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Analysis of risk factors for the occurrence of feather pecking in laying hen growers

B. HUBER-EICHER AND L. AUDIGÉ[1]

Federal Veterinary Office, Zollikofen and [1]Institute of Virology and Immunoprophylaxis, Mittelhäusern, Switzerland

Abstract 1. Potential risk factors for the occurrence of feather pecking in laying hen growers raised under commercial conditions were investigated on Swiss farms with more than 500 rearing places. On-farm interviews were conducted on a sample of 64 flocks which represented 42·6% of all farms concerned.
2. All variables considered were dichotomised and their univariate correlation with the occurrence of feather pecking was tested for significance at $P < 0{\cdot}20$ using χ^2 tests. Logistic regression with backward elimination was then used with the significant variables to identify the potentially most important factors influencing feather pecking. These variables included stocking density, light intensity, intensity of care, access to elevated perches, access to a roofed and littered outdoor area ('bad weather run'), time of access to the feeding facilities of the housing system, stocking density in the restricted area at the beginning of the rearing period, additional open feeding areas in the beginning and air quality.
3. The final model contained stocking density and access to elevated perches as significant factors ($P < 0{\cdot}05$). Flocks kept in high density ($\geqslant$10 birds per m^2) and with no access to elevated perches were 6·4 (95% Confidence interval 1·7 to 24·2) and 4·0 (95% Confidence interval 1·2 to 12·9) times more likely to be affected by feather pecking, respectively.
4. The study identified 2 risk factors for the occurrence of feather pecking in flocks of laying hen growers reared under commercial conditions. It is concluded that in order to reduce feather pecking chicks should be reared at low density and with access to elevated perches.

INTRODUCTION

Feather pecking consists of pecking or plucking the feathers of conspecifics and is judged to be an abnormal behaviour in poultry. It may result in severe feather damage or even injuries to the skin and wounded birds may eventually be pecked to death (Hughes and Duncan, 1972, Allen and Perry, 1975). This behaviour causes problems when keeping laying hens in confinement and has been described by Jacque as early as 1861. Ever since, it has remained an important topic for poultry farmers and today it is regarded as one of the major problems in intensively kept laying hens (Blokhuis *et al.*, 1997).

Several factors are known to promote the development of feather pecking in laying hens. Among these are housing conditions during the rearing period (Blokhuis and Van der Haar, 1989; Johnsen and Vestergaard, 1997; Gunnarsson *et al.*, 1999). As the occurrence of feather pecking is not only restricted to laying hens but can be observed in growers as well (Allen and Perry, 1975, Huber-Eicher and Wechsler, 1997, 1998), experience with this behaviour may potentially influence its development in laying hens.

There is very little known about the prevalence and the causation of feather pecking in commercially housed growers. To our knowledge, almost all research in this field comes from experimental studies. It remains unclear whether the factors shown experimentally to promote feather pecking are also important in the development of the behaviour under commercial conditions. Therefore, the Swiss Federal Veterinary Office promoted a representative survey on how growers are raised in Switzerland and on how prevalent are problems with feather pecking. The results of this survey are described in Huber-Eicher (1999) and will be summarised in this paper. The aim of this study is an in-depth analysis of potential risk factors for feather pecking in growers on the basis of the data collected in the survey, using multivariable statistical methods.

MATERIALS AND METHODS

Included in the survey were farms with more than 500 rearing places. There were 155 of such farms in Switzerland which represented 9·7% of all farms that rear laying hen chicks, but produce 93·1% of the hens (Data from the Federal Statistical Office for 1995).

In March 1997, all farms were invited by mail to join the survey. In order to avoid any fear from participating, we took great care to formulate as neutral a letter as possible. Five weeks later a 2nd letter was sent out to increase the number of participants. Finally 66 farms were eligible and

Correspondence to: B. Huber-Eicher, Federal Veterinary Office, Centre for Proper Housing of Poultry and Rabbits, Burgerweg 22, CH-3052 Zollikofen, Switzerland Email: Beat.Huber@bvet.admin.ch
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agreed to join the survey (42·6% of all the farms concerned). The number of rearing places was known for all farms and we were able to check if our sample was representative in this respect (Table 1). A χ^2 test for goodness of fit (Sokal and Rohlf, 1981) revealed, that there is no reason to believe that the sample is not representative (χ^2=0·617, df=5, P<0·975).

All farms were visited between April and December 1997. The data were collected during a 3 h on-site interview with the farmer. In addition, on a complementary inspection, measurements of the rearing house and the housing system where the latest flock had been reared were made. This latest flock also served as point of reference for the questions on housing, management and whether feather pecking had occurred or not.

Flocks were divided into those with and without feather pecking, according to the information of the farmers, despite the fact that farmers have different criteria for their judgement. Feather pecking starts with single individuals pecking the feathers of conspecifics. If it increases, more individual start pecking and feather damage can be observed, especially at tail feathers, the rump and on the back. With increasing frequency, the quality of pecking changes (Wechsler *et al.*, 1998). More severe pecks are delivered and birds start to pull out feathers with the consequence of denuded body parts, mostly at the rump and the wings. If the frequency of feather pecking further increases it gets to the stage where bloody injuries and dead birds can be found in a flock. According to the described development of feather pecking, the farmers were asked which of the following 4 criteria they used to make their judgement: 1) Observation of the behaviour but no feather damage, 2) feather damage, 3) denuded body parts, and 4) bloody injuries and losses. With those farmers who claimed to have observed feather pecking, we are confident that there was genuine feather pecking because observations were independent of the criteria used, and unlikely to bias the study (37·5% of all farmers). This may also apply to farmers who claim not to have feather pecking, based on the 1st criterion (observation of the behaviour) or the 2nd (feather damage) because these criteria are indicative of an early stage of feather pecking (51·6%). The judgement of the remaining 12·9% can be questioned. They believe that they do not have feather pecking in their flock but are using the 3rd criterion (denuded body parts) or the 4th (bloody injuries, losses). It is possible that they overlook feather pecking of a less marked degree, leading to a misclassification of the cases and an underestimation of the effects of the risk factors.

After checking the survey for completeness and variability, 40 variables were found to be meaningful and suitable for statistical analyses. For the analyses 2 farms had to be excluded because of incomplete data. A comprehensive description of these variables can be found in Huber-Eicher (in press). There were nominal and ordinal as well as continuous variables. Nominal variables were mostly dichotomous or could be rearranged to have only 2 categories. The distribution of ordinal and continuous variables were checked for the cut-off point that best separates the 2 groups of flocks with and without feather pecking. In this way all the variables were dichotomised. It was then possible to arrange the data in 2 × 2 tables with a specific variable as 1 factor and the occurrence of feather pecking (Yes/No) as the other. Variables and feather pecking correspond to risk factors and disease in epidemiological terms.

The association between each potential risk factor and the occurrence of feather pecking was then tested for statistical significance using χ^2 tests. Factors associated with feather pecking at a significance level of P<0·20 were selected for multivariable analysis (Dohoo *et al.*, 1996). One variable (additional open feeding areas) was forced into the model despite a P-value of 0·233 because early experiences with a substrate may have an influence on the development of feather pecking (Huber-Eicher and Wechsler, 1997). Selected variables at this stage of the analysis are presented in Table 2.

The strength of the association was assessed for each selected factor by the calculation of odds ratios (OR). The OR compares the odds of a flock developing feather pecking when exposed to a risk factor, to the odds when not exposed to the risk factor. In addition, the associations between pairs of risk factors were assessed. Arbitrarily, when the OR between the factors was >20 it was considered that both factors were strongly associated and only the

Table 1. *Representativity of the studied flocks with respect to flock size*

	All farms (n=155)		Sample (n=64)	
Flock size	Observed frequency	Relative frequency	Expected frequency	Observed frequency
500–1999	50	0·323	20·6	19
2000–3499	35	0·226	14·5	17
3500–4999	23	0·148	9·5	9
5000–6499	15	0·097	6·2	6
6500–9499	14	0·090	5·8	6
⩾9500	18	0·116	7·4	7
Total	155	1·000	64·0	64

χ^2=0·617, df=5, P>0·975

Table 2. *Definition of variables used in the analysis*

Variable	Definition and remarks
Time of access to feeding facilities of the housing system (early/late)	During the first 2 weeks chicks are kept in restricted areas. There, food is often provided on plates and, only later on do the chicks have access to whole barn and to automatic feeding facilities of the housing system. Early≤day 13
Intensity of care during the first 3 weeks (low/high)	This is the mean time per day spent by the farmer inside the barn multiplied by the number of daily controls, summed over weeks 1 to 3 and divided by the number of birds in the flock. Low ⩽ 0·8
Light intensity inside the barn (low/high)	The intensity was measured at the height of the growers and in the area where they were most active. Six measurements were taken at a specific point (up, down, left, right, front, rear) and the mean was calculated. Low ⩽ 6 lux
Air quality after week 4 (bad/good)	'Dusty' or 'rather damp' were judged as bad, 'Not dusty' or 'little dusty' as good.
Density (high/low)	Density of the birds was calculated by dividing the number of birds by available surface including the area of an eventual 'bad weather run' (definition below). Surfaces were deemed available if there is a clear height above them of at least 45 cm, if they are at least 30 cm wide and if the slope does not exceed 12%. High ⩾10 birds per m^2
Access to a 'bad weather run' (no/yes)	A 'bad weather run' is an area adjoining the poultry house, which has a concrete floor and is roofed and littered. The walls are made of wire mesh and the climate is the same as the outdoor climate.
Elevated perches (no/yes)	Perches are judged as being 'elevated' when they are at least 35 cm above the underlying surface.
Density in restricted area (high/low)	During the first 2 weeks chicks in deep litter systems and aviaries are kept in large rings made of cardboard or on the lowest tier, respectively. This guaranteed that the birds stayed in the vicinity of the food, water and heat. High ⩾35 birds per m^2
Additional open feeding areas in the beginning (small/large)	In the beginning of the rearing period farmers often provide food on additional plates, to ensure that birds have unlimited access to food. These open feeding areas are used by the chicks also for scratching and dustbathing. Small ⩽ 25 cm^2 per bird
Group size in restricted area (large/small)	(see 'Áddditional open feeding areas in the beginning') Large ⩾ 1200 birds
Automatic feeding (yes/no)	Pipeline feeder and automatic chain feeder are integrated into 'Áutomatic feeding'.

biologically more important factor was kept for further analyses.

There were too many variables (10) compared to the number of data points (64) to be included in the same model (Martin, 1997). Initially we divided the variables into 2 groups. The 1st group contained 4 variables that are influenced by management: time of access to the feeding facilities of the housing system; intensity of care during the first 3 weeks; light intensity inside the barn; and air quality after week 4. The 2nd group contained 5 factors concerning the housing system: density; access to a 'bad weather run'; access to elevated perches; density in the restricted area; and additional open feeding areas.

Both groups of variables were analysed separately using multivariable logistic regressions with backward elimination. Variables not significant at an alpha level of ⩽0·05 were rejected. Remaining significant variables of both groups were then combined and subjected to the same regression analysis. Analyses were carried out using the statistical software STATA version 5·0 (Stata, TX, USA).

A power calculation, which takes into account the number of flocks studied (64, the type I error (set to 0·05), the disease frequency (0·375), the frequency of exposure to the risk factor in the non-diseased population and a measure of the association between the factor and the disease occurrence called the relative risk (RR), was conducted (Schlesselman, 1982). RR is the ratio of disease frequency in the exposed group to disease frequency in the unexposed group (Waltner-Toews, 1983), that is the ratio of the risk that a flock develops feather pecking when exposed to a factor, to the risk of

developing feather pecking when not exposed to the factor. The power thus depends on the factor studied and the strength of association that should be identified as significant.

RESULTS

Sixty-four flocks were included in the study. In 24 (37·5%) of them feather pecking was reported. At the univariable analysis level, 10 variables out of 40 were found to be significantly (alpha level <0·20) associated with the occurrence of feather pecking (Table 3). One variable (additional open feeding areas in the beginning) was included because of potential biological importance, despite a non-significant *P* value (0·233).

On the other hand the variables 'group size in restricted area' and 'automatic feeding' were discarded from further analysis because, in an analysis of the relation between the explanatory variables, they had both shown a very strong (OR=21) association with 'time of access to feeding facilities of the housing system'.

When analysing the group of variables related to management factors only 'air quality' remained as a significant factor in the model (model 1, Table 4). With the other group of variables related to housing system the variables 'density' and 'elevated perches' were significant factors (model 2).

When the 3 factors of the 2 models were analysed together, the variable 'air quality' was rejected, making the final model equal to the model of the 2nd group. Flocks with a high density (⩾10 birds per m^2) and flocks with no access to elevated perches (height ⩾35 cm) were 6·4 and 4 times more likely to develop feather pecking than when they were kept in low density or with access to elevated perches, respectively.

In a final analysis we calculated the theoretical power of the study to detect differences between flocks with and without feather pecking. With the given sample size and frequency of feather pecking occurrence, this study had a power of 53% to identify as significant a risk factor that would be observed in 50% of flocks not affected by feather pecking and assuming a RR of 3, that is the risk to develop feather pecking would be 3 times higher when exposed to the factor than when not exposed.

Table 3. *Variables at the univariable analysis level significantly (alpha level <0·20) associated with the occurrence of feather pecking*

Variable	Feather pecking		Odds ratio (OR)	95% Confidence interval of OR	χ^2	*P*
	Yes	No				
Time of access to feeding facilities of the housing system						
Early	19	24	2·5	0·8–7·9	2·5	0·114
Late	5	16				
Intensity of care during the first 3 weeks						
Low	20	27	2·4	0·7–8·0	1·9	0·165
High	4	13				
Light intensity inside the barn						
Low	10	8	2·9	1·0–8·6	3·5	0·062
High	14	32				
Air quality after week 4						
Bad	14	13	2·9	1·0–8·2	4·1	0·043
Good	10	27				
Density						
High	20	20	5·0	1·5–16·4	7·1	0·008
Low	4	20				
Access to a 'bad weather run'						
No	21	29	2·7	0·7–9·9	2·0	0·160
Yes	3	11				
Elevated perches						
No	16	16	3·0	1·1–8·5	4·3	0·039
Yes	8	24				
Density in restricted area						
High	23	31	6·7	0·8–56·5*	3·8	0·051
Low	1	9				
Additional open feeding areas in the beginning						
Small	20	28	2·1	0·6–7·2	1·4	0·233
Large	4	12				
Group size in restricted area						
Large	15	17	2·3	0·8–6·3	2·4	0·121
Small	9	23				
Automatic feeding						
Yes	22	31	3·2	0·6–16·2*	2·1	0·146
No	2	9				

*Univariable logistic regression

Table 4. *Logistic regression models for the incident of feather pecking*

	Regression coefficient	SE	z	$P>\|z\|$	Odds ratio (OR)	95% Confidence interval of OR	Goodness-of-fit test $P>\chi^2$
Model 1							*
Air quality	1·07	0·53	1·998	0·046	2·91	1·02–8·28	
Intercept	–0·99	0·37	–2·683	0·007			
Model 2 and ®nal model							0·794
Density	1·86	0·68	2·745	0·006	6·42	1·70–24·21	
Elevated perches	1·38	0·598	2·316	0·021	4·00	1·24–12·92	
Intercept	–2·51	0·723	–3·479	0·001			

*It was not possible to calculate a goodness-of-fit test because of χ^2=0·00

DISCUSSION

This is the first time risk factors for feather pecking were investigated in the flocks of commercial growers in Switzerland. Two factors, high density and access to elevated perches, were found to contribute significantly and strongly to the occurrence of feather pecking in growers housed under commercial conditions. There is published evidence that high density increases feather pecking as measured by feather damage in laying hens (Allen and Perry, 1975, Simonsen *et al.*, 1980, Appleby *et al.*, 1988*a*) but Hughes and Duncan (1972) and Hughes and Black (1974) did not find a density effect. Such inconsistencies might arise when different densities are compared in different studies. Hansen and Braastad (1994) observed that in week 12 growers reared in high density (13 birds per m^2) feather pecked more than when reared in low density (6·5 birds per m^2). Hughes and Duncan (1972) did not find any significant difference in feather pecking during rearing between high and low density birds but the compared densities where much higher (14·2 and 21·0 birds per m^2 for low and high density, respectively). In our study high density had a significant effect on the occurrence of feather pecking and the best cut-off point between high and low was 10 birds per m^2. Should this threshold be biologically correct, it would explain the inconsistent results between studies.

The 2nd significant factor in our model was access to elevated perches. In 81·2% of the cases perches were accessible within the first 4 weeks of age (Huber-Eicher, 1999). Elevated perches during rearing do have a favourable influence on behaviour when birds are in lay. There are fewer floor eggs during the early production period (Appleby *et al.*, 1988*b*, Gunnarsson *et al.*, 1999) and less cloacal cannibalism (Gunnarsson *et al.*, 1999). But an epidemiological study by Gunnarsson *et al.* (1999) was unable to identify an association between access to elevated perches during rearing and feather pecking in laying hens as measured by feather damage.

In this study feather pecking was assessed through the judgement of the farmers. 69·7% used as a criteria feather damage or more severe consequences of the behaviour (Huber-Eicher, 1999). However, Wechsler and Huber-Eicher (1998) demonstrated with laying hens that access to elevated perches did in fact reduce feather damage but not the rate of feather pecking. Whether this also applies to growers should be the subject of further research.

Factors that are known to have an influence on feather pecking like light intensity, group size, air quality or genetics were not found to be statistically significantly associated with this behaviour. Regarding the low power of the study it should not be concluded that these factors are not relevant under commercial conditions. Conclusions should be concentrated on density and access to elevated perches that were found to be significant despite the low power. We, therefore, recommend that farmers use low densities during rearing and that they give access to elevated perches (height $\geqslant$35 cm) from no later than week 4 on, in order to reduce the occurrence of feather pecking in growers and to prevent behavioural problems in laying hens.

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