Relationships between multiple welfare indicators measured in individual chickens across different time periods and environments

CJ Nicol*, G Caplen, J Edgar, G Richards and WJ Browne

School of Veterinary Science, University of Bristol, Langford House, Langford BS40 5DU, UK
* Contact for correspondence and requests for reprints: c.j.nicol@bris.ac.uk

Abstract

The assessment of animal welfare requires the collection of multiple indicators of welfare but quantification of their associations in different contexts is lacking. Previous studies have examined correlations between a few indicators, but not relationships between many different indicators, or between indicators taken from the same individuals in more than one environment. We housed 60 hens for six sequential 35-day phases in different pen environments. During each phase, a series of behavioural and physiological measures was taken for every bird: body and plumage condition, surface body temperature, behaviours observed in the home pens and during test periods, tonic immobility, physiological blood profiles, and faecal sample composition. Most variation in nearly all measures was not explained by either individual bird or grouping effects but varied across phases within the birds. Acknowledging this, we examined correlations between all parameters at the phase within-bird level, selecting a conservative P-value. A consistent set of correlations showed that a slow approach response and alert behaviour in the novel object test was associated with higher bodyweight, lower body temperature and lower acute phase protein, heterophil:lymphocyte ratio and blood glucose level. A cluster analysis confirmed these correlations. Other important parameters known to be linked to the hens' environmental preference (eg comfort behaviour) were independent of the set described above. We conclude that statistical techniques can reveal patterns of independence and redundancy in the collection of behavioural and physiological measures of welfare.

Keywords: animal welfare, cluster analysis, laying hen, multi-level modelling, stress, welfare indicator

Introduction

Animal welfare science is increasingly seen as a multidisciplinary exercise. No one marker can indicate good or poor welfare (Mason & Mendl 1993) and welfare assessments are more likely to incorporate multiple markers than in the past. For example, information on physiology was obtained for only 2% of 300 laying hen flocks included in the Laywel database in 2005 (http://www.laywel.eu), whereas recent experimental studies have generally taken multiple measures of welfare, including organ weights, white blood cell ratios, plasma, faecal or egg corticosterone levels, tests of immune function and observations of behaviour (Nicol et al 2006; Barnett et al 2009; Singh et al 2009; Tactacan et al 2009; Thogerson et al 2009). The collection of multiple measures for monitoring hen welfare on farms has also become accepted practice (eg Welfare Quality, www.welfarequality.net).

If different aspects of welfare could be separated into independent, non-overlapping components (eg injury, stress response, resting comfort), and each component unambiguously measured, then just one measure would be needed to represent each component. The relative importance of the components could be weighted, and the measures combined to draw overall conclusions. In reality, though, welfare is not a combination of separate non-overlapping components. Different aspects are inter-related in complex ways (eg injury will affect resting comfort), and the underlying biological systems are hugely complex. As a precaution, scientists take many measures of each aspect of welfare (eg Rodenburg et al 2008).

This is a pragmatic approach, but one that risks potentially expensive and time-consuming redundancy in data collection (Richard et al 2007). In addition, combining non-independent measures to draw overall conclusions is difficult, especially when they do not co-vary in a consistent way. For example, Nicol et al (2006) found that hens housed in single-tier aviaries at low stocking densities had higher mortality and worse plumage condition than hens housed at higher densities, but lower percent liver weights, indicating relatively lower stress levels (eg Thaxton & Puvadolpirod 2000). It is difficult to interpret such findings without knowing whether the lack of co-variance occurs at a flock or an individual level. At a flock level, severe feather pecking could result in mortality and feather damage to a proportion of the flock, but in relatively low stress conditions for the surviving perpetrators. However, if individual