# Mobility scoring prior to hoof trimming

## - can it be used to detect potentially painful pathologies in the hooves of dairy cattle?

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*Mobility scoring före klövvård – kan metoden användas för att påvisa potentiellt smärtsamma klövpatologier hos mjölkkor?*

Joel Hedlund


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| **Keywords:** | mobility scoring, hoof trimming, lameness, dairy cattle, Early Detection and Prompt Effective Treatment (EDPET) |


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## Abstract

Lameness is a major welfare and economic problem in dairy cattle, most commonly caused by claw lesions that induce pain and impaired locomotion. Early detection is essential to prevent chronic pain and long-term consequences, and visual locomotion assessment is widely used for this purpose. The aim of this study was to evaluate whether systematic locomotion assessment using the AHDB Mobility scoring system can detect claw lesions expected to cause pain in Swedish dairy cows.

The study included 123 dairy cows from three farms in Sweden, assessed during routine hoof trimmings. Cows were mobility scored prior to trimming using the AHDB Mobility scoring system. During hoof trimming, claw lesions were diagnosed and classified based on their presence and type. Lesions were grouped according to whether they were expected to cause pain or not based on existing literature. Descriptive statistics were calculated, and the association between impaired mobility and painful claw lesions were evaluated using odds ratios.

Of the cows included, 10.8% were classified as lame (mobility score ≥2). Claw lesions were highly prevalent, with a mean of approximately five lesions per cow. Cows with at least one lesion expected to cause pain showed a slightly increased likelihood of impaired mobility compared with cows without such lesions. However, this association was weak and not statistically significant.

In conclusion, this study found only a limited association between mobility scores and the presence of claw lesions expected to cause pain at the individual level, thus suggesting mobility scoring to be insufficient as a sole diagnostic tool in evaluating the presence of painful claw pathologies.

*Keywords:* mobility scoring, hoof trimming, lameness, dairy cattle, Early Detection and Prompt Effective Treatment (EDPET)

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# Abbreviations

| Abbreviation | Description |
|---|---|
| CHDL | Claw-horn disruption lesions |
| CI | Confidence interval |
| DC | Digital cushion |
| DD | Digital dermatitis |
| DDFT | Deep digital flexor tendon |
| EDPET | Early diagnostics, prompt effective treatment |
| FT | Flexor tuberosity |
| HHE | Heel-horn erosion |
| IH | Interdigital hyperplasia |
| MS | Mobility score |
| OR | Odds ratio |
| P3 | Distal phalange |
| SH | Sole haemorrhage |
| SU | Sole ulcer |
| WL | White line |
| WLD | White line disease |
| WLH | White line haemorrhage |

# 1. Introduction

Lameness is one of the most prevalent health and welfare problems affecting dairy cattle worldwide, with significant economic and ethical implications. It is associated with reduced milk yield, reproductive performance and longevity, while severely compromising animal welfare (Garvey 2022). The issue persists across production systems despite decades of research, highlighting its multi-factorial nature and the complexity of its underlying causes.

Pain is a central component of lameness and represents one of the primary welfare concerns associated with the condition (Whay & Shearer 2017). When left undetected or inadequately treated, persistent nociceptive input may lead to a sensitization within the nervous systems, resulting in a heightened and prolonged pain response (Zoltick *et al.* 2024). This process contributes to the chronicity of lameness, where pain and altered gait patterns may persist even after the initial lesion has healed.

Accurate lameness assessment is therefore critical for both animal welfare monitoring and effective intervention, so is the understanding of which claw lesions are causing lameness. Regular lameness assessment allows for early treatment of affected animals, reducing the risk of chronic pain and secondary lesions. However, the assessment of lameness presents several challenges, as gait changes can be subtle and visual lameness assessment is subjective (Schlageter-Tello *et al.* 2014a). Over the past decades, various locomotion scoring systems have been developed to provide structured methods for evaluating gait, posture, and behaviour, with scales ranging from simple binary classifications to nine-point systems and continuous scales (Schlageter-Tello *et al.* 2014b). One example is the mobility scoring system (AHBD n.d.b), however, its capacity to detect claw lesions has only been sparsely researched (Logan *et al.* 2024) and is yet to be applied on Swedish dairy cattle.

The aim of this project was to evaluate whether systematic locomotion assessment with the mobility scoring system can detect potentially painful claw disorders in Swedish dairy cows, thereby enabling the prompt initiation of effective treatment. The hypothesis was that systematic mobility scoring prior to routine claw trimming can be used to determine the presence of painful claw disorders at the individual level.

# 2. Literature review

## 2.1 Lameness

One definition of lameness is “Lameness is used to describe the clinical presentation of impaired locomotion, regardless of the cause ” (Archer *et al.* 2010). Lameness is a very common ailment in dairy cows, with a recorded median prevalence of 22% lame cows per farm worldwide (Thomsen *et al*. 2023). In Sweden, a median prevalence of 5%, with a range between 0-25% lame cows per farm, has been recorded (Sjöström *et al.* 2018). However, the prevalences are not directly comparable, since the Swedish study used one set method for quantifying lameness and the worldwide study was based on available literature, thereby including several different methods for quantifying lameness.

Importantly, lameness in dairy cows has serious economic impacts, both by loss of production and culling of severe cases (Robcis *et al.* 2023). The loss of production related to lameness has been shown to be detrimental. The yearly cost per case of lameness has been estimated to €307.50 (Robcis *et al.* 2023), and lame dairy cows, regard-less of their clinical diagnosis, are up to 2 times more likely to be culled than non-lame dairy cows (Booth *et al.* 2004).

In dairy cows, a vast majority of lameness cases are caused by disorders affecting the hoof. In a study by Fenster *et al.* (2023), it was found that 69.5% of lameness cases encountered in ambulatory practice and 85.7% encountered in an in-house setting originating from the hoof. Thus, pain from the hoof is a central component of lameness in dairy cows, which inherently compromises the welfare of any affected animal. The Five Freedoms (FAWC 1993), being Freedom from hunger and thirst, Freedom of discomfort, Freedom from pain, injury and disease, Freedom to express normal behaviour and Freedom from fear and distress, was examined with regards to lameness by (Whay & Shearer 2017). In said paper, the authors concluded that not one freedom was left uncompromised, although the consequences of lameness are complex and hugely dependant on husbandry practices.

In a recent publication by Gladden (2025), it was also concluded that lameness compromises the welfare of cattle, this time using the Five Domains model (Mellor 2016). Four of the domains, being Nutrition, Physical development, Health and Behavioural interactions were concluded to be compromised which, in turn, compromised the fifth domain, Mental state.

## 2.2 Pain

Pain is defined as “an unpleasant sensory and emotional experience associated with, or resembling that associated with, actual or potential tissue damage”(IASP n.d.b). Pain is perceived by the brain, but to be able to perceive a noxious stimulus, the signal from the nociceptors must travel to the brain. Nociceptors are free sensory nerve endings in the periphery. These respond to for example prostaglan-dins, nerve growth factors, bradykinin and histamine, which are released as a consequence of tissue damage (Brodin *et al.* 2016). The tissue damage can be of mechanical, thermal or chemical origin which then is interpreted as noxious stimuli.

The journey of a noxious stimulus from the peripheral nerves to the brain is achieved in steps by transduction, transmission and modulation, before the final step, perception (Zoltick *et al.* 2024). Transduction takes place when a noxious stimulus is converted to an action potential capable of reaching the central nervous system (CNS), by means of signalling molecules such as cytokines, bradykinin and prostaglandins. The signal generated by the action potential during transduction, is then transported through nociceptive primary afferent neurons, of which there are two types, Aδ- and C-fibres. Aδ-fibres are myelinated and therefore rapidly transport localizable pain, described as “sharp” pain. C-fibres are non-myelinated and therefore conduct signals at a slower pace. Pain experienced from C-fibre activation is described as “dull”, “throbbing” or “aching” by humans (Thomson & Hahn 2012). Then, the signal arrives to the dorsal horn of the spine, where transmission takes place (Cao *et al.* 2024). Transmission is the conduction of signals through the spinal cord, the primary afferent neurons synapse with secondary afferent neurons in the dorsal horn and the pain signal is led on its way towards the brain through ascending pathways. Pain modulation is the suppression or heightening of the transmission of painful stimuli, by inhibitory or excitatory mechanisms. This can take place both in the CNS as well as in the periphery.

Pain signals first arrive to the brain stem, where the reticular activating system (RAS) projects the signals to the thalamus and limbic system (Zoltick *et al.* 2024). The thalamus re-projects the signals to the somatosensory cortex of the cerebrum, where a conscious perception of where the pain originates from as well as how severe it is. The limbic system, encompassing structures such as the amygdala, mediates the emotional aspects of pain perception. It can therefore be said that a painful sensation not only describes what/where the pain is (sensory-discrimina-tory) and how severe it is interpreted to be (cognitive-evaluative), but also what emotional response it evokes (affective-motivational) (Lindsay *et al.* 2021).

### 2.2.1 Types of pain

Pain can generally be divided into several types including nociceptive pain, inflammatory pain and neuropathic pain (Zoltick *et al.* 2024). Nociceptive pain arises from contact with a noxious stimulus, e.g. an external factor. It is often acute in nature and disperses with removal of the external factor/cause of noxious stimuli. Inflammatory pain is caused by inflammatory mediators such as bradykinin and prostaglandins which lowers the nociceptors threshold to stimuli. The inflammatory mediators are released as a response to tissue damage. Neuropathic pain arises from structural damage to peripheral nerves. However, one type of pain does not preclude the others, as multiple types of pain may be activated at the same time. Pain can also be categorised as acute or chronic. Acute pain is a pain with a sudden onset and short duration, it is also associated with a cause (Bonezzi *et al.* 2020). Chronic pain is pain that persists or recurs longer than three months (IASP n.d.a). Note that a known cause is not necessary to qualify as chronic pain.

### 2.2.2 Peripheral and central sensitization

Peripheral sensitization is "increased responsiveness and reduced threshold of nociceptive neurons in the periphery to the stimulation of their receptive fields." (IASP n.d.b), meaning that normally painful stimuli grant a greater pain experienced. As previously stated, inflammatory mediators conduce sensitization, but growth factors, inflammatory cytokines and chemokines can also enhance nerve terminal sensitization (Hucho & Levine 2007). Hyperalgesia, which is a heightened sensation of pain following a noxious stimulus, is a sign of peripheral sensitization which is noticeable clinically (IASP n.d.b).

Central sensitization is "increased responsiveness of nociceptive neurons in the central nervous system to their normal or subthreshold afferent input" (IASP n.d.b), i.e. normally non-painful stimulus may now grant precepted pain. Central sensitization is the result of synaptic plasticity through intense, sustained noxious stimulus (Latremoliere & Woolf 2009). Examples of this synaptic plasticity is an increased excitability, greater synapse efficacy and a decreased inhibition of noxious signals. The clinical presentation of central sensitization is termed allodynia, with the definition: "pain due to a stimulus that does not normally provoke pain"(IASP n.d.b). The link between peripheral- and central sensitization is that central sensitization can be triggered by peripheral sensitization. If there is a painful inflammatory condition in the periphery causing peripheral sensitization, the hyperalgesia "produced" may very well result in synaptic plasticity and central sensitization. The major difference between peripheral- and central sensitization is that peripheral sensitization generally requires an ongoing pathology in the periphery to be maintained, whereas central sensitization can illicit pain hypersensitivity long after the peripheral pathology no longer is present (Latremoliere & Woolf 2009).

Central sensitization is thus linked to chronic pain, as intense noxious stimulus over a prolonged period is needed for its formation and in turn central sensitization can cause pain for an extended duration.

## 2.3 Lameness assessment

There is a wide array of different manual systems to detect and classify the severity of lameness in cattle (Coetzee *et al.* 2017). The different systems vary in their comprehensiveness, depending on the thought user of the system, whether that be farmers, veterinarians or researchers.

One of the most frequently used systems in research settings, is the five point Sprecher lameness scoring system (Schlageter-Tello *et al.* 2014b), which focuses mainly on posture of the back and gait (Sprecher *et al.* 1997). Other commonly used assessment systems are Flower and Weary's (2006) 9-point (5 levels with 0.5 increments) lameness scale, which focuses on back position, head carriage, gait asymmetry and joint stiffness, with the animal's "ability to move freely" being assessed by these points. There is also Manson and Leaver's (1988) locomotion scoring system, which focuses on adduction and abduction, unevenness of gait, and "tenderness" while also considering the cow's "behavioural pattern".

### 2.3.1 The AHDB Mobility scoring system

The AHDB system was developed in 2007 as a consequence of a "confusingly large number of different locomotion scoring systems" being used at dairy farms in the UK (Bell & Huxley 2009). A cross-industry meeting containing veterinarians, consultants, farmers, hoof trimmers, academics and other industry representatives was held. The result of the meeting was the AHDB Mobility scoring system, which differs from other scoring systems by its intent on being used by who it is designed by, with its highly accessible design and focus on action. It is a 4-point scoring system with emphasis on if, and when, the cow's claws should be examined. Here follows descriptions of each score, as defined in AHDB (n.d.c):

- **Score 0, Good mobility**
  - "Walks with even weight-bearing and rhythm on all four feet, with a flat back"
  - "Long, fluid strides possible"
  - Suggested actions: continue with routine hoof trimmings if/when required and continue to include in mobility scoring sessions.
- **Score 1, Imperfect mobility**
  - "Steps uneven (rhythm or weight-bearing) or strides shortened; affected limb or limbs not immediately identifiable"
  - Suggested actions: would benefit from routine hoof trimming if/when required and recommends further observation.
- **Score 2, Impaired mobility**

- "Uneven weight-bearing on a limb that is immediately identifiable and/or obviously shortened strides (usually with an arch to the centre of the back)"
- Suggested actions: should be attended to as soon as possible, as the cow is lame. Hoof should be lifted to establish cause, then treated.

• **Score 3, Severely impaired mobility**
- "Unable to walk as fast as a brisk human pace (cannot keep up with the healthy herd)"
- "Lame leg easy to identify – limping; may barely stand on lame leg(s); back arched when standing and walking"
- "Very lame"
- Suggested actions: requires urgent attention, nursing and professional advice, as the cow is very lame. Should be examined as soon as possible and subsequently treated, as the cow will benefit from treatment. The cow should not be made to walk longer distances and should be kept in a sick-pen on straw. In severe cases, culling may be the only option

The main goal of this mobility scoring system is to help dairy farmers reduce the number of lame cows on their farms, by early identification and subsequent examination and treatment of individuals in need (AHDB n.d.c). This is in line with EDPET practice (Early Detection and-, Prompt Effective Treatment) (Pedersen & Wilson 2021). It has also been designed to allow records of herd mobility, enabling farmers to follow trends and couple that to existing claw pathologies (AHDB n.d.b). This may also allow farmers to pick up on negative changes at an earlier stage.

## 2.4 Anatomy

The bovine foot consists of two digits and two dewclaws, with the digits being functional and the dewclaws being vestigial (Cramer & Solano 2025a). Each digit contains three phalanges, P1-P3, with P3 being the distal phalange. The deep digital flexor tendon (DDFT) inserts on the palmar/plantar aspect of the P3, to a structure known as the flexor tuberosity (FT). The P3 is entirely encapsulated by the horn capsule, which is part of the epidermal layer of the hoof. The basement membrane (stratum basale) of the epidermal layer is the junction between epidermis and dermis. This means that if the dermis, known as the corium, is exposed, horn producing capability in the area is likely compromised. The subcutis contains connective tissue and fat which absorbs and dissipates forces during walking. The main structure of the subcutis is the digital cushion (DC), which lies beneath the heel bulb (HB) (Desrochers & Anderson 2001).

The P3 is held in place within the horn capsule by a system of collagen fibres, known as the suspensory apparatus (Cramer & Solano 2025a). These fibres run from their origin on the P3, through dermal lamellae and epidermal lamellae, (Osorio *et al.* 2012) to their insertion on the stratum basal of the hoof.

The horn capsule can be divided into wall horn and sole horn (Cramer & Solano 2025a). The junction between wall and sole is known as the white line (WL). The white line is composed of three different structural zones, namely the outer, the intermediate, and the inner zone. These zones are all comprised of different kinds of horns, formed from different types of papillae, which are situated on the dermal laminae within the hoof (Shearer & van Amstel 2017).

Topographical terms of the hoof (other than palmar [plantar]/dorsal and proximal/distal) include axial and abaxial. Axial (A) describes locations towards the interdigital space (IS), whereas abaxial (AB) describes locations towards the outer wall.

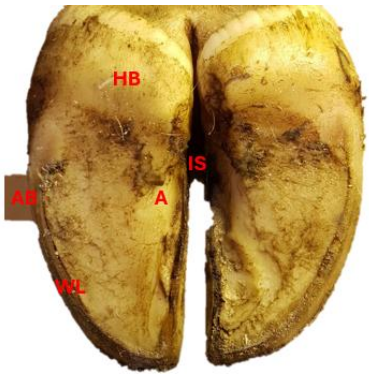



*Figure 1. External anatomy of the claw. HB= Heel Bulb, IS=Interdigital Space, AB=Abaxial, A=Axial, WL=White Line. Photo by Evgenij Telezhenko and markings by the author.*

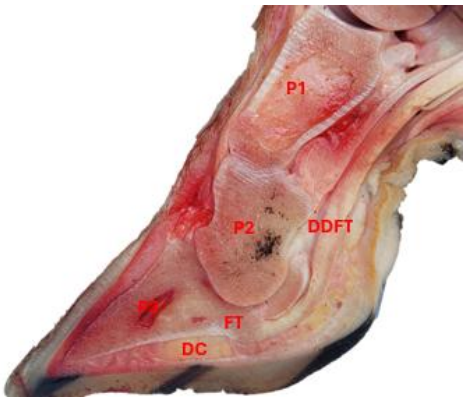



*Figure 2. Internal anatomy of the claw. P1-P3=Proximal, Medial and Distal phalange, DDFT=Deep Digital Flexor Tendon, FT=Flexor Tuberosity, DC=Digital Cushion. Photo by Evgenij Telezhenko and markings by the author.*

## 2.5 Hoof trimming

Hoof trimming is done to form a correct claw- and hoof conformation, which distributes load bearing forces in an optimal way to reduce pathologies. Traditionally, claw trimming is performed following the "Dutch Method" which was developed by Toussaint Raven (1989). However, newer methods have been developed, for example one described in a study by Manske *et al.* (2002b) as focusing on achieving certain angles of the claw. These angles are a 45-55 degree toe angle, as well as maintaining a straight toe axis, level bearing surfaces, symmetrical claws and dishing out the axial part of the sole (classic sole ulcer site).

Besides the prophylactic element, hoof trimming is also a vital part of diagnostics and therapy of hoof pathologies (Manske *et al.* 2002b).

The general principles of treatment of pathologies using hoof trimming comprise a few broad points (Guard 2006). Horn that is detached from underlying layers (as can be seen in white-line abscesses, heel horn erosion etc.) should be removed. Areas that would benefit from a relief of weight bearing, should be given that relief, for example by modelling out the sole around a sole ulcer and applying a block to put all weight bearing on the opposite claw. Lastly, topical compounds can be applied to lesions that benefit from it, for example application of salicylic acid on DD.

In Sweden there is a national incentive for scheduled hoof trimming. The Swedish Board of Agriculture (Jordbruksverket) pays a sum of 300 SEK per cow that is trimmed by a certified hoof trimmer at least two times a year (Jordbruksverket 2026). Besides the requirement of at least two hoof trimmings per year, there is also a requirement to establish a hoof health plan at least two times per year. This plan should include planning of coming hoof trimmings as well as what actions are to be taken to combat any pathologies present in the herd.

## 2.6 Pathologies – Claw Horn Disruption Lesions (CHDL)

### 2.6.1 Sole haemorrhage/ulcer

Sole haemorrhage (SH) and sole ulcer (SU) initially share a common pathogenesis (Bergsten 2003). They both typically occur when the FT of the P3 exerts pressure on the corium. This pressure, or contusion, causes a local inflammation and subsequent oedema and haemorrhage, which will be incorporated in growing horn in the case of SH. Regarding SU, contusion of the corium will destroy keratinocytes and thereby hinder new horn production and cause a defect in the horn, through which the corium will protrude (Cramer & Solano 2025b).

For the P3 to exert an increased pressure on the corium, the P3 will have to sink, which happens by a faulty suspensory apparatus (Lischer *et al.* 2002). Horses have more developed laminae, enabling them to carry their weight on the hoof-wall to a further extent. Cattle carry more of their weight on the heel rather than the hoof wall and are therefore more dependent on other supportive tissues to carry their weight. The suspensory apparatus, which attaches the distal phalanx to the hoof wall, has been shown to be crucial in the pathogenesis of SH/SU. It has been proven that in the periparturient stage, there is an increased laxity in the suspensory apparatus, which allows the pedal bone to sink and "pinch" the corium between the pedal bone and the sole, causing inflammation and bruising. It is theorized that hormonal changes, such as an increase of relaxin or relaxin-like-factor might be to blame (Tarlton *et al.* 2002). There is also certain evidence that would suggest that metabolic disease and endotoxins can be part of the pathogenesis, rendering SH/SU multifactorial diseases (Cramer *et al.* 2023).

Regarding SU, there is a correlation between increased incidence and greater parity (Sanders *et al.* 2009). Interestingly, it has also been shown that increased locomotion scores as well as greater parity are positively correlated to new bone development (exostosis) of the distal phalanx in the general location where sole ulcers tend to form (Newsome *et al.* 2016). It is not yet known whether the exostosis causes sole ulcers to a further extent, but since SU are formed due to pinching of the corium to such extent that its capability to produce horn is inhibited, it is a plausible scenario.

Regarding soft tissue support of the pedal bone, Räber *et al.* (2004) showed that there is a lower fat content in the DC in older cows and especially in those with CHDL. This may partly explain why SU incidence is higher in older cows.

Sole ulcers do generally generate a visible lameness (Flower & Weary 2006), in that same study subjective lameness scores of cows with SH did not differ significantly from scores of healthy cows. In another study (Flower *et al.* 2005) which measured stride length as a sign of lameness, there was also a clear connection between SU and lameness, and again no significant difference in lameness score between cows with and without SH. Sole ulcers have also been proven to contribute to a state of hyperalgesia (Whay *et al.* 1998), which persisted for at least 28 days after initial treatment. It is thus considered to be a claw pathology causing pain in the distal limb.

In 2019, prevalences of SH and SU were estimated to 10.8% and 4.3% respectively, based on data from hoof trimmers (Växa n.d.).

### 2.6.2 White line disease

White line disease (WLD) is a broad term which encompasses mainly fissures, separations and abscesses in the white line of the claw (Cramer & Solano 2025b). Since the horn of the white line is produced of different papillae and the different

types of horn bears varying qualities, the horn of the white line is an inherent weakness in the horn of the hoof. This makes external, mechanical factors an initiation point for WLD, such as uneven flooring and lateral/medial pushing with firmly planted feet, occurring for example in milking parlour holding areas.

However, the white line usually tolerates these kinds of stresses, if the horn of the white line is well keratinized (Shearer & van Amstel 2017). Poor keratinization is a product of poor blood flow to the corium, which occurs with sinking of the pedal bone. The resulting dyskeratotic horn is weak to physical forces and invasion of foreign materials. Once foreign material has entered the white line, it is driven deeper by weight bearing and locomotion. Bacteria that has entered the white line along the foreign material, colonizes the horn and ascends with the foreign material to the corium, where an abscess often forms, causing pain and lameness. WLD have been proven to contribute to a state of hyperalgesia (Whay *et al.* 1998). It can therefore be considered a painful claw pathology.

In a Swedish study from 2002, the prevalence of white line fissures was estimated to be 8.8% (Manske *et al.* 2002a). However, white line abscesses were not examined.

## 2.7 Pathologies – Hygiene associated

### 2.7.1 Digital dermatitis

Digital dermatitis (DD) is an infection of the skin of the bulbar area of the hoof (Döpfer *et al.* 1997). The full aetiology of bovine digital dermatitis is still not completely understood, but what is known is that the pathogenesis involves infection with spirochaetal bacteria of the family Treponema. It is thought of as a polymicrobial disease, since a vast number of different subspecies of Treponema has been isolated from DD lesions, along with a series of different species such as *Dichelobacter nodosus* and *Fusobacterium necrophorum*. The treponemes infect the palmar/plantar skin of the hoof, causing ulcerative erosive masses and epidermal hyperplasia, with the hyperplasia typically being more apparent in chronic cases. A 4-point classification system (M1-M4) based on the macroscopic appearance of the lesions has been developed. Early-stage DD (M1) consists of a small, rounded, red-grey lesion, up to 2 cm in diameter and that penetrates a maximum of 2 mm beneath the epithelial surface. M2 consists of a granulomatous lesion >2 cm in diameter and laying >2 mm beneath the epithelial surface. M3 differs slightly from M2, by having a scab over the lesion, signalling healing. M4 consists of hyperkeratotic lesions of varying appearances, and can be further subdivided into M4.1, which maintains the hyperkeratotic lesion, with the addition of a M1 foci. There are also further subdivisions, mainly focusing of the placement and expanse of the lesions (Wilson-Welder *et al.* 2015). It has been concluded that

all stages of DD contribute to lameness, with different degrees of association for different stages (Thomas *et al.* 2022).

Digital dermatitis is a big problem within the dairy industry. It is calculated that approximately 22-24% of all dairy cows in western Europe suffer from digital dermatitis at routine hoof trimmings (Menno Holzhauer 2021). One of the reasons for this, other than the fact that it is an infectious disease with inherent ability to spread, is its ability to survive and remain infectious in slurry. This effectively turns slurry, which is more or less abundant in dairy farms, into a reservoir, which greatly enhances the chances of DD becoming endemic (Klitgaard *et al.* 2017). Treponemes are thought to colonize and inhabit damaged skin, which has been theorized since treponemes have been found in various other pathologies of the hoof (sole ulcers, toe necrosis etc). The reason for the further investigation which revealed that these pathologies were colonized by treponemes, was that they were all non-healing/hard to treat (Wilson-Welder *et al.* 2015).

### 2.7.2 Heel-horn erosion

Heel-horn erosion (HHE) is a breakdown of horn in the bulbar area of the claw (Peterse 1985). This is due to opportunistic bacteria and chemical breakdown by agents mainly found in slurry. The lesions are characteristically V-shaped or round and can erode so deeply that the corium gets exposed. Severe cases like this are rare and can generate lameness, whereas milder lesions typically do not (Cramer & Solano 2025b). Even though HHE typically doesn't generate visible lameness, it can be used as a hygiene indicator, since the conditions which allow heel-horn erosion are the same that permits spread of digital dermatitis (AHDB n.d.a)

In 2019, an estimated prevalence of HHE was 5.4%, based on data from hoof trimmers (Växa n.d.).

### 2.7.3 Interdigital phlegmon (Foul in the foot)

Interdigital phlegmon (IP) is a bacterial infection of the interdigital skin (Kontturi *et al.* 2019). The pathogen most strongly associated with interdigital phlegmon is *F. necrophorum*, but *D. nodosus* and *Trueperella pyogenes* have also been detected, typically in a later stage of progression. The pathogenesis of IP begins with a defect in the interdigital skin barrier that facilitates infection. This defect might be caused by wet conditions. However, at this stage, no research points to that the weakening of the skin is sufficient to cause infection; a physical trauma that breaks the skin barrier is needed.

IP typically generates an acute and severe lameness with swelling of surrounding soft tissue, an active lesion in the interdigital skin with a distinctive smell, and a fever (Persson *et al.* 2019). Treatments vary depending on progression; an early detected, non-complicated case of IP can be sufficiently

treated with a bandage containing salicylic acid. If the IP is not diagnosed early enough, it can spread to underlying tissues (i.e. pedal bones, joints, ligaments), for which antibiotics are indicated (Cramer & Solano 2025b).

Somewhat unofficial data from 2017 would suggest that <1% of Swedish cows are treated for IP per year, however this does not take into account cows who did not receive veterinary intervention (Persson *et al.* 2019).

### 2.7.4 Interdigital hyperplasia

Interdigital hyperplasia (IH) is a fibrous growth (fibroma) in the interdigital space (AABP 2006). Its pathogenesis is not fully understood, but chronic irritation of the interdigital skin is thought to be one of the factors contributing to this multifactorial disease. Infections, such as IP and DD, as well as poor claw hygiene and uneven walking surfaces, are examples of factors that may irritate the interdigital skin.

It has also been proven that interdigital hyperplasia is highly inheritable (Gernand *et al.* 2012).

It is thought that smaller IH lesions do not typically generate lameness, while larger and especially ulcerated and/or infected lesions do (AABP 2006). IH can be painful, as that has been described as an important clinical marker of if surgical intervention is needed. However, in Sweden recommended treatment for IH by hoof trimmers is a bandage containing salicylic acid (Växa 2019).

In 2019, 3.4% of Swedish cows had IH, based on data from hoof trimmers (Växa n.d.).

# 3. Materials and methods

## 3.1 Farms, animals and farm visits

Data collection was performed on farms, concurrently as scheduled routine hoof trimmings. A total of three different farms (Farms 1-3), tended to by three different hoof trimmers, were visited. This resulted in four separate occasions for on-farm data collection throughout October 2025, as we visited Farm 1 for data collection twice. The selection of farms was based on connections with the Swedish University of Agricultural Sciences (SLU). The selected farms were dairy farms with freestall systems. Farm 1 is SLU's Livestock research centre Lövsta (located in Uppsala, Sweden), and two external hoof trimmers, by whom we were invited to partake in visits to their customers (Farms 2 and 3, which were private farms located in Svealand, Sweden), both had participated in other research conducted by SLU. The selection of cows included in the study is shown in the following table (Table 1)

*Table 1. Information regarding selection of animals and time visited each farm.*

| | Farm 1 | Farm 2 | Farm 3 |
|---|---|---|---|
| Farm herd size | ~300 | ~80 | ~55 |
| Cause of visit | Routine trimming | Routine trimming | Routine trimming |
| Selection of cows included performed by | Employee of Lövsta | Farmer | Farmer |
| Anticipated lameness status of included individuals | Both lame and sound individuals | Both lame and sound individuals | Both lame and sound individuals |
| Number of individuals included | 26 | 45 | 52 |
| Hoof trimming performed by | Employee of Lövsta, specializing in hoof trimming | Privately practising professional hoof trimmer | Privately practising professional hoof trimmer |
| Number of visits | 2 | 1 | 1 |

As the purpose of the hoof trimmings were routine trimming, the cows included were identified by the farmers. Unfortunately, no detailed information regarding

the farm-specific strategy of animal selection for these routine trimmings was available. However, in conversation with the farmers it was concluded that the hoof trimmings were of both prophylactic and therapeutic nature for different cows, as both sound cows and known lame cows of varying parity and lactation stage were included.

## 3.2 Data collection

### 3.2.1 Standardizing mobility scoring and diagnosing of pathologies

Leading up to the on-farm visits, an approximately two-hour long briefing and training session of the Mobility scoring system were carried out by two veterinarians and researchers, of which one was a registered Mobility scorer. Further training in mobility scoring was done by means of video material publicly provided by AHDB. An internal requirement of at least 70% successful mobility score pick rate on a test provided by the Registry of Mobility Scorers (RoMS) was set, in order to be eligible for mobility scoring in this study.

Additionally, an approximately two-hour long training session in diagnosing claw pathologies, based on the Nordic Claw Atlas (Växa 2020) was held by a different researcher highly experienced in claw health, to be able to accurately diagnose each claw.

To explore the usability of the research protocol and to be able to complete practical training, a pilot study was performed at Farm 1 before onset of official data collection. The pilot study mainly focused on practical aspects, such as what level of collaboration with the hoof trimmer is expected and fine tuning of protocols. The data gathered from the pilot study was not used in this study.

### 3.2.2 On-farm data collection

Method of data collection differed between Farm 1 and the two other farms, Farm 2 and 3. All data collection (mobility scoring and diagnosing pathologies [both in person and retrospectively]), were performed by the author and another, equally trained veterinary student.

Data collection at Farm 1 was, as stated, divided into two separate occasions. Cows were video recorded before entering the crush, to be mobility scored retrospectively. Whilst in the crush, presence and severity of claw pathologies (such as SU, DD and HHE) were diagnosed in accordance with the Nordic Claw Atlas (Växa 2020) and were recorded using a protocol (Appendix 1). Additionally, photographs of each foot, along with the individual's identification number, were taken to allow review post-visit. Data regarding hoof trimming technique as well as post-trimming mobility scores were also collected but not used in the current study.

On farms 2 and 3, it would prove to be practically impossible to accurately review each claw in accordance with the protocol due to high tempo. Therefore, the data regarding presence and severity of claw pathologies from these farms were entirely based on photographs taken on site, to be diagnosed retrospectively. The pictures taken were of the entire sole area of all claws, as well as a lateral profile picture of the hind claws, however only pictures of the sole-area were used in diagnosing pathologies (i.e. four pictures per cow). Furthermore, video recording each cow pre-trimming would also prove to be difficult, due mainly to a larger number of individuals being led to the crush at once, thus making the recording of each individual difficult. Therefore, all mobility scoring on Farms 2 and 3 were done in person at the farm.

## 3.3 Data analysis

All data regarding claw pathologies and mobility scores were compiled in Microsoft Excel. Descriptive statistics were calculated. These include number of cows in the study, distribution of mobility scores, distribution of claw pathologies per mobility score, mean number of lesions per cow, prevalence of cows with at least one lesion per pathology and prevalence of cows with at least one severe lesion per pathology.

### 3.3.1 Calculating lesion-prevalences

In a recent study by Laschinger *et al.* (2025), the metrics "intra-herd prevalence" and "cow-level prevalence" was used to calculate prevalences of pathologies and their severity per farm. These were adapted to fit the present study (since we did not examine whole herds). We renamed "intra-herd prevalence" to "intra-group prevalence of lesions", which describes the number of cows diagnosed with at least one lesion of a pathology. This was calculated by using the following formula:

$$Intra-group\ prevalence\ of\ lesions\ = \frac{Number\ of\ cows\ with\ at\ least\ one\ lesion}{Total\ number\ of\ cows\ in\ the\ group} \times 100$$

Intra-group prevalence of lesions was calculated for each pathology on every farm, as well as total intra-group prevalences for each pathology, where all cows included in the study were considered part of the same group.

Intra-group prevalence of severe lesions, describing the number of cows diagnosed with at least one lesion classified as severe (by the Nordic Claw Atlas's definition [Växa 2020]), were calculated using the following formula:

$$Intra-group\ prevalence\ of severe\ lesions\ = \frac{Number\ of\ cows\ with\ at\ least\ one\ lesion\ with\ the\ highest\ severity\ score}{Total\ number\ of\ cows\ in\ the\ group} \times 100$$

Intra-group prevalence of severe lesions was calculated for each pathology which had definitions of degrees of severity in the Nordic Claw Atlas (HHE, DD, SH, SU and WLH [Växa 2020]). These were calculated per farm, as well as a total cow-level prevalence, where all cows included in the study were considered part of the same group.

### 3.3.2 Calculating correlations of pathologies to impaired mobility

To calculate pathologies correlated to impaired mobility, pathologies were separated into two groups without consideration of degree of severity characterized by the Nordic Claw Atlas (Växa 2020). The two groups were defined during an internal meeting within the research group and based on whether the pathologies were expected to be painful or not, with reference to available literature (AABP, 2006; Whay *et al.* 1998; Thomas *et al.* 2022). The classifications of pathologies can be found in Table 2. These two groups were then put into a 2x2 table, together with the number of cows who were considered lame/had imperfect mobility, to calculate odds ratios (OR). The cows with pathologies which were expected to be painful were classified as the exposed group and vice versa. The groups of cows which were classified as lame (MS ≥2)/imperfect mobility (MS≥1) respectively was seen as a positive outcome. The data from the 2x2 table were put in an online statistical software intended for biomedical research ( MedCalc Software Ltd n.d.), from which OR, CI and p-value were extracted. Odds ratios are used to explain to what extent exposure to a condition correlate to certain outcomes.

*Table 2. Separation of diagnoses into two groups.*

| Pain expected | No pain expected |
|---|---|
| DD | HHE |
| SU | Haemorrhage* |
| Abscess of the white line | WL separation |
| IH | Hairy wart |
| | No pathology |

* Haemorrhage consists of both sole haemorrhage and white-line haemorrhage

# 4. Results

In total, 123 cows were included in the study, with 26 cows from Farm 1, 45 from Farm 2 and 52 from Farm 3. Since some cows had missing data (pre-trimming MS, pathologies not recorded or both), different metrics in the results have a varying number of individuals included. The reason for not excluding cows with some sort of missing data were that information could still be extracted from them, mainly regarding descriptive statistics. In total, 475 pictures of claws were reviewed. In the following table (Table 3), it is visualized the subgroups used in different metrics in this study. The table also shows the distribution of MS for each farm.

*Table 3. Number of individuals in different study groups as well as distribution of mobility scores (MS) per farm.*

| | Farm 1 | Farm 2 | Farm 3 | Total |
|---|---|---|---|---|
| Total individuals | 26 | 45 | 52 | 123 |
| Individuals with recorded MS | 23 | 44 | 52 | 119 |
| Individuals with recorded claw data | 26 | 44* | 52 | 122 |
| Individuals with recorded MS and claw data | 23 | 43 | 52 | 118 |
| Individuals with MS 0 | 16 | 24 | 27 | 67 |
| Individuals with MS 1 | 7 | 18 | 14 | 39 |
| Individuals with MS 2 | 0 | 0 | 11 | 11 |
| Individuals with MS 3 | 0 | 2 | 0 | 2 |

* *Two individuals were follow-ups of a previous treatment of interdigital hyperplasia, only MS and presence of interdigital hyperplasia were recorded.*

Out of the 119 cows in the study with a recorded MS, the total distribution is as follows in Figure 3. Most of the cows' mobility were not affected (MS=0), and only 2 cows got an MS of 3.

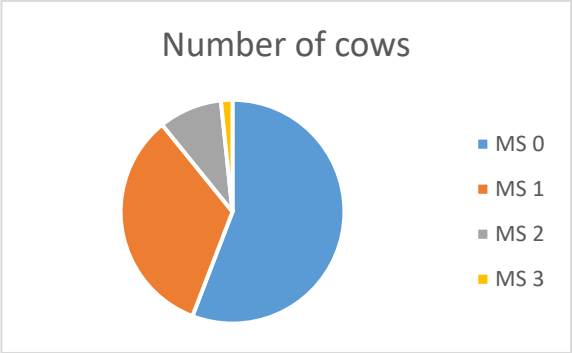



*Figure 3. Total distribution of MS.*

Given that each cow was mobility scored as an individual and not mobility scored per leg/hoof, all hoofs of the cow were, prior to production of the following table and figure, given the MS of the entire cow. This produced the following data regarding distribution of claw pathologies per grade of MS, extracted from the 118 cows with recorded diagnosed pathologies and MS. Note that the degree of severity presented in the following table and figure (Table 5, Figure 4), corresponds with degrees of severity present in the Nordic Claw Atlas, which is the basis for all diagnoses in this study.

*Table 4. Total number of claw pathologies per grade of mobility score (MS 0-3). Claw pathologies included heel horn erosions (HHE), digital dermatitis (DD), sole haemorrhage (SH), sole ulcer (SU), white line haemorrhage (WLH), other pathologies of the white line (WL), interdigital hyperplasia (IH) and hairy wart. Without pathology only included individuals without any diagnosis on any claw. Note that each number in the table corresponds to the number of claws diagnosed with each lesion, for each MS.*

| Pathologies | MS 0 | MS 1 | MS 2 | MS 3 |
|---|---|---|---|---|
| Mild HHE | 131 | 81 | 19 | 6 |
| Severe HHE | 28 | 12 | 4 | 1 |
| Mild DD | 12 | 10 | 3 | 1 |
| Severe DD | 2 | 0 | 0 | 0 |
| Mild SH | 47 | 27 | 10 | 1 |
| Severe SH | 3 | 2 | 4 | 0 |
| Mild SU | 20 | 16 | 3 | 0 |
| Severe SU | 1 | 4 | 0 | 1 |
| Mild WLH | 22 | 10 | 2 | 0 |
| Severe WLH | 1 | 3 | 1 | 0 |
| WL separation | 42 | 35 | 17 | 4 |
| Abscess of the WL | 0 | 3 | 0 | 1 |
| IH | 1 | 1 | 1 | 2 |
| Hairy wart | 1 | 0 | 0 | 0 |
| Without pathology | 20 | 8 | 4 | 0 |

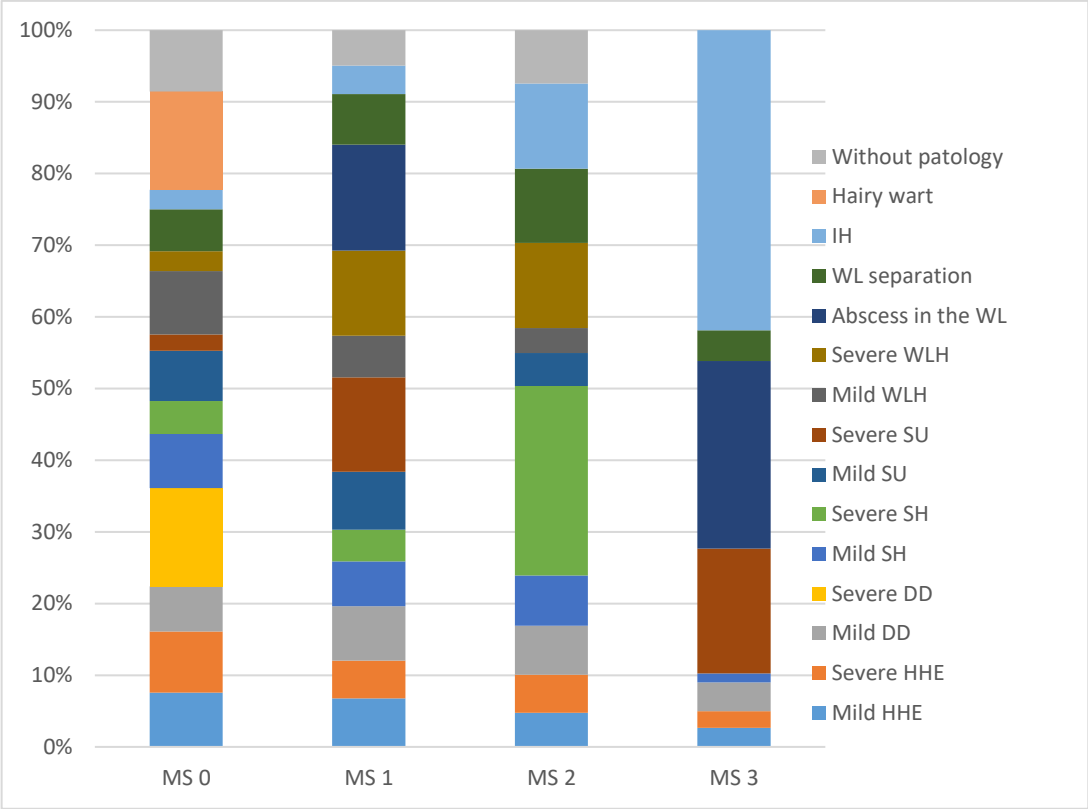



*Figure 4. Distribution in percentage of claw pathologies per grade of mobility score (MS). Claw pathologies included heel horn erosions (HHE), digital dermatitis (DD), sole haemorrhage (SH), sole ulcer (SU), white line haemorrhage (WLH), other pathologies of the white line (WL), interdigital hyperplasia (IH) and hairy wart. Without pathology only included individuals without any diagnosis on any claw.*

The total number of times each pathology was diagnosed, disregarding severity of each claw pathology, is presented below. Data is extracted from the 122 cows with recorded data regarding diagnosed pathologies.

*Table 5. Total number of lesions per claw pathology, disregarding severity. Claw pathologies included heel horn erosions (HHE), digital dermatitis (DD), sole haemorrhage (SH), sole ulcer (SU), white line haemorrhage (WLH), other pathologies of the white line (WL), interdigital hyperplasia (IH) and hairy wart.*

| Pathologies | Number |
|---|---|
| HHE | 286 |
| DD | 28 |
| SH | 98 |
| SU | 45 |
| WLH | 39 |
| Abscess of the WL | 4 |
| WL separation | 102 |
| IH | 5 |
| Hairy wart | 1 |
| Total amount of diagnoses | 608 |

These data were then used to calculate the mean number of diagnosed pathologies per cow. The mean was 4.98 lesions per cow and the standard deviation was 2.66.

Intra-group and cow-level prevalences were calculated for each farm respectively, see tables below. The number of individuals for each study group used to calculate the prevalences were based on the individuals with recorded claw data for each farm respectively (see Table 3).

*Table 6. Intra-group prevalence of lesions for each pathology at Farm 1. Number of cows included were 26.*

| Pathologies | n | Prevalence expressed in % |
|---|---|---|
| HHE | 20 | 76.92 |
| DD | 7 | 26.92 |
| SH | 7 | 26.92 |
| SU | 3 | 11.54 |
| WLH | 1 | 3.85 |
| WL separation | 8 | 30.77 |
| Abscess of the WL | 0 | 0 |
| IH | 0 | 0 |
| Hairy wart | 1 | 3.85 |
| Without pathology | 2 | 7.69 |

*Table 7. Intra-group prevalence of severe lesions at Farm 1. Number of cows included were 26.*

| Pathologies | n | Prevalence expressed in % |
|---|---|---|
| HHE | 2 | 8.70 |
| DD | 0 | 0 |
| SH | 0 | 0 |
| SU | 0 | 0 |
| WLH | 0 | 0 |

*Table 8. Intra-group prevalence of lesions for each pathology at Farm 2. Number of cows included were 44.*

| Pathologies | n | Prevalence expressed in % |
|---|---|---|
| HHE | 41 | 93.18 |
| DD | 8 | 18.18 |
| SH | 23 | 52.27 |
| SU | 12 | 27.27 |
| WLH | 16 | 36.36 |
| WL separation | 12 | 27.27 |
| Abscess of the WL | 4 | 9.09 |
| IH | 3 | 6.82 |
| Hairy wart | 0 | 0 |
| Without pathology | 1 | 2.27 |

*Table 9. Intra-group prevalence of severe lesions at Farm 2. Number of cows included were 44.*

| Pathologies | n | Prevalence expressed in % |
|---|---|---|
| HHE | 16 | 36.36 |
| DD | 2 | 4.55 |
| SH | 1 | 2.27 |
| SU | 5 | 11.36 |
| WLH | 2 | 4.55 |

*Table 10. Intra-group prevalence of lesions for each pathology at Farm 3. Number of cows included were 52.*

| Pathologies | n | Prevalence expressed in % |
|---|---|---|
| HHE | 38 | 73.08 |
| DD | 7 | 13.46 |
| SH | 34 | 65.39 |
| SU | 13 | 25 |
| WLH | 13 | 25 |
| WL separation | 36 | 69.23 |
| Abscess of the WL | 0 | 0 |
| IH | 1 | 1.92 |
| Hairy wart | 0 | 0 |
| Without pathology | 4 | 7.69 |

*Table 11. Intra-group prevalence of severe lesions at Farm 3. Number of cows included were 52.*

| Pathologies | n | Prevalence expressed in % |
|---|---|---|
| HHE | 6 | 11.54 |
| DD | 0 | 0 |
| SH | 6 | 11.54 |
| SU | 1 | 1.92 |
| WLH | 3 | 5.77 |

A total intra-group prevalence of lesions, as well as a total intra-group prevalence of severe lesions were also calculated. In this calculation, all cows included in the study with recorded pathologies were considered part of the same group.

*Table 12. Collective intra-group prevalence of lesions for each pathology. Total number of cows included were 122.*

| Pathologies | n | Prevalence expressed in % |
|---|---|---|
| HHE | 99 | 81.15 |
| DD | 22 | 18.03 |
| SH | 64 | 52.46 |
| SU | 28 | 22.95 |
| WLH | 30 | 24.59 |
| WL separation | 56 | 45.90 |
| Abscess of the WL | 4 | 3.28 |
| IH | 4 | 3.28 |
| Hairy wart | 1 | 0.82 |
| Without pathology | 7 | 5.74 |

*Table 13. Collective intra-group prevalence of severe lesions. Total number of cows included were 122*

| Pathologies | n | Prevalence expressed in % |
|---|---|---|
| HHE | 24 | 19.67 |
| DD | 2 | 1.64 |
| SH | 7 | 5.74 |
| SU | 6 | 4.92 |
| WLH | 5 | 4.10 |

The following two tables (Table 15 and 16) present the calculations of OR, based on the separation of pathologies into two groups (see Table 2) and two definitions of affected mobility (see table descriptions below). The study group for these calculations were the individuals with both a recorded MS and pathology-data (see Table 1). In both calculations, only a weak correlation between “Pain

expected" and affected mobility were found, with wide confidence intervals and without statistical significances.

*Table 14. 2x2 table with "Lame" specified as MS ≥2. Total number of cows included were 118.*

| | Pain expected | No pain expected |
|---|---|---|
| Lame | 6 | 7 |
| Sound | 44 | 61 |
| | | |
| OR | | 1.1883 |
| 95% CI | | 0.3735 to 3.7804 |
| p-value | | 0.7701 |

*Table 15. 2x2 table with "Imperfect mobility" specified as MS ≥1. Total number of cows included were 118.*

| | Pain expected | No pain expected |
|---|---|---|
| Imperfect mobility | 25 | 27 |
| Sound | 25 | 41 |
| | | |
| OR | | 1.5185 |
| 95% CI | | 0.7266 to 3.1735 |
| p-value | | 0.2667 |

# 5. Discussion

The aim of this study was to evaluate whether systematic locomotion assessment using the AHDB Mobility scoring system can identify dairy cows with painful claw lesions. Data were collected during routine hoof trimming on three different Swedish farms, including a total of 123 cows. Each cow was mobility scored prior to trimming, and claw lesions were subsequently diagnosed and recorded during trimming, with supporting photographic documentation. Lesions were classified based on whether they were expected to be painful according to existing literature. By comparing mobility scores with the presence of such lesions, this study sought to assess the usefulness of mobility scoring as a diagnostic tool at the individual cow level.

The prevalence of lameness (MS ≥2) was 10.84%, which is slightly higher than the recorded Swedish median prevalence of lameness of 5% (Sjöström *et al.* 2018). Since lameness is dependent on animal husbandry practices, there are farm-specific factors that come to play, and the higher prevalence could reflect the few numbers of farms included. However, the prevalence falls within the spread reported in the above-mentioned study which was 0-25%. It should also be noted that the groups studied in this article were not entire herds, but rather groups of cows which were selected for trimming, which might inflate the prevalence of lesions compared to other studies. It is thereby not necessarily inferable to the national population and can thus not be righteously compared. The distribution of claw pathologies per grade of MS (Figure 4) could suggest that a few pathologies (IH, abscess of the WL, severe SU) present in the bar constituting MS 3 would hugely contribute to a high MS. While not necessarily untrue, one should keep in mind the small amount (n=2) of cows presenting a MS of 3 in the study. The mean number of lesions per cow was an interesting statistic, as it proved that it is often impossible to reduce a cow's hoof-problems to a single pathology. This statistic is, to the best of my knowledge, not commonly presented in other literature on the subject. This statistic would come to influence further statistics calculated in this study (see further explanation below). The most common lesion in this study was HHE, with prevalences ranging from 73-93% at each farm (Tables 5, 7 and 9) and a calculated total prevalence of 81%. This differs widely from the Swedish estimated prevalence of 5.4% (Växa n.d.). The reason could be differences in farm-specific factors as mentioned before, but an even more probable cause is under-registration of HHE by hoof trimmers. Again, the prevalences are not entirely comparable due to an inherent bias, the cows included in this study were picked out by the farmer and does not necessarily reflect the entire herd.

The present study identified a wide variety of claw pathologies of different severities. The protocol for data collection was based on the Nordic Claw Atlas

(Växa 2020), which states with pictures what constitutes a mild and severe lesion for a set type of pathologies. The Nordic Claw Atlas is mainly aimed for practical use and intended for farmers and hoof trimmers, as a guideline to benefit in field diagnostics. This doesn't necessarily mean that a severe lesion, by the Nordic Claw Atlas's definition, has any implication for lameness. This would prove abundantly clear as approximately 20% of all cows included in the study had severe HHE lesions, as HHE is generally not thought to significantly, contribute to lameness (Cramer & Solano 2025b). Therefore, the present study instead attempted to classify claw pathologies into painful and not painful, based on previous research (Table 2). The reason for this rather crude separation into only two groups, is due to a general lack of knowledge regarding to what extent pathologies cause pain and virtually non-existing knowledge regarding the pathology-specific amount of pain experienced. This marks an important area for which more research is needed. It was initially envisaged to study each pathology, mild and "severe" separately to try and link the different pathologies to specific mobility scores, or at least a range of mobility scores. The data did however not permit that, as the average cow included in the study had several (approximately five) pathologies. This makes it very difficult to sort out which pathology is the major contributor to the cow's lameness, and therefore the method mentioned above was instituted.

As per the literature review, SU, DD, IH and WLD are seen as painful lesions which contribute to lameness (AABP 2006; Whay *et al.* 1998; Thomas *et al.* 2022). WLD is a broad term in the English literature and has been divided into different categories in the Nordic Claw Atlas, namely WL haemorrhage, abscess of the WL and WL separation. In this study, only abscess of the WL was included in the "Pain expected"- group. Since WLD mainly figures as WLD in English literature and not in its further subdivisions, WL haemorrhage and WL separation were instead included in the "no pain expected"-group. The reason for excluding WL haemorrhage exclusion was that other haemorrhages of the claw (i.e. SH) have been stated to not, at least significantly, cause lameness (Flower *et al.* 2005). One question that has sparked regarding these "haemorrhages" is whether they contribute to the painfulness of other pathologies. Given what we know of the pathology of SH (WL haemorrhage also included since it also involves sinking of the pedal bone), that they involve inflammation of the corium. Since inflammation is a vital element in the development of hyperalgesia, a theory could be that the hyperalgesia sparked by haemorrhages of the claw could increase pain experienced by other claw lesions, but further research is needed to explore this possibility.

The exclusion of WL separation from the "Pain expected" group was based on poor definition and the pathology only being logged as "existing/non existing" in the protocol. The definition of WL separation in this study was "any crack, fissure

or separation which disrupts the continuity of the white line". This means that any small crack within the WL as well as larger separations were logged in the same manner. This shows in the data, as approximately 46% of all cows had at least one claw which was logged as "WL separation", but not nearly as many looked capable of causing lameness. Based on these findings, it is recommended to consider defined grades of WL separation in future studies.

"Hairy wart" was also put into the "No pain expected" group. It has been shown that all M-stages of DD do increase locomotion scores, however with active/ulcerative lesions increasing the most and chronic/proliferative ones (such as hairy wart) not having as strong an association (Thomas *et al.* 2022), which was the basis for the decision to include this lesion in the "no pain expected" group. In this study, only one claw was diagnosed with hairy wart, on a sound individual (MS=0). That being said, it is ultimately impossible to be aware of the amount of pain an animal is experiencing, and this decision might need to be reconsidered in future studies.

IH was included into the "Pain expected"- group even though smaller lesions are not thought to generate a visible lameness. However, during discussion in an internal meeting it was agreed that IH often stems from other painful lesions (DD, IP) and that IH's can themselves get infected with DD/IP, which is painful. It was also concluded that bigger IH's should, if nothing else, cause notable discomfort because of their size. However, it is uncertain whether IH is painful and there is a need for further research on the area.

To calculate odds ratios, two different MS limits were used, MS ≥2 and MS ≥1, which corresponds to the labelling "Lame" and "Imperfect mobility" respectively. The labelling "Lame" was picked since AHDB themselves have defined an MS of two or above as lameness (AHDB n.d.c), as well as other articles defining MS ≥2 as lame (Logan *et al.* 2024). The decision to also calculate OR for MS ≥1 was made in order to broaden the base of animals who had an affected mobility. In the context of this study, MS was not intended for monitoring the collective herds hoof health, but as a diagnostic tool for the occurrence of claw pathologies at an individual level, for which the inclusion of all animals with an affected mobility was deemed appropriate.

The findings of an OR >1 for both lame and imperfect mobility indicates that the group "Pain expected" are more likely to be lame than "No pain expected". However, it is only a very slight indication, with wide confidence intervals and non- significant results. This indicates that using mobility scoring as a solitary diagnostic tool to detect painful claw lesions is not sufficient.

## 5.1 Limitations and considerations for further studies

On of the limitations of this study is related to the sample of individuals included. This study included cows scheduled for hoof trimmings, thereby the cause of hoof

trimming was not mainly to treat cows suffering from claw lesions, even though treatments occurred. This gives a naturally generated control group of sound cows, which is needed to infer conclusions to a wider population. What was found in calculating the OR with corresponding CI, was that not all cows who had ”Pain expected” lesions had an affected mobility, and vice versa. A possible solution to this could be to only include cows with known pathologies, to examine their correlation with MS. Apart from the obvious selection bias and no naturally generated control group, it would also exclude many of the mainly acute hoof lesions, simply because the researchers would not be aware of their existence due to their acute nature.

Another limitation is the small number of included farms. By including a larger number of farms, the distribution of claw pathologies would likely be more representative, as farm-specific “flora” of pathologies can be suspected.

The on-farm data collection would need revising prior to further attempts. The protocol used in this study used the Nordic Claw Atlas as a reference point to classify lesions as mild or severe. This gives a clear picture to the reader as to how the lesions at each cow looked visually, however, there is a need for a new definetion of what constitutes severity in terms of pain, if the data is to be compared with MS. As concluded before, this is an area in need of further research to fully understand what causes pain in the hooves of cows. The broadening of “WL separation” into mild and severe (with corresponding definitions) would be interesting, as that may come to influence the results. Regarding the data collection, one important limitation is the inherent subjectiveness both in diagnosing pathologies and mobility scoring. While the scorers received training in both areas before the on-farm visits, more objective methods which might become more available in the future could produce more consistent results.

Another on farm limitation was the pace of the hoof trimmers. Since the collected data were from scheduled hoof trimmings, the purpose of the professional hoof trimmers’ visits on the private farms were not to contribute to our study. They had a set number of cows they were going to trim that day, and their regular pace was required to meet that number. This resulted in less available time diagnosing per claw, for which the diagnostics were entirely based on photos taken post-trim of each claw. This would come to mean that signs of certain lesions could have been trimmed away (mainly haemorrhages and HHE) and others being covered by topical compounds/bandages (mainly DD and IH), potentially affecting the results. The high pace would also mean a greater number of cows needed to be herded to the crush, rendering the mobility scoring more difficult. This could be solved by hiring professional hoof trimmers for the purpose of research.

## 5.2 Conclusion

In conclusion, this study found only a weak association between impaired mobility and the presence of claw lesions expected to cause pain at the individual cow level. Although cows with such lesions tended to show higher mobility scores, the relationship was inconsistent and not statistically significant. These findings suggest that while the AHDB Mobility scoring system is valuable for herd-level monitoring, it should not be relied upon as a sole indicator of painful claw pathology at the individual level.

This study found a slight implication that individuals with at least one finding of a certain set of claw lesions, would have an impaired mobility. However, the strength of this finding is lacking, as there was a wide spread of the findings and they were not statistically significant.

# References


AHDB (n.d.a). *Common Lameness problems*. Agriculture and Horticulture Development Board. https://ahdb.org.uk/common-problems [2025-12-08]

AHDB (n.d.b). *Mobility scoring for dairy cows*. Agriculture and Horticulture Development Board. https://ahdb.org.uk/knowledge-library/mobility-scoring-for-dairy-cows [2025-10-13]

AHDB (n.d.c). *Mobility scoring: how to score your cows*. Agriculture and Horticulture Development Board. https://ahdb.org.uk/knowledge-library/mobility-scoring-how-to-score-your-cows [2025-12-04]

AABP (2006). *Interdigital Hyperplasia*. American Association of Bovine Practitioners Lameness Committee. https://www.aabp.org/committees/resources/AABP%20Interdigital%20Hyperplasia.pdf [2025-11-05]

Archer, S., Bell, N. & Huxley, J. (2010). Lameness in UK dairy cows: a review of the current status. *In Practice*, 32 (10), 492–504. https://doi.org/10.1136/inp.c6672

Bell, N. & Huxley, J. (2009). Locomotion, lameness and mobility in dairy cows. *Veterinary Record*, 164 (23), 726–726. https://doi.org/10.1136/vr.164.23.726

Bergsten, C. (2003). Causes, risk factors, and prevention of laminitis and related claw lesions. *Acta Veterinaria Scandinavica*, 44 (1), S157. https://doi.org/10.1186/1751-0147-44-S1-S157

Bonezzi, C., Fornasari, D., Cricelli, C., Magni, A. & Ventriglia, G. (2020). Not all pain is created equal: Basic definitions and diagnostic work-up. *Pain and Therapy*, 9 (1), 1–15. https://doi.org/10.1007/s40122-020-00217-w

Booth, C.J., Warnick, L.D., Gröhn, Y.T., Maizon, D.O., Guard, C.L. & Janssen, D. (2004). Effect of lameness on culling in dairy cows. *Journal of Dairy Science*, 87 (12), 4115–4122. https://doi.org/10.3168/jds.S0022-0302(04)73554-7

Cao, B., Xu, Q., Shi, Y., Zhao, R., Li, H., Zheng, J., Liu, F., Wan, Y. & Wei, B. (2024). Pathology of pain and its implications for therapeutic interventions. *Signal Transduction and Targeted Therapy*, 9 (1), 155. https://doi.org/10.1038/s41392-024-01845-w

Coetzee, J.F., Shearer, J.K., Stock, M.L., Kleinhenz, M.D. & Amstel, S.R. van (2017). An update on the assessment and management of pain associated with lameness in cattle. *Veterinary Clinics: Food Animal Practice*, 33 (2), 389–411. https://doi.org/10.1016/j.cvfa.2017.02.009

Cramer, G. & Solano, L. (2025a). *Anatomy of the Distal Limb of a Cow - Musculoskeletal System*. MSD Veterinary Manual. https://www.msdvetmanual.com/musculoskeletal-system/lameness-in-cattle/anatomy-of-the-distal-limb-of-a-cow [2025-12-08]

Cramer, G. & Solano, L. (2025b). *Lameness Originating in the Hoof in Cattle - Musculoskeletal System*. MSD Veterinary Manual.

https://www.msdvetmanual.com/musculoskeletal-system/lameness-in-cattle/lameness-originating-in-the-hoof-in-cattle [2025-12-04]

Cramer, G., Shepley, E., Knauer, W., Crooker, B.A., Wagner, S. & Caixeta, L.S. (2023). An iterative approach to the development of a sole ulcer induction model in Holstein cows. *Journal of Dairy Science*, 106 (7), 4932–4948. https://doi.org/10.3168/jds.2022-22726

Desrochers, A. & Anderson, D.E. (2001). Anatomy of the distal limb. *Veterinary Clinics of North America: Food Animal Practice*, 17 (1), 25–38. https://doi.org/10.1016/S0749-0720(15)30052-9

Döpfer, D., Koopmans, A., Meijer, F.A., Szakall, I., Schukken, Y., Klee, W., Bosma, R.B., Cornelisse, J.L., van Asten, A. & Huurne, A.A. (1997). Histological and bacteriological evaluation of digital dermatitis in cattle, with special reference to Spirochaetes and Campylobacter faecalis. *The Veterinary Record*, 140, 620–3. https://doi.org/10.1136/vr.140.24.620ee

FAWC (1993). *Report on Priorities for Animal Welfare Research and Development.* Farm Animal Welfare Council. Second edition, Ministry of Agriculture, Fisheries and Food. https://edepot.wur.nl/134980 [2025-11-06]

Flower, F.C., Sanderson, D. & Weary, D. (2005). Hoof pathologies influence kinematic measures of dairy cow gait. *Journal of Dairy Science*, 88, 3166–73. https://doi.org/10.3168/jds.S0022-0302(05)73000-9

Flower, F.C. & Weary, D.M. (2006). Effect of hoof pathologies on subjective assessments of dairy cow gait. *Journal of Dairy Science*, 89 (1), 139–146. https://doi.org/10.3168/jds.S0022-0302(06)72077-X

Garvey, M. (2022). Lameness in dairy cow herds: Disease aetiology, prevention and management. *Dairy*, 3 (1), 199–210. https://doi.org/10.3390/dairy3010016

Gernand, E., Rehbein, P., von Borstel, U.U. & König, S. (2012). Incidences of and genetic parameters for mastitis, claw disorders, and common health traits recorded in dairy cattle contract herds. *Journal of Dairy Science*, 95 (4), 2144–2156. https://doi.org/10.3168/jds.2011-4812

Guard, C. (2006). Quantification and the associated costs of lameness on today's dairies. *American Association of Bovine Practitioners Conference Proceedings*, 144–146. https://doi.org/10.21423/aabppro20064695

Hucho, T. & Levine, J.D. (2007). Signaling pathways in sensitization: Toward a nociceptor cell biology. *Neuron*, 55 (3), 365–376. https://doi.org/10.1016/j.neuron.2007.07.008

IASP (n.d.a). *Definitions of Chronic Pain Syndromes.* International Association for the Study of Pain. https://www.iasp-pain.org/advocacy/definitions-of-chronic-pain-syndromes/ [2025-12-07]

IASP (n.d.b). *Terminology*. International Association for the Study of Pain. https://www.iasp-pain.org/resources/terminology/ [2025-12-03]

Jordbruksverket (2026). *Djurvälfärdsersättning för mjölkkor*. https://jordbruksverket.se/stod/jordbruk-tradgard-och-rennaring/djur/djurvalfardsersattning-for-mjolkkor [2025-11-05]

Klitgaard, K., Strube, M.L., Isbrand, A., Jensen, T.K. & Nielsen, M.W. (2017). Microbiota analysis of an environmental slurry and its potential role as a reservoir of bovine digital dermatitis pathogens. *Applied and Environmental Microbiology*, 83 (11), e00244-17. https://doi.org/10.1128/AEM.00244-17

Kontturi, M., Junni, R., Simojoki, H., Malinen, E., Seuna, E., Klitgaard, K., Kujala-Wirth, M., Soveri, T. & Pelkonen, S. (2019). Bacterial species associated with interdigital phlegmon outbreaks in Finnish dairy herds. *BMC Veterinary Research*, 15 (1), 44. https://doi.org/10.1186/s12917-019-1788-x

Latremoliere, A. & Woolf, C.J. (2009). Central sensitization: a generator of pain hypersensitivity by central neural plasticity. *The Journal of Pain*, 10 (9), 895–926. https://doi.org/10.1016/j.jpain.2009.06.012

Lindsay, N.M., Chen, C., Gilam, G., Mackey, S. & Scherrer, G. (2021). Brain circuits for pain and its treatment. *Science Translational Medicine*, 13 (619), eabj7360. https://doi.org/10.1126/scitranslmed.abj7360

Lischer, Ch.J., Ossent, P., Räber, M. & Geyer, H. (2002). Suspensory structures and supporting tissues of the third phalanx of cows and their relevance to the development of typical sole ulcers (Rusterholz ulcers). *Veterinary Record*, 151 (23), 694–698. https://doi.org/10.1136/vr.151.23.694

Logan, F., McAloon, C.G., Ryan, E.G., O'Grady, L., Duane, M., Deane, B. & McAloon, C.I. (2024). Sensitivity and specificity of mobility scoring for the detection of foot lesions in pasture-based Irish dairy cows. *Journal of Dairy Science*, 107 (5), 3197–3206. https://doi.org/10.3168/jds.2023-23928

Manske, T., Hultgren, J. & Bergsten, C. (2002a). Prevalence and interrelationships of hoof lesions and lameness in Swedish dairy cows. *Preventive Veterinary Medicine*, 54 (3), 247–263. https://doi.org/10.1016/S0167-5877(02)00018-1

Manske, T., Hultgren, J. & Bergsten, C. (2002b). The effect of claw trimming on the hoof health of Swedish dairy cattle. *Preventive Veterinary Medicine*, 54 (2), 113–129. https://doi.org/10.1016/S0167-5877(02)00020-X

MedCalc Software Ltd. *Odds ratio*. Version 23.4.8. https://www.medcalc.org/en/calc/odds_ratio.php [2025-12-05]

Mellor, D.J. (2016). Updating animal welfare thinking: Moving beyond the "Five Freedoms" to "A Life worth Living". *Animals*, 6, 21. https://doi.org/10.3390/ani6030021

Menno Holzhauer (2021). Digital dermatitis in dairy cattle is still a serious problem in Western Europe. *Journal of Environmental Science and Engineering A*, 10 (1). https://doi.org/10.17265/2162-5298/2021.01.005

Newsome, R., Green, M.J., Bell, N.J., Chagunda, M.G.G., Mason, C.S., Rutland, C.S., Sturrock, C.J., Whay, H.R. & Huxley, J.N. (2016). Linking bone development on

the caudal aspect of the distal phalanx with lameness during life. *Journal of Dairy Science*, 99 (6), 4512–4525. https://doi.org/10.3168/jds.2015-10202

Osorio, J.S., Fraser, B.C., Graugnard, D.E., Singh, S.S., Drackley, J.K., Garrett, E.F. & Loor, J.J. (2012). Corium tissue expression of genes associated with inflammation, oxidative stress, and keratin formation in relation to lameness in dairy cows. *Journal of Dairy Science*, 95 (11), 6388–6396. https://doi.org/10.3168/jds.2011-5143

Pedersen, S. & Wilson, J. (2021). Early detection and prompt effective treatment of lameness in dairy cattle. *Livestock*, 26 (3), 115–121. https://doi.org/10.12968/live.2021.26.3.115

Persson, Y., Jansson Mörk, M., Pringle, M. & Bergsten, C. (2019). A case-series report on the use of a salicylic acid bandage as a non-antibiotic treatment for early detected, non-complicated interdigital phlegmon in dairy cows. *Animals*, 9 (4), 129. https://doi.org/10.3390/ani9040129

Peterse, D.J. (1985). Laminitis and interdigital dermatitis and heel horn erosion: A European perspective. *Veterinary Clinics of North America: Food Animal Practice*, 1 (1), 83–91. https://doi.org/10.1016/S0749-0720(15)31352-9

Robcis, R., Ferchiou, A., Berrada, M., Ndiaye, Y., Herman, N., Lhermie, G. & Raboisson, D. (2023). Cost of lameness in dairy herds: An integrated bioeconomic modeling approach. *Journal of Dairy Science*, 106 (4), 2519–2534. https://doi.org/10.3168/jds.2022-22446

Räber, M., Lischer, Ch.J., Geyer, H. & Ossent, P. (2004). The bovine digital cushion – a descriptive anatomical study. *The Veterinary Journal*, 167 (3), 258–264. https://doi.org/10.1016/S1090-0233(03)00053-4

Sanders, A.H., Shearer, J.K. & De Vries, A. (2009). Seasonal incidence of lameness and risk factors associated with thin soles, white line disease, ulcers, and sole punctures in dairy cattle. *Journal of Dairy Science*, 92 (7), 3165–3174. https://doi.org/10.3168/jds.2008-1799

Schlageter-Tello, A., Bokkers, E.A.M., Groot Koerkamp, P.W.G., Van Hertem, T., Viazzi, S., Romanini, C.E.B., Halachmi, I., Bahr, C., Berckmans, D. & Lokhorst, K. (2014a). Effect of merging levels of locomotion scores for dairy cows on intra- and interrater reliability and agreement. *Journal of Dairy Science*, 97 (9), 5533–5542. https://doi.org/10.3168/jds.2014-8129

Schlageter-Tello, A., Bokkers, E.A.M., Koerkamp, P.W.G.G., Van Hertem, T., Viazzi, S., Romanini, C.E.B., Halachmi, I., Bahr, C., Berckmans, D. & Lokhorst, K. (2014b). Manual and automatic locomotion scoring systems in dairy cows: A review. *Preventive Veterinary Medicine*, 116 (1), 12–25. https://doi.org/10.1016/j.prevetmed.2014.06.006

Shearer, J.K. & van Amstel, S.R. (2017). Pathogenesis and treatment of sole ulcers and white line disease. *Veterinary Clinics of North America: Food Animal Practice*, 33 (2), 283–300. https://doi.org/10.1016/j.cvfa.2017.03.001

Sjöström, K., Fall, N., Blanco-Penedo, I., Duval, J.E., Krieger, M. & Emanuelson, U. (2018). Lameness prevalence and risk factors in organic dairy herds in four European countries. *Livestock Science*, 208, 44–50. https://doi.org/10.1016/j.livsci.2017.12.009

Sprecher, D.J., Hostetler, D.E. & Kaneene, J.B. (1997). A lameness scoring system that uses posture and gait to predict dairy cattle reproductive performance. *Theriogenology*, 47 (6), 1179–1187. https://doi.org/10.1016/S0093-691X(97)00098-8

Tarlton, J.F., Holah, D.E., Evans, K.M., Jones, S., Pearson, G.R. & Webster, A.J.F. (2002). Biomechanical and histopathological changes in the support structures of bovine hooves around the time of first calving. *The Veterinary Journal*, 163 (2), 196–204. https://doi.org/10.1053/tvjl.2001.0651

Thomas, A.D., Orsel, K., Cortés, J.A. & Pajor, E.A. (2022). Objective determination and quantification of pain and inflammation associated with digital dermatitis in feedlot cattle. *Applied Animal Behaviour Science*, 253, 105684. https://doi.org/10.1016/j.applanim.2022.105684

Thomsen, P.T., Shearer, J.K. & Houe, H. (2023). Prevalence of lameness in dairy cows: A literature review. *The Veterinary Journal*, 295, 105975. https://doi.org/10.1016/j.tvjl.2023.105975

Thomson, C.E. & Hahn, C. (2012). *Veterinary Neuroanatomy: A Clinical Approach*. Elsevier Health Sciences.

Toussaint Raven, E. (1989). *Cattle footcare and claw trimming: the origin and prevention of the necrotising inflammations of the corium (ulcerations of the claw).* 3rd impression, with amendments. Farming Press Books.

Växa (2019). *Smittsamma/hygienrelaterade klövskador*. https://www.vxa.se/contentassets/cf68d0efa33f4443954555f786dd8a05/smittsamma---hygienrelaterade-klovskador.pdf [2025-11-05]

Växa (2020). *Nordisk klövatlas – Bilder och definitioner av klövdiagnoser.* https://indd.adobe.com/view/6a29094f-951e-489c-bec8-fa16f34be9dc [2025-12-04]

Växa (2025). *Klövhälsa*. https://www.vxa.se/radgivning-och-kurser/analysera-nulaget/analysera-djurhalsan/klov/ [2025-12-04]

Växa (n.d.). *Health statistics of dairy cattle in Sweden 2019–20*. https://www.sva.se/media/kk2fabfs/health-statistics-2019-2020-vaexa.pdf [2025-12-04]

Whay, H.R. & Shearer, J.K. (2017). The impact of lameness on welfare of the dairy cow. *Veterinary Clinics of North America: Food Animal Practice*, 33 (2), 153–164. https://doi.org/10.1016/j.cvfa.2017.02.008

Whay, H.R., Waterman, A.E., Webster, A.J.F. & O'Brien, J.K. (1998). The influence of lesion type on the duration of hyperalgesia associated with hindlimb lameness in dairy cattle. *The Veterinary Journal*, 156 (1), 23–29. https://doi.org/10.1016/S1090-0233(98)80058-0

Wilson-Welder, J.H., Alt, D.P. & Nally, J.E. (2015). Digital dermatitis in cattle: current bacterial and immunological findings. *Animals*, 5 (4), 1114–1135. https://doi.org/10.3390/ani5040400

Zoltick, A.H., Mann, S. & Coetzee, J.F. (2024). Pain pathophysiology and pharmacology of cattle: how improved understanding can enhance pain prevention, mitigation, and welfare. *Frontiers in Pain Research*, 5, 1396992. https://doi.org/10.3389/fpain.2024.1396992

# Popular science summary

Is it possible to notice painful conditions in the foot of a cow just by watching them walk? This is a question asked by quite a few researchers within the field of cattle medicine.

Lameness, or limping, is a common suffering, with about every fifth cow suffering from it. One of the major contributing factors to lameness is pain. This pain might increase with time, if the underlying cause is not treated. Apart from the discomfort and pain experienced by the cow, lameness also causes economical losses, through for example decreased milk production and slaughtering of cows due to their lameness. Most cows who are lame, are so due to conditions in their hooves.

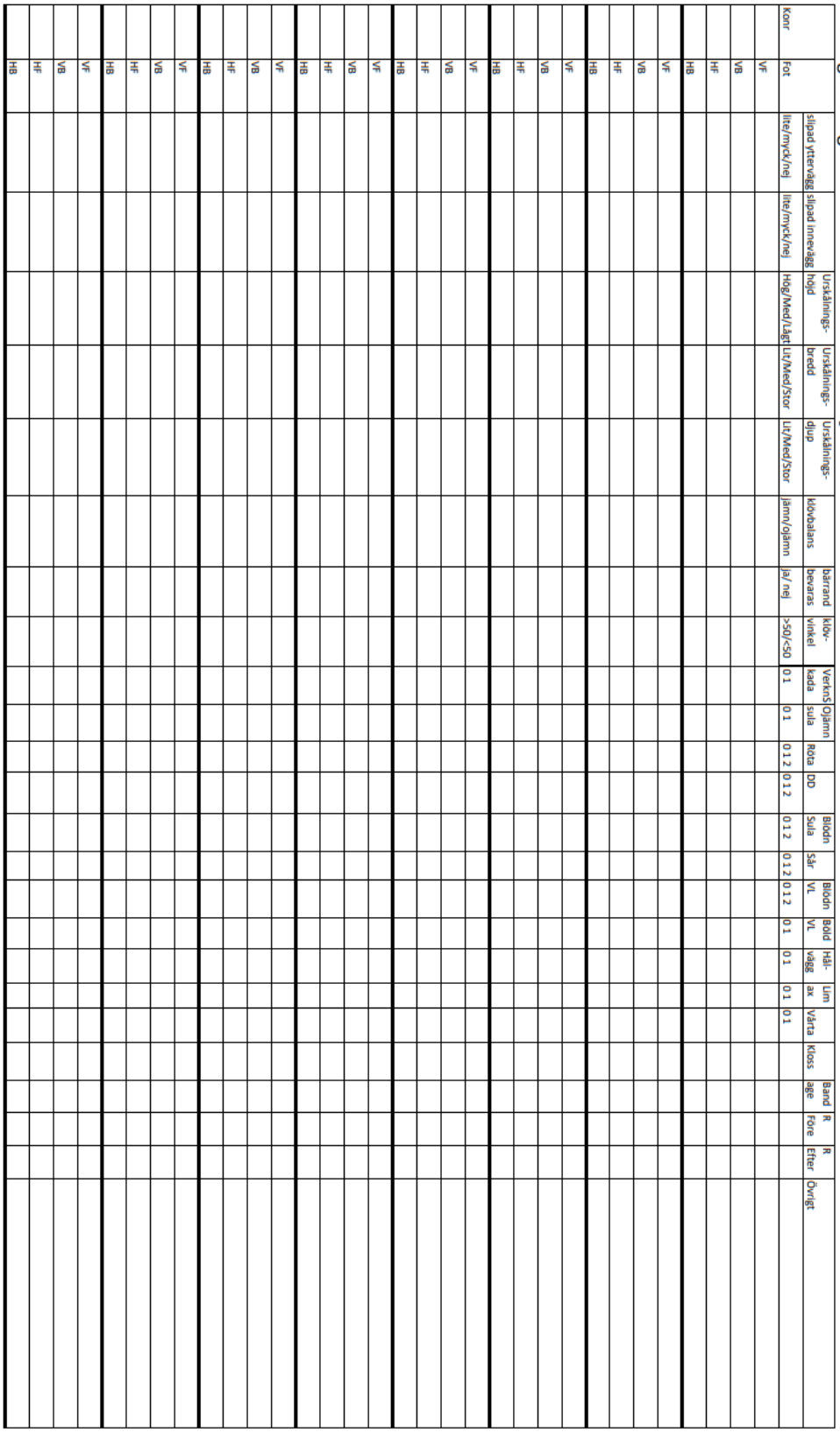
One of the simplest ways to determine whether a cow is lame or not is by observing her walking. This has sparked a wide variety of different methods and systems of assessing lameness, with one of them being the AHDB Mobility scoring system. This system classifies cows on a scale from normal movement to severely impaired mobility. The idea behind this system is practical: if a cows movement looks abnormal, her hooves should be examined and treated promptly. However, it is still unclear how well this scoring system can detect painful conditions in the hooves of cows, especially under Swedish farming conditions. This study was set out to examine whether systematic mobility scoring can detect painful conditions in the hooves of Swedish dairy cows.

The study included 123 dairy cows from three different farms in Sweden, all examined during routine hoof trimmings. Before trimming, the cows' walking patterns were assessed using the AHDB Mobility scoring system. During trimming, each hoof was examined and photographed, and any hoof lesions were diagnosed. Some hoof conditions, such as sole ulcers, digital dermatitis and white line abscesses, are known to cause pain and lameness. Other findings, like heel-horn erosion are common but usually not painful. The cows were therefore grouped based on whether they had at least one lesion that would be expected to cause pain. These findings were then compared to the cow's mobility scores to see whether painful hoof lesions were associated with impaired movement.

The findings were that hoof lesions were very common. On average, each cow had almost five lesions, showing that most cows had more than one hoof condition at the same time. The most common condition was heel-horn erosion, a condition often linked to hygiene but not necessarily to visible lameness. About 11% of the cows were classified as lame, which is slightly higher than the

Swedish average but still within the normal range. Importantly, cows with lesions expected to be painful were only slightly more likely to show impaired mobility than cows without such lesions. This association was weak and not statistically significant. In other words, some cows with painful hoof lesions did not appear clearly lame, while others with impaired mobility did not have lesions typically associated with pain. This means that only relying on mobility scoring, as a way to notice painful conditions in the feet of cows, is not good enough.

# Appendix 1



Klövregistreringar

Datum

gård

klövvårdare

| Konr | Fot | slipad yttervägg lite/mycket/nej | slipad innervägg lite/mycket/nej | Urskålnings-höjd Hög/Med/Lågt | Urskålnings-bredd Lit/Med/Stor | Urskålnings-djup Lit/Med/Stor | klövbalans jämn/ojämn | bärrand bevaras ja/ nej | klöv-vinkel >50/<50 | VerkmS kada | Ojämn sula | Röta | DD | Blödn Sula | Sår | Blödn Vl. | Böld Vl. | Hål-vägg | Lim ax | Vårta | Kloss | Band age | R. Före | R. Efter | Övrigt |
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| | HF | | | | | | | | | | | | | | | | | | | | | | | | |
| | HB | | | | | | | | | | | | | | | | | | | | | | | | |
| | VF | | | | | | | | | | | | | | | | | | | | | | | | |
| | VB | | | | | | | | | | | | | | | | | | | | | | | | |
| | HF | | | | | | | | | | | | | | | | | | | | | | | | |
| | HB | | | | | | | | | | | | | | | | | | | | | | | | |
| | VF | | | | | | | | | | | | | | | | | | | | | | | | |
| | VB | | | | | | | | | | | | | | | | | | | | | | | | |
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