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Short Communication

Risk factors for insect bite hypersensitivity in Friesian horses and Shetland ponies in The Netherlands

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ABSTRACT

Insect bite hypersensitivity (IBH) is an equine skin allergy caused by bites of *Culicoides* spp. and impacts on the welfare of affected horses. The aim of this study was to identify and quantify risk factors for IBH. Data from 3453 Friesian horse mares and 7074 Shetland pony mares scored for IBH by inspectors during obligatory foal inspections were analysed using breed-specific multivariable logistic regression models. The combined effect of month and year of scoring, Province and inspector were significantly associated with IBH in both breeds. In Shetland pony mares, withers height and coat colour were also significantly associated with IBH, while body condition had a nearly significant effect. The outcomes from this study on risk factors might contribute to the development of more efficient measures to reduce the prevalence of IBH.

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Insect bite hypersensitivity (IBH) is a common allergic skin disease found in many horse breeds worldwide and is caused by bites of *Culicoides* spp. (Braverman et al., 1983). IBH seriously reduces the welfare of affected horses. The aetiology of IBH is multifactorial and involves both environmental and genetic factors (Schurink et al., 2011). Geographic region, year, breed, gender, age and coat colour of horses have been suggested as potential risk factors in studies using data from questionnaires (Braverman et al., 1983; Halldórsóttir and Larsen, 1991; Van den Boom et al., 2008). However, the literature reveals contradicting results, which can partially be attributed to the small size of datasets used. In humans, many studies show that obesity is a risk factor for allergies (Hersoug and Linneberg, 2007) but, to the best of our knowledge, body condition (i.e. the amount of fat stored in a body) has not been investigated as a potential risk factor for IBH in horses. The aim of the current study was to identify and quantify risk factors related to IBH in two horse breeds in The Netherlands.

Friesian horse (FH) and Shetland pony mares (SP) were visually scored for IBH once a year (Tables 1 and 2) during obligatory foal inspections, which enabled the collection of many records. Scoring of IBH clinical symptoms was made as uniform as possible during a training session. After editing, the dataset contained 3763 IBH observations from 3453 FHs and 10,079 from 7074 SPs. For each breed the potential risk factors were analysed separately by applying a backward procedure and logistic regression with 'animal' as

repeated effect to account for multiple observations per mare using the GENMOD procedure in SAS 9.2 (SAS Institute).

A large dataset containing unselected data was analysed since all mares with foals entering the studbook were scored for IBH. Prevalence within FHs was 18.2% and within SPs 7.5%. Breed-specific analyses were performed as breed was completely confounded with year of scoring and inspector. Scoring mares on symptoms by inspectors during foal inspections might not be the most accurate method (i.e., inspector was significantly related to IBH outcome), but scoring clinical symptoms is still the gold-standard. Inspector and region in SPs and inspector and year in FHs were partly confounded and as a consequence their effects could not be separated.

Factors included in the final multivariable model for FHs are presented in Table 1 and for SPs in Table 2. Despite a significant higher prevalence in mares kept stabled in both breeds, housing system was not included in the model as stabling of horses was considered a consequence of IBH instead of a causative effect (Van Grevenhof et al., 2007). Stabling as a preventive method is considered most effective in closed stables (Meiswinkel et al., 2000), especially around sunset when *Culicoides* spp. were found to be most active.

Provinces within The Netherlands and month and year of scoring were significantly associated with IBH in SPs and FHs. Identified low- and high-risk regions for both breeds largely overlap (Tables 1 and 2) and were in agreement with previous studies (Van Grevenhof et al., 2007; Van den Boom et al., 2008). Regions containing soils of clay with heather and woody vegetation and low annual rainfall, few cold days and many warm days per year

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Table 1Multivariable logistic regression outcomes of risk factors ($P < 0.05$) for insect bite hypersensitivity in Friesian horse mares ($n = 3453$) in The Netherlands.^a

Variable	<i>n</i>	Prevalence	OR (95% CI) ^b	<i>P</i> -value
Inspector ^c	13–1361	14.7–37.5	1.0–13.2	<0.0001
Province ^d				0.0058
Drenthe	245	20.8	1.1 (0.8–1.6)	
Flevoland and Noord-Holland	119	9.2	0.4 (0.2–0.8)	
Friesland	2425	17.0	1.0	
Gelderland	255	22.0	1.3 (0.9–1.9)	
Groningen	191	22.5	1.4 (1.0–2.0)	
Limburg and Noord-Brabant	165	20.6	1.3 (0.8–2.0)	
Overijssel	207	24.2	1.4 (1.0–2.0)	
Utrecht	53	20.8	1.1 (0.6–2.2)	
Zeeland and Zuid-Holland	103	14.6	0.8 (0.5–1.5)	
Month × year				0.0003
June 2004	167	15.0	1.0	
July 2004	806	15.5	1.2 (0.7–2.0)	
August 2004	957	18.9	1.3 (0.8–2.2)	
September 2004	661	19.5	1.5 (0.9–2.4)	
October 2004	160	31.3	2.0 (1.0–3.9)	
June 2008	40	12.5	4.2 (0.9–19.9)	
July 2008	244	16.0	5.2 (1.4–19.8)	
August 2008	404	18.3	6.4 (1.9–21.3)	
September 2008	267	19.9	9.7 (2.6–35.6)	
October 2008	57	5.3	NE ^e	

^a Correlation between repeated observations was 0.22. Age at observation modelled as a 2nd order polynomial had a nearly significant effect on insect bite hypersensitivity (P linear term = 0.0542 and P quadratic term = 0.0292).^b Odds ratio (95% confidence interval).^c 12 Inspectors scored Friesian horse mares. Range of number of observations, prevalence and odds ratio per inspector are presented.^d The Province of Friesland was set as the reference Province to enable direct comparison with results from Shetland pony mare data.^e NE, not estimable due to confounding with inspector 12.**Table 2**Multivariable logistic regression outcomes of risk factors ($P < 0.05$) for insect bite hypersensitivity in Shetland pony mares ($n = 7074$) in The Netherlands.^a

Variable	<i>n</i>	Prevalence	OR (95% CI) ^b	<i>P</i> -value
Inspector ^c	144–1400	1.7–23.3	1.0–31.0	<0.0001
WHC ^d				0.0297
Mini	2876	5.7	1.1 (0.8–1.4)	
Small	2231	6.2	1.0	
Middle	2439	8.7	1.4 (1.1–1.7)	
Tall	2533	8.6	1.4 (1.1–1.8)	
Coat colour				0.0172
Bay	626	4.5	1.0	
Black	4131	8.6	1.6 (1.0–2.4)	
Black paint	332	9.0	1.9 (1.0–3.3)	
Chestnut	3643	6.5	1.1 (0.7–1.7)	
Chestnut paint	562	6.9	1.3 (0.7–2.2)	
Other	785	5.6	1.3 (0.7–2.1)	
Province				0.0013
Drenthe	738	12.7	3.6 (1.5–8.6)	
Flevoland and Noord-Holland	61	6.6	3.6 (0.7–20.3)	
Friesland	408	2.7	1.0	
Gelderland	3200	9.8	5.0 (1.5–16.2)	
Groningen	326	11.0	4.4 (2.2–9.0)	
Limburg	1248	2.4	9.2 (2.5–34.0)	
Noord-Brabant	2196	7.6	5.8 (1.7–20.0)	
Overijssel	1302	3.9	2.8 (1.0–7.9)	
Utrecht	122	3.3	7.3 (1.5–35.2)	
Zeeland and Zuid-Holland	478	4.0	2.1 (0.5–9.6)	
Month × year				<0.0001
2003 ^e	2946	8.3	9.3 (2.2–39.3)	
June and July 2005	110	7.3	10.1 (2.1–48.8)	
August and September 2005	1199	8.9	12.8 (3.0–54.5)	
October and November 2005	450	9.6	14.0 (3.2–60.4)	
June and July 2006	414	9.2	12.2 (2.8–53.5)	
August and September 2006	1921	8.2	6.7 (1.6–28.3)	
October and November 2006	432	6.0	7.5 (1.7–33.3)	
June and July 2009	672	9.1	8.3 (2.0–34.9)	
August and September 2009	1599	2.6	2.7 (0.6–11.1)	
October and November 2009	336	0.9	1.0	

^a Correlation between repeated observations was 0.14. Age at observation did not significantly affect insect bite hypersensitivity ($P > 0.05$).^b Odds ratio (95% confidence interval).^c 17 Inspectors scored Shetland pony mares. Range of number of observations, prevalence and odds ratio per inspector are presented.^d WHC, withers height category: mini ≤ 86 cm, small 87–92 cm, middle 93–98 cm and tall 99–107 cm.^e Month of scoring not registered in 2003.

Table 3

Logistic regression outcomes of body condition score (i.e. the amount of fat stored in a body) using a multivariable model for insect bite hypersensitivity in Shetland pony mares in The Netherlands.^a

Variable	n	Prevalence	OR (95% CI) ^b	P-value
Body condition score				0.063
Low	146	6.2	1.5 (0.7–3.2)	
Normal	2535	3.7	1.0	
High	128	9.4	2.3 (1.2–4.5)	

^a Body condition was scored simultaneously with insect bite hypersensitivity in 2009 on a subset of the investigated Shetland pony mares ($n = 2809$). Other factors significantly affecting insect bite hypersensitivity in the multivariable model on this subset were inspector ($P < 0.0001$) and combined effect of month and year of scoring ($P < 0.0001$).

^b Odds ratio (95% confidence interval).

were associated with increased prevalence (Van Grevenhof et al., 2007). Regions with low prevalence were found along the coast line, related to high wind speeds, which suppresses *Culicoides* spp. density (Meiswinkel et al., 2000). Shelter and moisture at pasture significantly coincided with increased IBH prevalence in Icelandic horses (Björnsdóttir et al., 2006). Annual and monthly variations in *Culicoides* spp. population density were related to changes in environmental conditions (Takken et al., 2008). The preferences of *Culicoides* spp. for specific environmental conditions will lead to differences in exposure of horses to *Culicoides* spp., resulting in regional, annual and even monthly varying IBH prevalence.

Age at observation did not significantly affect IBH. Published results concerning an association between age and IBH are controversial, although an increased risk with age is expected to be related to longer exposure to factors that enhance the development of IBH and not necessarily due to an increased susceptibility to IBH (Halldórsdóttir and Larsen, 1991). In SPs, withers height category (WHC) and coat colour were significantly related to IBH (Table 2). Middle height and tall mares and black paint mares had increased odds to show symptoms, compared to small and bay mares. We hypothesised that WHC was not an effect in itself (e.g. genetic effect, as rejected by Schurink et al., 2009), but was related to different selection decisions made by owners of various WHC. Coat colours might differ in attractiveness for *Culicoides* spp., but the effect of specific coat colours on IBH differed between studies (Braverman et al., 1983) and many studies did not find an effect (Halldórsdóttir and Larsen, 1991; Van Grevenhof et al., 2007). Due to confounding between WHC and coat colour, these effects could not be separated in this study.

In SPs, mares with either low or high body condition score (BCS) showed increased odds to present IBH symptoms compared to mares with normal BCS (Table 3). BCS measured during studbook inspections (i.e., separate from IBH recording) was not significantly associated with IBH (data not shown). Hersoug and Linneberg (2007) hypothesised that the risk of allergies was increased in obese individuals at least partly due to immunological changes, since white adipose tissue secrete more adipokines and cytokines, resulting in a decreased immunological tolerance to antigens and skewing towards a Th2-biased immune response. We could not confirm the hypothesis that body condition was a potential risk factor for IBH, although the odds of IBH was significantly increased in horses with high BCS compared to horses with normal BCS

(OR = 2.3). Ideally, a cohort study should be performed to better investigate and verify the effect of body condition on (the development of) IBH.

In summary, the combined effect of month and year of IBH scoring, inspector and region were risk factors for IBH in both FHs and SPs in The Netherlands. WHC and coat colour were also significantly related to IBH in SPs, while BCS had a nearly overall significant effect. Our findings and results from other research suggested that exposure to *Culicoides* spp. should be reduced to decrease or even prevent IBH clinical symptoms. Sensitive horses could be moved to low-risk habitats or the current habitat could be adapted to reduce exposure to *Culicoides* spp. IBH prevalence is increased in horses with specific coat colours, though identified high-risk coat colours differ between studies. Maintaining a normal body condition would help to minimize the odds of having IBH.

Conflict of interest statement

None of the authors of this paper has a financial or personal relationship with other people or organisations that could inappropriately influence or bias the content of the paper.

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