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# A cross sectional study of the prevalence and associated risk factors for capped hock and the associations with bursitis in weaner, grower and finisher pigs on commercial farms in Great Britain

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**Abstract**

The prevalence of capped hock in 5601 post weaning pigs from 93 representative pig farms in England was 17.2%. The prevalence increased with age. Once adjusted for age, the lowest prevalence of capped hock was observed in pigs kept on soil floors (usually covered with deep straw bedding). There was no significant increase in the risk of capped hock in pigs kept on solid concrete floors with deep straw bedding. However, pigs kept on solid concrete with some, or the entire pen, sparsely bedded and pigs kept on partially or fully slatted floors had an approximately three fold increased risk of capped hock. This did not vary significantly between these four floor types. This was in contrast to the associated risks for bursitis in the same pigs, where as the floor went from highly resilient (straw and solid floors) to hard and perforated (fully slatted) the risk of bursitis increased similar to a dose response. No other variables that were measured were associated with a change in risk for capped hock, while observation of pigs slipping or slip marks and wet, dirty and worn pens were also associated risks for bursitis. These results indicate that capped hock and bursitis are both affected by exposure to floors, but in different ways. The prevalence of capped hock was associated only with floor hardness, with deep straw protecting the pigs, while bursitis was associated with both changes in bedding depth (hardness), floor material (soil versus concrete) and floor construction (solid versus slatterd floors) and in factors associated with locomotion (slipping and slip marks). These results indicate that the aetiology of capped hock and bursitis might differ.

*Key words:* Pig; Limb lesions; Capped hock; Bursitis; Flooring; Hierarchical logistic regression; Welfare

**1. Introduction**

A capped hock is an adventitious fluid filled swelling in the subcutaneous connective tissue over the point of the tarsus (hock) of the hind limb (Penny and Hill 1974). Adventitious bursae are swellings which develop below the hock in the lateroplantar, plantar or medial planes on the hind limb and occur less commonly on the front limbs (Smith 1993). Capped hock and bursitis have been described as unsightly blemishes (Smith 1993) that are not painful (Probst et al., 1990; Berner et al., 1990; Smith 1993) and do not cause lameness (Orsi 1967; Bäckström and Henricson 1966; Probst et al., 1990). However, these lesions are not normal, they represent a pathological response to an environment that is less than ideal.

Most estimates of the prevalence of capped hock in pigs come from abattoir surveys. Mouttotou et al. (1998) reported a prevalence of 3.7% in 3989 pigs from 20 farms in south-west England. Penny and Hill (1974) reported a higher prevalence of 11% in 11811 pigs from approximately 50 farms in Somerset. In Scotland, Smith (1993) reported a prevalence of 2.8% in 14046 pigs from 146 farms. In the only study to date of prevalence of capped hock in live grower and finisher pigs, Mouttotou et al. (1999) examined 912 pigs from 17 pig farms in the south-west of England aged between 8 and 24 weeks. The prevalence of capped hock was 0.7%.

Mouttotou et al. (1999) proposed that the lack of cushioning between the calcaneous and the skin at the point of the hock makes this area particularly vulnerable to injury when the pigs slip and fall. Smith (1993) proposed that differences between individual pigs determine whether a pig developed capped hock or bursitis since he reported a negative association between the prevalence and severity of capped hock and bursitis which he attributed to differences in lying and sitting posture. However, this negative association could also occur if the associated risks for capped hock and bursitis were distinct and uncorrelated.

In previous risk factor studies of grower and finisher pigs, capped hock and adventitious bursitis have been combined into one outcome variable when attempting to identify risk factors. The risks associated with bursitis and capped hock combined or bursitis alone in previous studies are presence of slatted floors and lack of bedding (Smith, 1993; Mouttotou et al., 1998; 1999; Guy et al., 2002), presence of metal slats compared with plastic (Smith, 1993), high stocking density (Smith 1993), presence of steps in the pen (Mouttotou et al., 1999) and wet slurry on the floor (Mouttotou et al., 1999). Penny and Hill (1974) reported a reduced risk associated with pigmented breeds however, having accounted for the effect of different management systems Guy et al. (2000) did not detect any effect of breed.

A separate paper on bursitis in the pigs used in the current study on capped hock is presented elsewhere (Gillman et al., submitted) but briefly, the prevalence of bursitis was 40.6% and the lowest prevalence of bursitis was observed in pigs on soil floors. The risk of bursitis then increased with floor type in the following order; solid concrete floors with deep bedding and solid concrete floors with deep and sparse bedding, part slatted floors and solid concrete floors with sparse bedding and, finally, fully slatted floors. Within slatted pens an increased risk was associated with metal slats compared with concrete. Additionally, faeces or spilled food on the floor and wet, worn or damaged floors, and where pigs were seen slipping during data collection were associated with an increased risk of bursitis. Gillman et al. (submitted) proposed that bursitis is associated in a dose response way with increasing floor hardness and increasing presence of voids and also with factors that affect locomotion. In this paper we present the prevalence, severity, associated environmental risks and population attributable fraction for capped hock, excluding bursitis, and compare this with the estimates for bursitis from the same pigs. In addition, a description of the pathology of capped hock and typical histological findings is presented

## 2. Materials and methods

A total of 549 breeder to finisher farms with >100 breeding sows were randomly selected from the National Pig Association (NPA) database and invited to participate in the study, 18% agreed. The prevalence and population attributable fractions of capped hock was calculated in 5061 pigs from 93 farms in England. An additional ten convenience selected farms, five in Scotland and one in Wales and four in England, were included in the risk factor analysis bringing the sample size up to 6274 pigs from 103 farms. The correlation between capped hock and bursitis was investigated in 6180 of these pigs for which data on the prevalence and severity of both lesions was available.

On each farm one pen each (7 in total) of pigs aged 6, 8, 10, 12, 14, 18 and 22 weeks were randomly selected. If there were less than 10 pigs in the pen all the pigs were examined, if there were more than 10 pigs in the pen 10 were randomly selected for examination. Both hind limbs were examined for evidence of capped hock whilst the pig moved freely around the pen. The severity of capped hock was scored on a 0-3 scale with 0 = no visible swelling, 1 = swelling <25%, 2 = swelling 25-50% and 3 = swelling >50% of the size of the tarsal joint. Eight observers recorded data on the pigs

Observations were also made on the number of pigs per pen, how long the pigs had been in the pen, and whether pigs were seen slipping on the floor. The pens the pigs were housed in were examined and details of construction and condition, with particular attention to floors, was recorded. Thirteen observers recorded data on the pens. The farm manager was interviewed on details of the herd health and management.

*2.1 Data analysis*

A pig was defined as affected with capped hock if a lesion of score 1 or more was present on one or both of the hind limbs. The crude prevalence of capped hock was calculated as

No. of pigs with capped hock on randomly selected farms from NPA database

No. of post weaning pigs examined on randomly selected farms from NPA database

The outcome variable used in the risk factor analysis was the proportion of pigs affected with capped hock > score 0 per pen. The outcome was

No. of pigs with capped hock per pen

No. of pigs examined per pen (max.10)

To account for the clustering of pens on farms a 2-level binomial logistic regression model was used with pens (level 1) nested within farms (level 2). MLwiN version 2.01 (Rasbash et al., 1999) was used for all multilevel analysis.

To assist with exploration of highly correlated variables two sub models were developed separating pens with slatted floors from solid floored pens with bedding . From these models floor type and bedding depth were recoded and combined to create a single six-level variable which allowed all pens to be included in one model. The prevalence of capped hock increased with age and age was correlated with certain floor types, therefore age was included as a continuous variable in the model throughout the initial screening of variables. The number of sows per herd, number of pigs per pen and observer were also added to all three models. The models were rebuilt with pigs with a maximum lesion severity of score 1 classified as unaffected.

The model took the form:

Y- didn't they say change Y – how about (proportion with CH) $_{ij} = \beta_0 + \sum\beta_h x_{ij,h} +$

$$\sum\gamma_l x_{j,l} + v_j + u_{ij}$$

Where $\beta_0$ = constant, $h(1,2,\ldots,H)$ indicates variables collected at level 1 e.g. age, and $l(1,2,\ldots,L)$ indicates the variables collected at level 2 e.g. herd size, i is the number of pens, i = 1…646, j is the number of farms, j = 1…103.

I suggest you change as I recommended for Claire

$Y_{ij} = \beta_0 + \sum\beta X_{ij} + \sum\beta X_j + v_j + u_{ij}$

Where $\beta_0$ = constant, and $\beta X$ is a vector of fixed effects varying at level 1 (ij) or level 2 (j) i is the number of pens, i = 1…646, j is the number of farms, j = 1…103 and $v_j + u_{ij}$ are the level 2 and 1 residual variance

The Hosmer-Lemeshow goodness-of-fit test was used to assess model fit (Dohoo et al., 2003 p.360-361). At the end of the study inter observer variability was investigated between five of the observers on a sample of 27 pigs. The kappa statistic was calculated to determine the level of agreement.

The population attributable fractions for capped hock were calculated from the randomly selected farms in England using

$$AF_p = RD * p(E+) / p(D+)$$

Where $AF_p$ is the population attributable fraction, RD is the risk of capped hock in the exposed group minus the risk of capped hock in the reference category group, p(E+) is the proportion of pigs on each floor type and p(D+) is the proportion of pigs with capped hock on each floor type (Dohoo et al., 2003 p.128-130). A chi-squared test was used to investigate whether an association between the presence of capped hock and bursitis in individual pigs was present. For further details on the materials and methods see Gillman et al. (submitted).

## 3. Results

### *3.1 Prevalence and severity of capped hock from randomly selected farms in England*

The prevalence of capped hock in 5601 pigs from the 93 randomly selected farms in England was 17.2%. This ranged from 0 -54% by farm and 0 – 100% by pen: 12.1% had capped hock score 1, 4.3% had capped hock score 2 and 0.7% had capped hock score 3. The prevalence increased with age (Table 1). The proportion of pigs affected varied by floor type with the lowest on soil and the next lowest on solid floored deeply bedded pens (Table 1).

### *3.2 Risks associated with capped hock*

Once adjusted for age, there was an increased risk of capped hock of 3.2 – 3.8 fold (Table 2) in pigs in pens with solid concrete floors with deep and sparse bedding, solid concrete floors with sparse bedding only, with partially slatted and fully slatted floored pens. There was no significant effect of herd size, number of pigs per pen or observer on the associated risks for capped hock. When only pens with slats were considered (Table 3) there was a reduced risk associated with plastic (OR 0.5) and metal (OR 0.4) slats compared with concrete.

Models were rebuilt with the classification of an affected pig altered to include only pigs with score 2 or 3 capped hock lesions. The same risks were identified as above and additionally signs of wear on the floor were associated with an increased risk of capped hock and there was reduced risk of capped hock associated with more than 350 sows on farm and with a damaged floor in the dunging area in slatted pens.

*3.3 Model fit and observer variability*

The Hosmer-Lemeshow goodness-of-fit test indicated that there was no significant difference between the observed values and the values predicted by the three models (Slatted pens; $\chi^2 = 0.29$, df = 9, p = 1.00; Solid pens: $\chi^2 = 0.28$, df = 9 p = 1.00; All pens: $\chi^2 = 0.21$, df = 9, p = 1.00). The average kappa statistic for observer agreement was 0.14 (range -0.27 – 0.43). The identity of the observer was added to the models to control for inter observer differences. This did not alter the interpretation of any of the fixed effects in any of the models.

*3.3 Population attributable fractions*

In all ages of pig the largest proportion of capped hock was attributable to fully slatted floors and the next largest to part slatted floors (Table 4). In weaners, growers and finishers 69%, 49% and 29% of capped hock respectively was attributable to partially and fully slatted floors collectively.

*3.4 Associations between bursitis and capped hock*

There was a positive association between the presence of capped hock and bursitis of any score within pigs ($\chi^2$ 57.0 1df p<0.001). A total of 52.4% of 1065 pigs with capped hock also had bursitis and 39.5% of 5155 pigs without capped hock had bursitis. Among pigs affected with both lesions there was a general trend for bursitis score to increase as capped hock score increased (Table 5).

*3.5 Pathology*

No pigs with capped hock score 3 were identified during visits to farms from which pigs for the pathology study were selected so examples of this score could not be investigated. Fluid filled bursa sacs were not present in capped hock score 1 lesions (Figure 1). The appearance of a swollen hock might have been due to a proliferation of collagenous connective tissue. Lesions grossly classified as score 2 contained fluid filled bursal sacs (Figure 2). Histological examination of the score 2 sections (Figure 3) revealed that a lumen was present and in some cases inflammatory cells or signs of haemorrhage were evident in the bursa wall. The pathology of capped hocks was identical to that of bursitis (Gillman et al., submitted).

**4. Discussion**

The pig farms in this study were representative of the English pig farm population in size, geographical location and ratio of indoor and outdoor farms; in total approximately 2% of the GB pig holdings with breeding sows were visited (Woodbine et al., 2007). Therefore this study should provide a more accurate measure of the prevalence of capped hock in England in herds with at least 100 breeding sows than previous studies which have used a smaller number of farms from a limited geographical region (Penny and Hill 1974; Mouttotou et al,. 1998; 1999). There might have been a bias towards herds with higher health and welfare standards because the sampling frame was herds that were part of an assurance scheme. However, the proportion of pig farms in GB participating in the assurance scheme was high (>85%) therefore much of the variation would have been captured within the sampling frame. Compliance in this study was voluntary, only 18% of those invited to take part agreed and no data are available on non compliant farmers. This may have biased the sample towards highly motivated farmers with higher health and welfare standards. If this is the case it is possible that the prevalence presented here is an underestimate of the prevalence in the English finishing herd.

The prevalence of capped hock was higher than that reported in previous studies; approximately 25 times more than that reported by Mouttotou et al. (1998) in a similar analysis, and between two (Penny and Hill 1974) and six (Smith 1993) times more than that reported from abattoir surveys. The difference in prevalence might be a true difference, because farms were more representative and because slatted floors are increasingly common in pig farming, or because of scoring or observer differences. Identifying and scoring lesions is subjective. In this study we aimed to make the scoring as objective as possible by using the pigs bony anatomy as the comparison, so that small pigs could have absolutely smaller lesions of the same severity as a larger pig with larger lesions. We also trained observers at the start of the study. However, in the small inter observer variability study carried out at the end of the study the agreement was low, perhaps indicating that drift had occurred during the course of the study underlining the need for continual reassessment and training. To address this variability the identity of the observer was controlled for in the models. This did not have any effect on the interpretation of the effect of age or flooring indicating that overall the impact of this inter observer variation was small.

The prevalence of the most severe lesions in this study was close to the entire prevalence reported by Mouttotou et al. (1998); this could indicate that the mild lesions were not included in the Mouttotou et al. (1998) measure of prevalence. Mouttotou et al. (1998) used a simple presence / absence method of scoring the lesion (Mouttotou 1998) which might have contributed to under scoring.

In the pathology study a bursal sac was not present in the examples of lesions score 1, therefore, the models were rerun with the classification of a pig with capped hock redefined as those with lesions score 2 or 3. Several additional factors were identified however these did not further clarify the pattern of risks (see results). It might be that the proliferation of collagenous connective tissue associated with score 1 lesions is in itself a pathological response to hard floors and could be a precursor to the development of a bursal sac. If the high prevalence in this study reflects the fact that milder lesions were included, this does not appear to have altered the main risks associated with capped hock and the models were a good fit for the data.

The increase in the prevalence of capped hock with age might be due to the increasing period of time spent on hard floors, to increasing time spent lying down (Ekkel et al., 2003) or because as pigs grow their limbs support more weight when lying per weight bearing surface area. A pattern of increasing prevalence of bursitis with age was also observed in these pigs (Gillman et al., submitted) and reported in previous studies (Mouttotou et al., 1999).

In this study, using the full model, the key risk factor for capped hock was pens without deep bedding in all areas. Interestingly, there was very little difference in the risk of capped hock between solid floors with sparse or sparse/deep bedding, part slatted or fully slatted floors. This suggests that there was little difference in the risk of capped hock by floor construction and rather it is presence of deep bedding over the entire pen that prevents this condition. This was in contrast to the associated risks for bursitis in the same pigs (Table 7), where as the floor went from highly resilient (straw and solid floors) to hard and then to perforated (fully slatted) the risk of bursitis increased mimicking a dose response. No other variables that were measured were associated with a change in risk for capped hock, while observation of pigs slipping or slip marks and wet and dirty pens were also associated risks for bursitis. These results indicate that capped hock and bursitis are both affected by exposure to floors, but in different ways. The prevalence of capped hock appeared to be associated only with a soft or hard surface on the floor, with deep straw protecting the pigs, while bursitis was associated with both changes in bedding depth (hardness) and in floor construction (weight bearing surface area) and in factors associated with locomotion (slipping and slip marks). These results indicate that the aetiology of capped hock and bursitis might differ. Further evidence for this comes from the sub models where there was a reduced risk of capped hock associated with plastic and metal slats compared with concrete and, in contrast, there was a reduced risk of bursitis in concrete slats. There was also some indication that there was a breed component associated with the risk of bursitis that was not associated with capped hock.

The suggestion by Mouttotou et al. (1999) that capped hock is an injury caused by slipping and knocking the hock joint is not supported by this study; conversely bursitis appears to be associated with these factors. The fact that capped hock and bursitis were positively correlated but did not have identical risks also suggests that Smith’s hypothesis (1993), that individual choice of posture determines whether a pig develops capped hock or bursitis is unlikely.

It is remarkable that such a detailed on farm study provided no further clues to the aetiology of capped hock, which we conclude is different from that of bursitis. However, we probably have the knowledge to reduce its prevalence. In this sample a large proportion of the prevalence of capped hock was attributed to un-bedded part and fully slatted pens, particularly in weaned pigs. However, in solid pens, while providing some bedding and preventing slipperiness might reduce the prevalence of bursitis it will have no effect on the prevalence of capped hock until there is deep bedding throughout the pen. A cohort study might provide further evidence for aetiology of these lesions and an intervention study could be done to test the hypotheses raised here that lesion reduction is possible by changing floor type.

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