USE OF CONJOINT ANALYSIS TO WEIGHT WELFARE ASSESSMENT MEASURES FOR BROILER CHICKENS IN UK HUSBANDRY SYSTEMS

S M Haslam* and S C Kestin

Division of Farm Animal Science, School of Clinical Veterinary Science, University of Bristol, Langford, Bristol BS40 5DU, UK

* Contact for correspondence and requests for reprints: sue.haslam@bris.ac.uk

Abstract *Animal Welfare 2003, **12**: 669-675*

For the purposes of farm animal welfare assessment, Farm Assurance Schemes and enforcement of animal welfare legislation, a requirement arises for a unitary welfare score which may be the amalgamation of several animal welfare measures. In amalgamating measures, weighting to reflect the importance of the individual measures for animal welfare is desirable. A study is described in which conjoint analysis was used to collect and evaluate expert opinion to weight a number of welfare assessment measures for the importance of each to broiler welfare in UK husbandry systems. The statistically combined opinion of the experts consulted revealed the weighting factors of the welfare assessment measures selected, with respect to the importance for bird welfare, to be: 0.26 for mortality levels on the growing unit; 0.24 for the level of leg weakness; 0.16 for the level of hock burn; 0.14 for stocking density; 0.10 for enrichment provision; and, 0.10 for the level of emergency provision. Criteria for selection of welfare assessment measures for use in the field, and level of agreement between experts consulted for the study, are discussed. It is concluded that weightings of welfare assessment measures by expert opinion, using conjoint analysis, might be used in the construction of a welfare index for assessment of broiler welfare on-farm. Such an index should not be considered as a 'gold standard' for welfare measurement but as an evolving standard for welfare assessment, based on current knowledge.

Keywords: *animal welfare, broiler chicken, conjoint analysis, welfare assessment measures, welfare index*

Introduction

With increasing consumer concern for the welfare of food animals, the need for welfare assessment systems applicable to commercial situations is becoming more evident. There are a number of welfare assessment methods in use in Europe which produce a single welfare score or index, including the TGI35, implemented through legislation in Austria (Bartussek 2001), and the TGI200 used by organic organisations in Germany (Sundrum *et al* 1994). Additionally, there are a number of experimental studies that have attempted to produce a single numerical value for welfare by combining a number of welfare assessment measures (WAMs) (Bracke *et al* 2001; Horning 2001; Scott *et al* 2001). Expert opinion has been used in the determination of the relative importance to pigs of various factors affecting welfare (Bracke *et al* 2001) and there is considerable precedent for the use of expert opinion in many fields other than animal welfare, such as toxicology, epidemiology, marketing, engineering

and risk analysis (Mattison 1992; Sutmoller & Wrathall 1996). The method by which expert opinion is collected and collated varies between studies. One such method, conjoint analysis (CA), has been used to evaluate pig welfare using consumer and expert opinion (Den Ouden *et al* 1997) and to elicit patient preferences for health care in the field of human medicine (Ryan & Farrer 2000). Adaptive CA has been used to rank welfare attributes throughout the broiler production chain (Maurice *et al* 1999). Consequently, CA of expert opinion might be used to combine and prioritise WAMs to be used in a welfare assessment index.

Method

WAMs which might be used to assess bird welfare, for broilers in any UK husbandry system, were derived empirically using the Five Freedoms identified by the Farm Animal Welfare Council (FAWC) (Webster 1995). Those measures considered practically recordable during an audit, and which were likely to be accurately recorded and comparable between farms and producer groups, were identified. The relevance of these measures to bird welfare was investigated with reference to the considerable body of literature relevant to bird welfare (Kirkden *et al* 1996); the six WAMs found to be most relevant were selected to be subject to CA in this study. The levels of WAMs to be tested by CA were also derived from the relevant literature. A statistics package (SPSS Conjoint Version 8.0) was used to generate an orthogonal set of 'plan cards', each of which represented a 'virtual' broiler-growing house in terms of the six WAMs identified. Thus, each virtual house was described in terms of its stocking density, total mortality for the flock cycle, level of leg weakness and of hock burn at slaughter, and provision for emergencies and for enrichment. The levels of each measure available to the experts were: 22, 28, 34 and 40 kg m^{-2} for stocking density; 3, 5, 9 and 15% for mortality; 0, 10, 20 or 30% of birds with gait score over 2 for leg weakness; 5, 15, 25 or 35% for hock burn; and levels 1, 2, 3 or 4 for provision both for emergencies and for enrichment. The cards generated were a representative sample of all possible combinations of all WAMs, selected to meet statistical criteria such as efficiency, orthogonality and balance. A set of cards was sent to the panels of experts, accompanied by a brief summary of the relevant scientific literature which indicated current levels of each WAM in the UK national flock and instructions for completion of the questionnaire. The three groups of experts were asked to score each house from 1 (worst welfare) to 10 (best welfare), taking account of all of the levels of each of the WAMs. The groups of experts chosen were: veterinary surgeons in the United Kingdom with post-graduate qualifications in poultry medicine and production (DPMP) (12); veterinary surgeons in the United Kingdom with post-graduate qualifications in welfare science, ethics and law (DWEL) (4); and, research groups registered with the UK Poultry Research Liaison Group, other than those with a sole interest in laying birds (21). The responses were analysed using SPSS Conjoint 8.0, which uses a main effects general linear model to relate respondent scores to the importance, or utility, they assigned to each WAM. The average of the utility value assigned by all of the respondents was then calculated for each WAM to give an overall utility value for each. The consistency of scoring between cards, for each expert, was determined using Kendall's tau, which measures the strength of the linear association between two non-parametric variables (Petrie & Watson 1999). The extent of agreement between experts (concordance) was assessed using Kendall's Coefficient of Concordance (Kendall's *W*), both between all experts and between experts within each group. Kendall's *W* is a non-parametric test of the hypothesis that several related samples are from the same population and which measures the agreement of raters (SPSS 1990). Kendall's tau and Kendall's *W* range between 0 (no agreement) and 1 (complete agreement).

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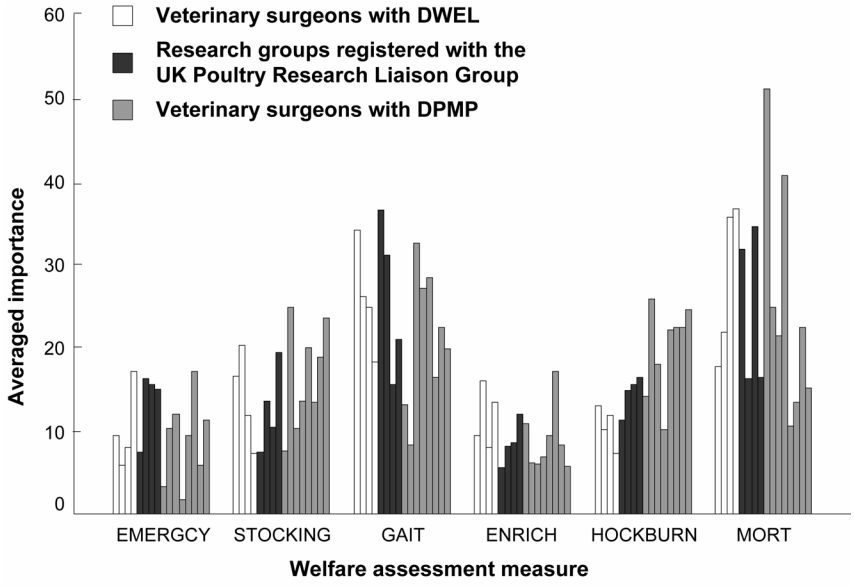
Results

Sixteen completed plan cards were returned, representing 43% of the questionnaires sent out. Three further respondents replied but considered that they did not have sufficient expertise to complete the plan cards. The importance of each WAM assigned by individual experts is illustrated in Figure 1.



EMERGCY	Level of emergency provision
STOCKING	Stocking density of the birds
GAIT	Percentage of birds with gait score of 3 or more
ENRICH	Level of enrichment provision
HOCKBURN	Percentage of birds with hockburn lesions
MORT	Percentage of birds found dead or culled during the flock cycle

Figure 1 **Importance of each WAM assigned by individual experts. DWEL, post-graduate qualification in welfare science, ethics and law; DPMP, post-graduate qualification in poultry medicine and production.**

The consistency with which all experts scored the cards for each WAM was high. The average Kendall's tau value was 0.87; the range was 0.92 to 0.67, with twelve of the sixteen having a tau value of 0.9 or above.

The coefficient of concordance between experts (0.64) was found to be moderately good but was higher between experts within each expert group (0.7, 0.77 and 0.67 for DPMP, DWEL and research workers, respectively). This may reflect the different priorities, experience and knowledge of the experts consulted.

The averages of the weightings given to each parameter are summarised in Figure 2. Thus, in the combined opinion of the experts consulted, the weighting factors of the WAMs with respect to their importance for bird welfare were: 0.26 for the mortality level on the growing unit; 0.24 for the level of leg weakness; 0.16 for the level of hock burn; 0.14 for stocking density; 0.10 for the level of enrichment provision; and, 0.10 for the level of emergency provision.

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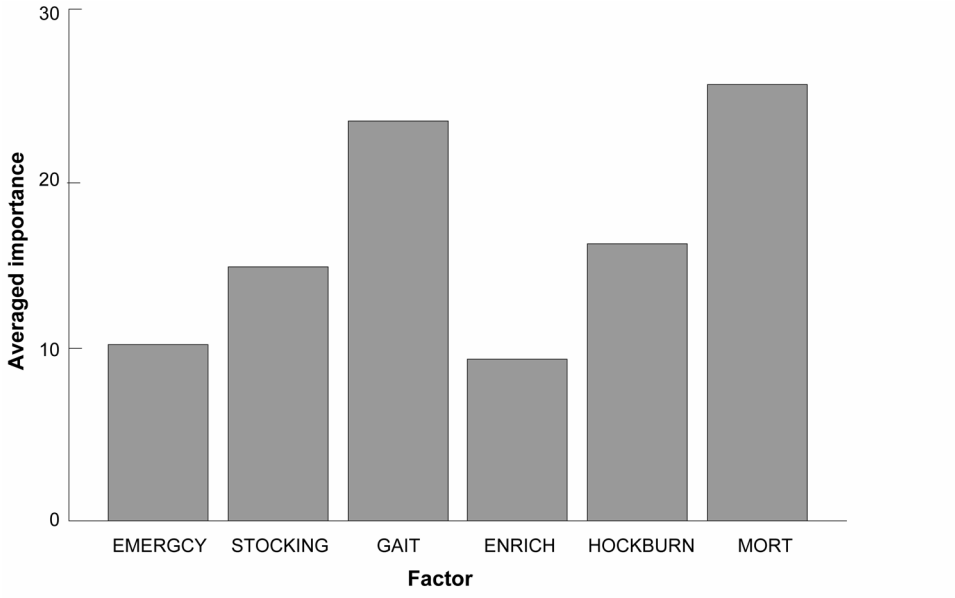

EMERGCY	Level of emergency provision	1–4
STOCKING	Stocking density of the birds	22–40 kg m^{-2}
GAIT	Percentage of birds with gait score of 3 or more	0–30%
ENRICH	Level of enrichment provision	1–4
HOCKBURN	Percentage of birds with hockburn lesions	5–35%
MORT	Percentage of birds found dead or culled during the flock cycle	3–15%

Figure 2 **Summary of importance weighting of WAMs for birds in a broiler house.**

Discussion

Selection of welfare assessment measures

In this study, WAMs were selected empirically using the framework of the Five Freedoms and selecting those that can practically be collected in a half-day audit, on any type of broiler husbandry system, and which are likely to be both accurately recorded and comparable between farms and producer groups. The importance of using measures which can "realistically be measured on farm" (Rousing *et al* 2001) and are "practicable" (Horning 2001; Johnson *et al* 2001) and which are "repeatable", "reliable" and "reproducible" have been emphasised (Alban *et al* 2001; Winckler & Willen 2001). In this study, one expert who was consulted suggested that production figures, such as daily weight gain, might be used as a WAM. However, selection for fast growth rate is related to poor welfare for many farm species (Rauw *et al* 1998). Specifically for broiler chickens, levels of leg weakness have been positively correlated with live weight gain (Kestin *et al* 1994; Sanotra *et al* 2001) and many feed restriction regimes, which reduce growth rate, have been shown to reduce levels of pulmonary hypertension syndrome (Dale 1990; Schlosberg *et al* 1991; McGovern *et al* 1999). Additionally, selection for high bodyweight in broilers has been shown to be correlated with negative immune performance in terms of lower antibody responses when challenged with

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sheep erythrocytes (Miller *et al* 1992; Quereshi & Havenstein 1994). Furthermore, broiler breeders are necessarily kept on extremely low planes of nutrition in order to remain small enough to breed successfully (FAWC 1998). For these reasons, production parameters are controversial methods of welfare assessment and, for the purposes of this study, WAMs other than those associated with fast growth rate were selected.

Independence of factors

Factors selected for use in CA are required to be independent of each other (SPSS 1997). The instructions accompanying the questionnaire therefore clearly specified the aspect of welfare to be considered for each WAM when assessing welfare in each 'virtual' house, in order to eliminate interaction between WAMs as far as possible.

Conclusions

The use of CA to capture expert opinion allows expert evaluation of welfare measures at different levels, which is not possible with traditional numerical rating methods. In using CA to collect and collate expert opinion to weight welfare measures, it is essential that each measure is defined so that it is independent of all other measures included. Clearly care needs to be taken in using results from expert opinion to weight welfare measures in amalgamated welfare assessment scores as experts may differ in their assessments, which are likely to be affected by their previous experience and priorities. However, in this study there was a good coefficient of concordance between experts both within groups and between all experts selected, so that, in the absence of other methods by which the relative importance of various welfare measures to the animal may be assessed, it may be the most reliable and coherent method currently available. In the selection of WAMs for inclusion in a welfare assessment or index, not only their relevance to bird welfare but also the practicality of taking measures in the field and the comparability of measures between houses and producer groups must be considered. Given these limitations, it is clear that any index produced by this method should be considered as an evolving standard for welfare assessment, to be modified in the light of novel scientific research, rather than as a 'gold standard' for welfare measurement. Furthermore, it is essential that any index constructed in this way is validated using alternative measures which have been shown to reflect bird welfare. In the combined opinion of the experts consulted for this study, the weighting factors of the WAMs selected, with respect to their importance for bird welfare, were: 0.26 for mortality levels on the growing unit; 0.24 for the level of leg weakness; 0.16 for the level of hock burn; 0.14 for stocking density; 0.10 for enrichment provision; and, 0.10 for the level of emergency provision.

Animal welfare implications

In the absence of the ability to "ask the birds", the relative importance of different welfare measures must necessarily be determined using experts in bird health and welfare. In this study, expert opinion has been collated using CA to weight WAMs, a technique which might be used in the construction of a welfare index for assessment of broiler welfare on-farm to give a single score. An objective and scientifically validated welfare score would facilitate comparison of welfare between farms, producer groups and husbandry systems, for the purposes of Farm Assurance Schemes, product labelling for consumers and enforcement of animal welfare legislation. Consumers would be empowered to select birds raised in higher-welfare systems, and producers with low scores would readily be able to identify and correct problem areas in order to improve bird welfare.

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