**Application**

The growing dairy herd sizes as well as concerns over antimicrobial use on farms calls for early disease detection to prevent negative welfare and economic impacts. This systematic review aims to summarise what is already known about changes in social behaviour of dairy cows with disease and its potential as an early indicator of disease using automated methods in the emerging field of precision livestock farming (PLF) in agriculture.

**Introduction**

Early detection of disease in dairy farming is of major interest in animal welfare research to aid in early intervention from farmers to prevent the negative welfare and economic impacts (af Sanderberg et al., 2023). There is a growing interest in utilising social behaviour changes of dairy cows for early disease detection, using automated methods, on the basis of sickness behaviour. Sickness behaviour is an adaptive response by the individual caused by the interaction between the central nervous system and the immune system mediated by cytokines which are released upon infection/inflammation or injury (Dittrich, Gertz and Krieter, 2019). This communication between the brain and the immune system is essential to maintain survival of the individual (Dantzer and Kelley, 2007). Previous studies have shown animals are motivated to perform these sickness behaviours, for example inactivity in rats, which aids in conserving energy (Sepulveda-Varas et al., 2013). Those behaviours not critical to the immediate survival of the animal, such as social interactions (e.g displacements) or grooming are expected to change before changes in essential behaviours, as those are predicted to have a higher sensitivity to a disease challenge(Caplen and Held 2021). Not all aspects of sickness behaviour have yet been investigated completely or explained, however, some of these behaviours provide an opportunity for the early detection of sick individuals (Dittrich, Gertz and Krieter, 2019) before clinical signs of disease and the detection of subclinical conditions.

**Materials and Methods**

The objective of this systematic review was to summarise the changes in social behaviour with disease occurrence in dairy cows. The search for relevant literature was conducted following the PRISMA guidelines using two electronic databases, CAB abstracts and Web of Science, accessed between January and April 2024. The initial search yielded 1934 papers, through initial abstract and title screening, papers were included if the abstract reported social behaviour changes with disease in adult dairy cows. Review papers, those that did not compare healthy and sick individuals and papers that included an additional intervention, for example, effect of group size on behaviour without disease comparison were excluded. This resulted in 13 papers being included in this review

**Results**

All of the included studies have focused on naturally occurring cases of disease, eight studies reported a decrease in actor displacements for sick individuals and three papers reported a decrease in reactor displacements. On the other hand, four papers reported an increase in reactor displacements for sick individuals. Seven papers have utilised cameras to record social interactions while five studies used electronic feed-bins. Majority of the studies have also focused on changes in behaviour during the transition period, comparing matched healthy and sick individuals.

**Conclusions**

The reported changes show conflicting results and may be attributed to confounding factors such as regrouping, social rank, or competition for resources, although the intra-individual differences need to be considered for future research on behavioural changes with disease as well as inter-individual differences (Thomas et al., 2024). Where possible future research should consider analysing multiparous and primiparous cows separately, analyse individuals in a stable social environment, and include a variety of social interactions rather than just focusing on displacements at the feed-face. The reviewed papers raise a few important and yet unanswered questions such as, to what extent is the social behaviour of individuals impacted by the disease versus the normal daily disturbances and to what extent is the behaviour change associated with pain or the systemic response to disease. An automatic detection system that tracks individuals and identifies their behavioral events is needed and this systematic review will be used to aid in the development of automatic detection algorithms on farm using cameras for early and subclinical disease detection.

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