

Our group

The group which organized this information – KeelBoneDamage Net - is composed of various trade associations, industry suppliers of poultry housing, nutrition, and genetics, as well as scientists and other stakeholders across the continent of Europe. In this document, we briefly explain the problem of keel bone fractures and provide specific suggestions to reduce their occurrence.

Introduction

Fractures to the keel bone are an important problem facing the commercial laying hen industry, with an estimated 30 to 90 % of a flock having some level of damage to the keel by 45 weeks of age. The actual range of affected hens varies widely and is likely to be dependent on a host of factors including: age, rearing environment, nutrition, genetic line, housing system, among others. Although birds with and without fractures may act similarly (unless using special observation methods), fractures can normally be identified easily by palpating your hens (<http://www.keelbonedamage.eu/activities/practical-information-for-stakeholders/>). We believe fractures, particularly when fresh and in a state where bone pieces are not immobilized but in separate pieces, cause the hens pain and decrease livability and productivity. Productivity effects appear to be especially large in hens older than 50 weeks of age. Given how widespread the problem is and the negative effects on welfare and productivity, research is ongoing to determine the causes of keel fracture and steps that can be taken to reduce their occurrence.

In this pamphlet, we provide specific management and nutrition interventions that have shown promise in experimental and/or commercial settings which ideally you can adapt for your own facility and needs. Each suggestion should be considered on its own merits and whether the adaptation will affect other aspects of your flock negatively. For instance, while fractures appear in both cage and non-cage housing systems, solutions to reduce hazardous mobility would differ between the two housing types. In a second example where caution is needed, while increased lighting may improve visibility and hen movement, it may also increase risk of feather pecking.

Rearing

Chicks/pullets continuously develop the skeletal and cognitive mechanisms needed for the rest of their lives, so the rearing period is essential to make sure hens have strong bones and can move throughout the system without injuring themselves. When possible, the rearing and laying environments should be as similar as possible, especially in terms of cage and non-cage rearing and laying systems. During rearing, furnishings should be introduced gradually so the pullets can learn how to use them appropriately leading to more accurate movements. Generally, increased activity is known to lead to better bone health. Producers should also consider specific interventions including:

- Early access to perches and/or ramps. Increasingly, we have realized that hens are not good flyers but are much better in walking or making short jumps to move vertically. Thus pullets should be provided with alternative means to move vertically by the provision of ramps or perches positioned closely to each other in a manner limiting accumulation of faeces in litter or sleeping (on ramps).
- Research has found that hens begin using ramps with access to upper tiers in a multi-tier aviary as early as 10 days of age with benefits leading to more flexible bones at 16 weeks of age and decreased fractures during lay.
- Early provision of perches is also known to decrease floor eggs which may indicate the absence of perches during rearing can result in hens having difficulty accessing the nest boxes during lay.
- Benefits of providing perches during rearing appears to extend to hens in caged laying housing systems as well.
- Placing food and water at different heights.
- By placing these resources at different locations, birds will be forced to become more active and move vertically more often leading to improved skeletal development.

Lay period

Although we don't know the exact cause of keel fractures, the scientific consensus is that birds have collisions with furnishings in their environment that leads to fractures. Collisions happen in both cage and non-cage systems where the causes may be panics or high density traffic, such as at dusk as birds move up to roost. Rapid wing-flapping during panics or as birds try to regain their position during and after falling are also suspected causes. Hence, producers should try to aid movement and prevent panics. Some specific recommendations include:

- To reduce panics:
 - Producers should gradually begin walking through their barns/sheds with different colour clothing, from different directions, and at different times of day. Producers should initially move slowly, and, as hens become habituated, can begin moving faster and on a more regular basis. Ideally, this should start as early as possible, including during rearing and/or within the first week following population.
 - Radios and other variable noises are also likely to help, particularly if begun in the rearing barn.
- To aid movement (most relevant in non-cage systems) and following on from introduction in rearing:
 - Perches
 - Perches should be positioned to aid movement in the vertical direction, particularly around high traffic areas like the nest box.
 - Generally, perches should be placed at an angle less than 45 degrees from each other and less than 50 cm vertically, or 75 cm horizontally.
 - A more extensive document was produced by our group on perches, including placement as well as different materials and shapes. It can be downloaded at : <http://www.keelbonedamage.eu/wp-content/uploads/KBW-perch-recommendations-Aug14.pdf>.
 - Ramps
 - Ramps have been shown to increase the amount of controlled movements in hens leading to reduced collisions during the key period of dusk.
 - The prevalence of keel bone fractures has been shown to be 9 % lower in commercial aviaries with ramps (64 %) than aviaries without ramps (73 %).
 - Benefits of ramps have been found to be most helpful to reduce fractures if included in both rear and lay.
 - Sufficient lighting to allow for accurate movement
 - Dim lighting (0.8–1.5 lux) may reduce the accuracy of jumps between structures and hens appear to jump quicker at 5–60 lux.
 - Lighting transitions (i.e. dusk, dawn) should be done gradually (e.g. over 30 min) to cue birds to begin moving, although recent research by our group in commercial aviaries did not find extending duration reduced occurrence of keel fractures.

Nutrition

Nutrition is a difficult factor to make recommendations for, as genetic requirements have changed over time as egg production and the length of the lay cycle has increased dramatically. Additionally, different housing systems such as free range will have higher demands on feed, while variations in exposure to sunlight, calcium content in water, and other environmental factors will affect the specific requirements. Given these factors, final diet formulations should be made in consultation with a nutritional expert. Below are general recommendations based on conducted research.

- During rearing:
 - Ca:
 - Pullets should receive a minimum of 9 g/kg diet between 0–14 weeks old and then increase to 35 g/kg diet from 14 weeks.
 - Ca:P should be approximately 2:1
 - Vitamin K (2 to 12 mg menadione/kg) is supported by evidence of increased bone volume used for calcium storage.
- During lay:
 - Phytase
 - Feed with 0.11 to 0.26% nonphytate phosphorus supplemented with phytase may serve to better retain calcium.
 - Supplementing with Omega-3
 - Use of linolenic acid (e.g., from flaxseed) from 23 to 30 weeks of age was shown to improve bone strength and result in less fractures, though producers should be careful of effects on egg quality.
 - Alternative calcium delivery schedules
 - While it is unlikely that increasing daily calcium will allow the hen to absorb more calcium, there is evidence to support that giving a burst of calcium in the 2–3 h period immediately before the dusk period will allow the bird to absorb more calcium. In this sense, the amount of calcium provided over a 24 h period is the same, but the hen is able to absorb more during a key point in the 24 hour cycle when the majority of the egg shell is formed.
 - Multiple strategies exist to provide the burst of calcium and have typically been focused in older hens (e.g. 60 weeks of age) to improve shell quality, but generally are based on increasing the amount of calcium in the gut/crop during the night time. Specific strategies include: 1) providing two diets, the second diet in the 2–3 hours immediately before roosting that contains more calcium, or 2) supplementing the diet with a calcium particulate like limestone or oyster shell. The two combinations could also, in theory, be combined.
 - Our group will be investigating this strategy more in the coming year, but preliminary results look promising where birds receiving particulate calcium in combination with a feed additive to increase calcium absorption were less susceptible to fracture.

Things we don't know but are working on

- Productivity and keel bone fracture
 - We believe birds with fractures will be less productive as resources used for egg production will be shifted towards bone healing. We are currently developing this data, including an online tool that can be used to estimate the cost-benefit analysis of these suggested interventions.
- Genetic lines
 - Isolated reports of differences in keel fracture frequency and severity exist between genetic lines and there are obvious differences we expect would relate to fracture, e.g., brown laying lines tend to have stronger bones but poorer flying abilities. Nonetheless, we have been unable to find a commercially viable genetic line that we can confidently say is less likely to develop KBF. Genetic efforts to reduce keel fracture is an area that scientists and industry are fervently working on, though for now, the evidence suggests that small differences between lines are likely outweighed by management factors like housing and nutrition. Hence, our recommendation is that producers focus on management factors as recommended in this pamphlet.

Interested in more information?

We encourage you to consult your national trade association or get in touch with the scientists and industry that are working on this topic by accessing www.keelbonedamage.eu and/or emailing our group administrator, Ms. Lilian Smith (Lilian.Smith@vetsuisse.unibe.ch). **Most importantly, we are eager to hear whether these strategies were of help to you! Please let us know!**

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Interventions to reduce keel bone fractures

