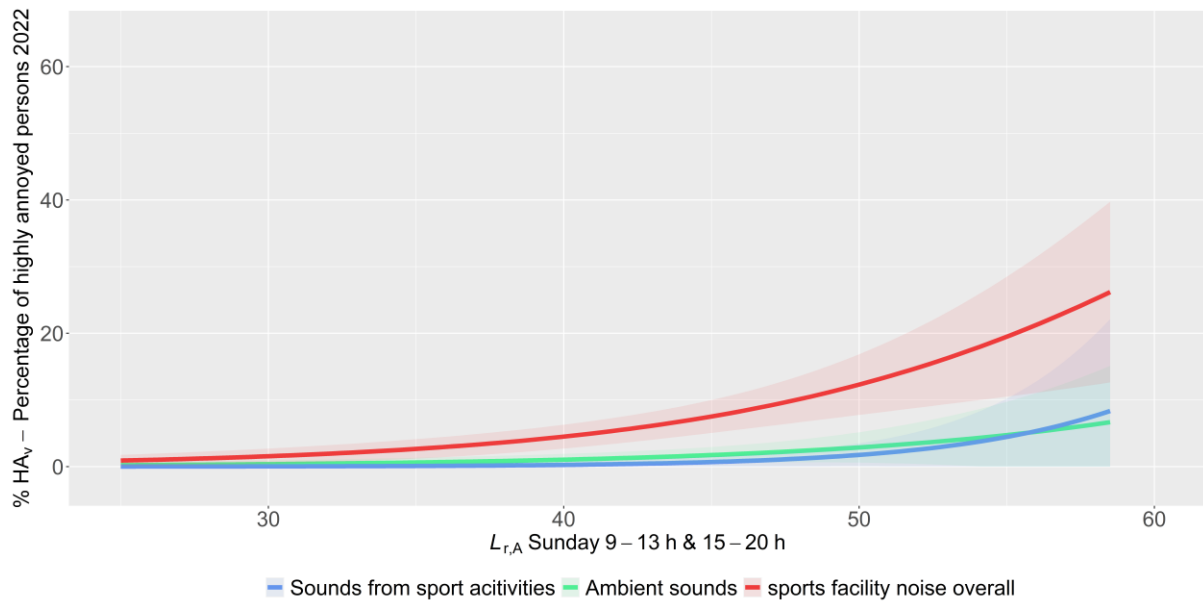


Figure 4: Exposure-response relationships for $L_{r,A}$ on Sundays from 9 a.m. to 1 p.m. and 3 p.m. to 8 p.m. and % H_{AV} from total sports noise, sports noise and background noise (2nd survey wave, n = 651)

Besides the noise rating level, other factors may have a significant influence on noise annoyance due to sports facilities as well. Based on the correlation analyses, potential predictors were identified and used as additional predictors in multiple logistic regression analyses. The following variables were selected: satisfaction with the living environment and satisfaction with one's own apartment or house, sojourn quality outdoors, societal relevance and personal relevance of the local sports facility. Figure 5 and Figure 6 display the exposure-response-curves for the multiple logistic regressions in comparison with the simple logistic regressions for both survey waves.

In the first survey wave, the noise annoyance due to sports facilities is significantly impacted by the societal relevance (OR = 0.44; $p < 0.01$) and the sojourn quality outdoors (OR = 0.53; $p < 0.05$). The societal (OR = 0.43; $p < 0.01$) and personal relevance (OR = 0.36; $p < 0.05$) have a significant influence on noise annoyance from sports facilities in the 2nd survey wave. Thus, people who rate the societal relevance of sports facilities as higher are less likely to be annoyed by sports facilities noise (in both survey waves).

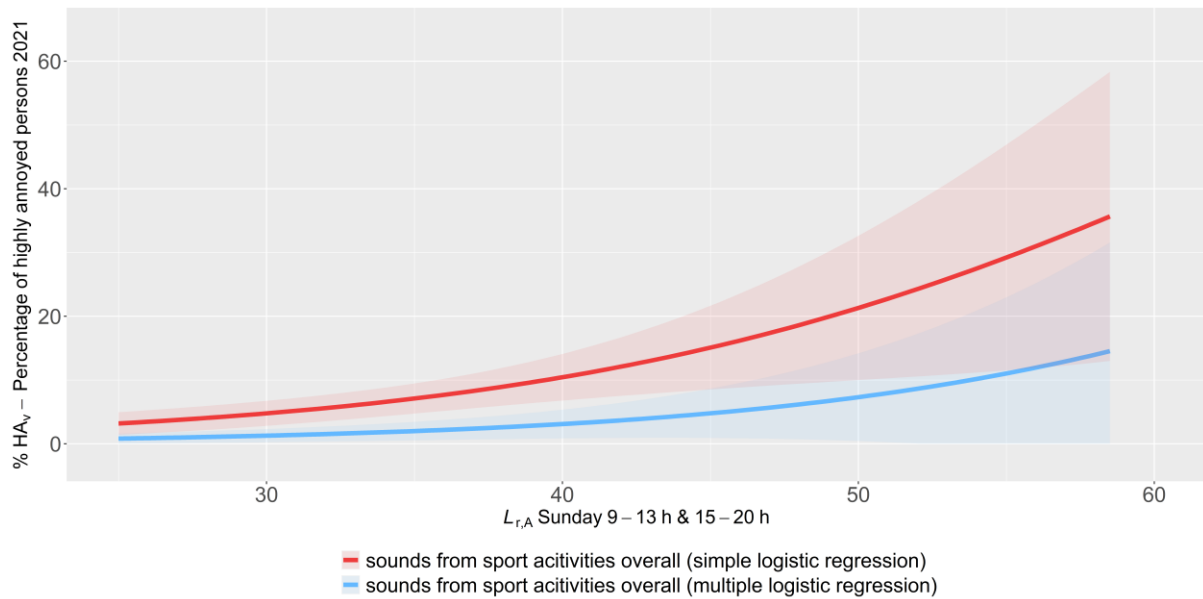


Figure 5: Exposure-response relationship for $L_{r,A}$ on Sundays from 9 a.m. to 1 p.m. and 3 p.m. to 8 p.m. and % HA_V from sports facility noise overall in a comparison between the simple logistic and the multiple logistic regression for the 1st survey wave

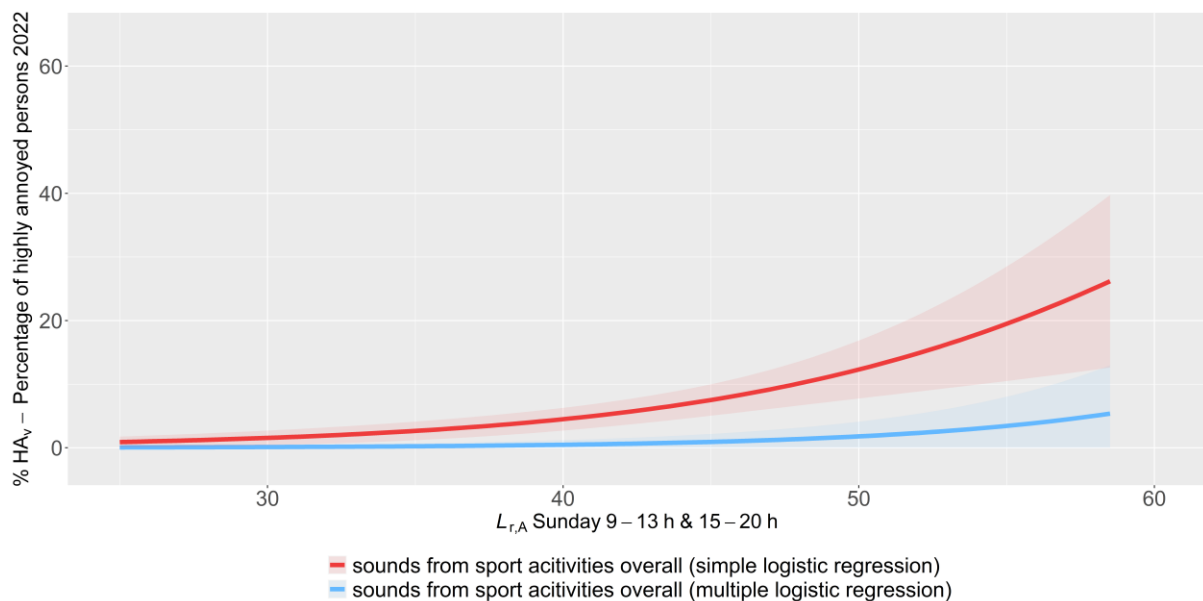


Figure 6: Exposure-response relationship for $L_{r,A}$ on Sundays from 9 a.m. to 1 p.m. and 3 p.m. to 8 p.m. and % HA_V from sports facility noise overall in a comparison between the simple logistic and the multiple logistic regression for the 2nd survey wave

DISCUSSION

Results of the current study show that noise from sports facilities is especially annoying for residents on weekends. This trend is found for other noise sources as well. For instance, noise annoyance due to leisure facilities⁵ and motorcycle noise⁶ is higher on weekends compared to Mondays to Fridays. As many people tend to be more at home during the weekends and try to relax, the noise from sports facilities can be especially annoying during these times. Moreover, sport events or games tend to be more often during weekends than during the week, when there is largely training on the sports facilities. Hence, assessing the noise rating levels

of sports facilities separately for different weekdays seems to be more suitable than using an average rating level across the year. In Germany, the calculation for sports facilities exposure is regulated in such a way.

The correlation analyses and multiple logistic regression analyses indicate that the societal relevance of the local sports facilities rated by the participants is a relevant factor influencing participants' noise annoyance rating. The higher the societal relevance of the local sports facilities is rated, the lower is the annoyance due to noise from sport facilities. This is in line with previous research that show evidence of attitudes towards the source co-determining the noise annoyance⁷.

The difference in the temporal framework of the annoyance questions in the two survey ways needs to be considered when interpreting the exposure-response-curves.

CONCLUSION

To promote inner city development and enabling sporting activities close to one's home, the conflicts between residents and local sports facilities need to be addressed thoroughly.

Acknowledgements

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