

Assessing quality of life in companion and kennelled dogs: a critical review

CJ Hewson*, EF Hiby†‡ and JWS Bradshaw†§

* CJ Hewson Limited, 74 Houblon Road, Richmond, Surrey TW10 6DE, UK

† Anthrozoology Institute, Department of Clinical Veterinary Science, University of Bristol, Langford, Bristol BS40 5DU, UK

‡ World Society for the Protection of Animals, 89 Albert Embankment, London SE1 7TP, UK

§ Correspondence: J.W.S.Bradshaw@bristol.ac.uk

Abstract

Two distinct approaches have emerged for the assessment of quality of life (QoL) and welfare in domestic dogs. One approach, which has so far been applied only to companion dogs, is derived from proxy assessment of QoL in human beings, with the owner or veterinarian acting as the proxy. Because dogs are a different species to human beings, assessment by proxy is even more challenging than when the subject being assessed is human. Our evaluation of published studies indicates that existing canine QoL instruments are imperfect, in part because of avoidable deficiencies such as failure to define QoL and using measures of health status as sole indicators of QoL. The second approach to QoL assessment, which stems from animal welfare science, is based upon objective measurement of behaviour and stress physiology, and has been applied mainly to dogs in laboratory and rescue kennels. We review these and our own recent studies, and conclude that although interpretation of signs of acute stress may be relatively straightforward, signs of chronic stress such as stereotypic behaviour require further research before they can be incorporated into QoL measures. So far, there has been little attempt to integrate proxy assessment with objective measures. We recommend that this integration would be beneficial. Fundamentally, both approaches aim to describe and quantify aspects of some inner state of well-being, and it should eventually be possible to map each on to the other.

KeyWords: animal welfare, assessment, definitions, dog, quality of life, stress

Introduction

Domestic dogs (*Canis lupus familiaris*) are widely kept in almost all human societies and may be the species most well adapted to social interaction with man (Hare & Tomasello 2005). It is therefore unsurprising that the concept of quality of life (QoL) is being extended to companion dogs and evaluated using proxy assessment, under which owners and/or attending veterinarians rate the animal's QoL on its behalf. There is still no consensus about the veterinary definition of QoL, and a review of definitions is outside the scope of this paper. Later, we outline some drawbacks of imprecise or absent definitions in the literature. There is also an older tradition of assessing the 'welfare' of stray and abandoned dogs, and recently the principles of animal welfare science, which takes objective behavioural and physiological measures as its 'proxies', have been applied to this group. This paper illustrates important aspects of QoL research in veterinary medicine, by means of a critical review of selected papers from the recent veterinary literature, and highlights some central aspects of QoL research in companion dogs. We follow this with a discussion of some approaches to the assessment of the QoL of kennelled dogs.

Recent veterinary research on the quality of life of companion dogs

Our goal here is to illustrate important procedural aspects of research into the QoL of companion dogs, by reviewing papers that describe the QoL of dogs with identified clinical conditions. To do this, we searched the Veterinary Information Network database (<http://www.vin.com>) for papers published between 2000 and July 2006. We reviewed those that were in English, that included QoL in the title or abstract, and that reported QoL in companion dogs. We excluded one paper that described how a method of assessing QoL was developed but that did not describe the QoL of a population of dogs (Wiseman-Orr *et al* 2004).

The search identified 10 papers. All concerned the QoL of dogs with medical or surgical conditions. All assessed the dogs' QoL using a human proxy. The proxy was the owner (Mellanby *et al* 2003; Snelling & Edwards 2003; Craven *et al* 2004; Yearley *et al* 2004; Freeman *et al* 2005; Wojciechowska *et al* 2005a,b; Yazbek & Fantoni 2005; Hammel *et al* 2006; Milner 2006) or the researcher (Graham *et al* 2002). Assessment was by self-administered questionnaire (Snelling & Edwards 2003; Yearley *et al*

2004; Freeman *et al* 2005; Wojciechowska *et al* 2005a; Yazbek & Fantoni 2005) or telephone questionnaire (Mellanby *et al* 2003; Craven *et al* 2004; Hammel *et al* 2006; Milner 2006), or, in one case (Graham *et al* 2002), a visual analogue scale used during examination of the dogs. Some QoL assessments were restricted to one or two global questions about the dogs' QoL (Mellanby *et al* 2003; Snelling & Edwards 2003; Craven *et al* 2004; Yearley *et al* 2004; Hammel *et al* 2006; Milner 2006). Four of the papers used more detailed questions to assess QoL (Graham *et al* 2002 — 6 questions; Freeman *et al* 2005 — 18 questions; Wojciechowska *et al* 2005a,b — 38 questions; Yazbek & Fantoni 2005 — 11 questions). Those questions concerned clinical signs related to the condition of interest and aspects of the dogs' demeanour (eg "irritability", "mood") (Graham *et al* 2002; Freeman *et al* 2005; Yazbek & Fantoni 2005). Wojciechowska *et al* (2005a,b) emphasised non-physical aspects of QoL (eg enjoyment of the company of strangers, control over access to food) and included only four questions about physical health.

Our review focusses on several criteria that we derived, in part, from existing recommendations for human QoL research (Gill & Feinstein 1994; Hagerty *et al* 2001; Michalos 2004). We describe the criteria below, together with our assessment of the papers.

Criterion 1: Was quality of life defined?

Quality of life is an abstract idea that is socially constructed and cannot be measured directly (Michalos 2004). While no universal definition of canine QoL has been agreed, we assume that most definitions would allow several specific if overlapping constituents of QoL. These constituents might be: different types of pleasure or pain, in a hedonistic definition of QoL; or different types of preferences if QoL is conceived as preference satisfaction; or, if all ethical concerns are considered in the definition, the animal's physical and mental state and the extent to which its nature is satisfied (Fraser *et al* 1997; Appleby & Sandøe 2002). Inclusion of a definition is essential in order to justify the QoL parameters that are measured, to direct methodology, and to interpret the results. Moreover, where owners rate their animals' QoL, they should be given a clear definition of QoL that is consistent with the researchers' definition. Without clear *a priori* definition, any result lacks validity because there is no way of knowing what the proxy has assessed.

Except for Wojciechowska *et al* (2005a,b), none of the papers explicitly defined QoL. The studies that used global questions did not report how or if QoL was defined in those questions. However, Craven *et al* (2004) reported that "Quality of life was defined by the owner's perception of the animal's general demeanour and well-being, ability and willingness to perform its usual daily activities, and level of interaction with the owner". Although Graham *et al* (2002) and Hammel *et al* (2006) had not defined QoL, they drew conclusions about treatment efficacy and prognosis using the QoL results.

Criterion 2: Did the authors distinguish between health status and quality of life, and between overall quality of life and health-related quality of life?

These distinctions are needed for outcome validity and scientific parsimony, as illustrated by two of the papers (Freeman *et al* 2005; Yazbek & Fantoni 2005). Freeman *et al* (2005) developed and evaluated "a questionnaire for assessing health-related QoL in dogs with cardiac disease", named the FETCH (Functional Evaluation of Cardiac Health) questionnaire. The authors did not define health-related QoL (HRQoL) and they assessed the questionnaire's criterion validity by correlating the FETCH scores with the International Small Animal Cardiac Health Council (ISACHC)'s classification of disease severity. However, it is not clear what HRQoL or QoL meant, and the authors used the terms interchangeably.

The FETCH questionnaire pertained to the extent to which the disease "impacted your dog's comfort or sociability during the last seven days by, for example, (1) Making your dog cough; and (2) Making your dog wheeze".

Neither comfort nor sociability was defined. If "comfort" may be understood to be an experience or feeling, the FETCH questionnaire suggested that HRQoL was the effect of disease severity (coughing; wheezing) on the dogs' experience or feeling. However, the ISACHC classification measures disease severity, not QoL, and is not, therefore, a suitable gold standard for any QoL measure — unless limited comfort or sociability is the same as disease severity, in which case HRQoL is a redundant term. Michalos (2004) warned against using measures of health to make statements about QoL, noting that the Sickness Impact Profile (Bergner *et al* 1981) is often used, wrongly, as a measure of QoL in human subjects.

A further difficulty with the FETCH questionnaire is that the questions are very complex: owners have to identify the extent to which cardiac disease makes their dogs cough, and then assess the extent to which that has affected comfort (undefined) or sociability (undefined). It is probable that many owners in the study (Freeman *et al* 2005) based their ratings on the extent to which the disease induced the clinical sign — an estimate of disease severity. For those owners who did estimate the effect of the signs on the dogs' "comfort or sociability", the compound nature of this part of the question and subjectivity of the owners would have reduced the validity of the data. For example, it is not clear how to rate a dog whose comfort is profoundly affected, but not its sociability.

Yazbek and Fantoni (2005) evaluated the "validity of a health-related quality of life scale for dogs with signs of pain secondary to cancer". They used QoL and HRQoL interchangeably and did not define either. However, they noted that "most QoL questionnaires incorporate at least 3 broad domains: physical, psychological, and social functioning". The HRQoL questions were typical of clinical veterinary interviews and included a global QoL question. Thus overall QoL was, apparently, a component of HRQoL.

Michalos (2004) has reviewed the pitfalls of using HRQoL and argued against its use partly because health is synonymous with some definitions of QoL. In turn, we suggest that the simplest way to assess the extent of the negative contribution of disease to dogs' QoL is to acknowledge physical health as a component of QoL, and to combine the contribution of disease-specific clinical signs to overall QoL with the contribution of other aspects of life (Michalos 2004), both subjective and objective. If other aspects of life are not included in QoL assessment, there is a danger of ignoring sources of suffering other than those associated with physical disability, and of ignoring sources of pleasure. Moreover, human research indicates that neither self-reported health nor satisfaction with health is a strong predictor of people's overall happiness, when other potential predictors are included (Michalos 2004).

Criterion 3: Did the researchers identify domains of quality of life?

The recommendation for human QoL research is that QoL instruments must gather information about all possible QoL domains, in order to provide complete information about the whole of the subject's life (Hagerty *et al* 2001). Reliance on global QoL questions ignores information about particular aspects of life and so cannot demonstrate the full extent to which treatments may or may not improve QoL.

As noted earlier, most of the papers in our review relied on global QoL questions; those papers did not identify domains within QoL or HRQoL. However, Yazbek and Fantoni (2005) reported questions that encompassed "physical state", "emotional behaviour", and "interactions with the owner". Wojciechowska *et al* (2005a,b) identified several domains of QoL, based on their definition of it, and noted that the scope of the domains needs to be elucidated by basic research.

Criterion 4: Did the researchers take account of patients' preferences regarding how much their illness caused distress or interfered with different aspects of their lives?

This point concerns the subjective element of QoL, and is essential if dogs' own experiences of their lives are to be taken into account, however incompletely. Because animals cannot speak for themselves, assessing their preferences creates particular problems. Proxy assessments cannot be said to be adequate until more research is done to identify what individual dogs' preferences are, and how well proxies can identify them. Most of the papers that we reviewed did not take explicit account of dogs' preferences. However, Yazbek and Fantoni (2005) asked "Does your dog still do what it likes?"; Freeman *et al* (2005) asked if cardiac disease limited "your dog's favourite activities due to exercise restriction?" or changed "the types of food your dog is willing to eat". Wojciechowska *et al* (2005a,b) noted that their questionnaire did not take adequate account of individual preference. They acknowledged that this was a weakness of the philosophical basis of their QoL definition.

Criterion 5: Design and statistical analysis

This criterion is not peculiar to QoL research and a detailed discussion of it is beyond the scope of this paper. The most notable point is that only three of the papers reviewed here discussed or evaluated the different kinds of validity and reliability (see Streiner & Norman [1995] for definitions). Yazbek and Fantoni (2005) evaluated "validity" (unspecified). However, that analysis provided information about the extent to which dog and owner factors might bias the outcome, but did not describe the validity of the outcome itself (Streiner & Norman 1995). Freeman *et al* (2005) used Spearman's correlation coefficient to show that the FETCH questionnaire had test-retest reliability. However, concordance statistics are a better approach for measuring reliability (Streiner & Norman 1995) because they take into account the role of chance in the similarity of repeated evaluations on the same subject. Wojciechowska *et al* (2005a,b) assessed test-retest reliability using concordance, but acknowledged that further research on construct and criterion validity was needed.

Conclusions from literature review

Our review illustrates the considerable challenges of QoL research in companion dogs. We suggest the following preliminary checklist for QoL research:

- Define your terms
- Avoid redundant terms
- Don't rely on global questions alone to assess QoL
- Take account of the animal's preferences in the most objective way possible
- Be rigorous in all aspects of design and analysis

Our final recommendation is to follow developments in the assessment of canine behaviour, learning and preferences that are being developed by animal welfare scientists. These developments have the potential to provide some objective validation of aspects of QoL. We now present aspects of these approaches in the context of assessing the QoL of kennelled dogs.

Assessing the quality of life of kennelled dogs

The complexities inherent in the use of human proxies to assess canine QoL suggest that physiological and behavioural measures, validated through the application of animal welfare science, may also be useful. Moreover, in some circumstances, such as recent arrival at a rescue centre, there may be no suitable proxies available. In a series of studies conducted in the Netherlands, Beerda and co-workers (Beerda *et al* 1997, 1998, 1999a,b, 2000) have proposed a number of physiological and behavioural indicators of both acutely and chronically suboptimal welfare in kennelled dogs. The physiological measures include heart rate, circulating catecholamines, circulating and urinary cortisol, and immune status. Behavioural measures include abnormal behaviour (stereotypies and repetitive behaviour, self-mutilation, coprophagy), behaviour indicating frustration (chewing, vocalising), conflict behaviours (body-shaking, paw-lifting), and a lowered fearful posture.

While QoL will be affected temporarily by the experience of acute stressors, it is chronic stress that will probably have the greatest impact. Interpretation of responses to chronic stress is not straightforward, since both physiological and behavioural responses characteristic of acute stress may attenuate if the stressor is continuously present (Beerda *et al* 1997). Attenuation can be caused by adaptation at various levels, including sensory input, cognitive appraisal of such input, and inhibition of responses; the adaptation in itself has the potential to be useful as an indicator of chronic stress (Beerda *et al* 1997). We now consider some behavioural and physiological indicators of QoL.

Behavioural indicators of quality of life

The domestic dog is the most diverse of the mammalian species in terms of both morphology (Wayne & Vilà 2001) and behaviour. Breed differences in reactivity to potential stressors (Svartberg 2006) and in the functionality of various signalling structures (Goodwin *et al* 1997) complicate the interpretation of behaviour as an indicator of acute stress. Furthermore, the links between behaviour and underlying emotional states may be especially difficult to unravel in the domestic dog, because of artificial selection for behavioural traits that would be maladaptive in the wild ancestor (Barnard & Hurst 1996).

The domestication of the dog has been a complex process that has resulted in many different types (herding, hunting, guarding, companion etc) with distinctive appearances and distinct behavioural repertoires. Although we can presume that the capacity to experience suffering evolved as an adaptation that was useful to the dog's wild ancestors, there is no reason to assume that selective breeding for specific behavioural traits in domestic animals has also modified emotional capacity in an adaptive way. For example, an animal could be bred to behave in a docile way even in situations in which it feels fearful. Thus selective breeding may result in the originally adaptive links between sensation, emotion and behaviour becoming dissociated, to the point where it may become difficult to predict when an individual dog might or might not be suffering (Barnard & Hurst 1996). For example, very high behavioural thresholds for pain appear to have been bred into fighting dogs, and it seems likely that other systems linked to emotional processes may have been modified as a by-product of this breeding. In herding breeds such as the collie, the internal organisation of predatory behaviour in the wolf has been modified through breeding and then training (Coppinger *et al* 1987); anecdotally, such dogs display more behaviour patterns indicative of frustration than other breeds when prevented from responding to stimuli eliciting herding behaviour. Despite the difficulties of interpreting indicators of chronic stress in dogs, noted by Beerda *et al* (1997), it is generally agreed that repetitive abnormalities of behaviour, such as self-mutilation and stereotypic behaviour, are indicative of chronic stress in the dog, although their performance may not necessarily indicate current stress (see Mason & Latham 2004).

Abnormal repetitive behaviour

Repetitive behaviours are common in dogs that have been kennelled long-term. The behaviours include circling, pacing, jumping, tail-chasing, wall bouncing, flank-sucking and paw-chewing (Hubrecht *et al* 1992). Stereotypies probably develop gradually in kennelled dogs. No such behaviour was observed in 26 dogs in the first two days after arrival in a rescue shelter (Hiby *et al* 2007), or in 30 gundogs newly housed in military kennels (Hiby 2005). However, Tyson (2005) recorded 59% of 44 dogs transferred from other kennels stereotyping on the first day after arrival at a rescue shelter. Most single-housed, kennel-bred beagles perform repetitive behaviour (eg 84% recorded by Hubrecht *et al* 1992; Beerda *et al* 2000). Hiby (2005) observed stereotypies in 46% of German shepherd dogs single-housed for two years or more.

Abnormal repetitive behaviours may not all have the same causes. For example, in parrots, stereotypies such as perch-circling and wire-chewing are triggered or exacerbated by very different factors to those that promote over-grooming (Garner *et al* 2006). The same may be true of dogs. Although spatial and social restriction are often supposed to be two of the most important causes of stereotypies in dogs, Gaines and Rooney (unpublished data 2007) found similar prevalences of stereotypies (38% and 40%, respectively) in two populations of single-housed military shepherd dogs, one kept in kennels with floor area 7.3 ± 2.5 m², and the other 18.6 ± 1.2 m²: these populations had distinctly different urinary cortisol titres (see Figure 1). Some dogs may perform repetitive behaviour only when they are aware that a person is nearby, either because they are frustrated by being unable to gain the person's attention, or because performance of repetitive behaviour is rewarded by attention. For example, in the two populations referred to, 62% of the stereotyping dogs were observed to show stereotypic behaviour only when the observer was standing in front of the kennel, and not when their behaviour was being recorded remotely by CCTV.

Although it is difficult to argue against abnormal repetitive behaviour having been originally triggered by chronic stress, it is not straightforward to determine whether the performance of a stereotypy is a direct reflection of present QoL. Repetitive behaviour might indicate the current level of frustration, but might also be performed as part of a coping strategy, or as a "behavioural scar" resulting from extensive changes in central control of behaviour (Mason 1991). Those stereotypies that are an index of frustration should mirror other indicators of poor welfare (Mason & Latham 2004) such as the cortisol:creatinine (C/C) ratio. In two military shepherd dog populations, C/C ratios tended to be higher in dogs that stereotyped when observed remotely, compared to dogs that did not, arguing against a "Do-it-yourself-enrichment" or coping function (Gaines & Rooney, unpublished data 2007). However, Tyson (2005) found that rescued dogs whose C/C ratios decreased between days 1 and 7 in the shelter were more likely to

display stereotypies on day 7 than were those dogs whose C/C ratio had increased, suggesting that some of the former dogs were using stereotypies as coping strategies.

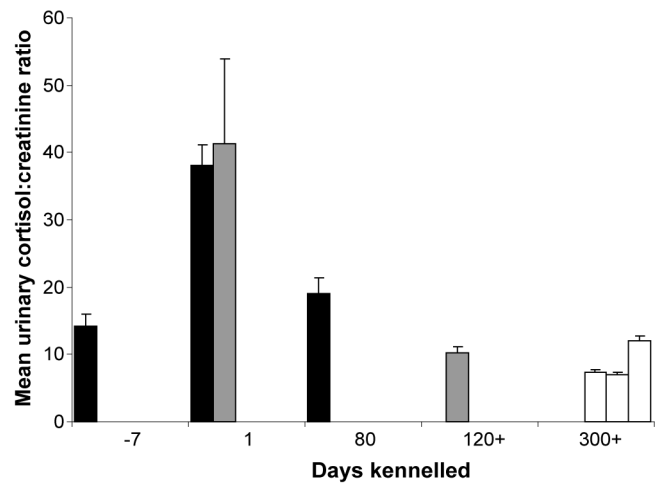
Given the diversity of behaviour and motivation evident between types and breeds of the domestic dog, it could be argued that, except when dealing with single-breed groups, physiological parameters may be more informative than behaviour. Difficulties with physiological measures are that their measurement, or the taking of samples for their measurement, can be stressful in itself, potentially confounding the information obtained (eg plasma cortisol, heart rate). However, hormones and their metabolites can be measured from urine or saliva collected as part of the dog's normal husbandry, and may eventually offer a routine method for assessing welfare in kennelled dogs in a wide variety of situations. Of the possible physiological measures, the stress hormone cortisol has received the greatest attention. Some recent advances in the interpretation of cortisol measures will now be described.

Cortisol

Cortisol, usually measured in saliva or urine to avoid the necessity to take blood samples, is the most widely used physiological indicator of welfare in dogs (eg Jones *et al* 1990; Beerda *et al* 1996; Hennessy *et al* 1997; Bergeron *et al* 2002; Kobelt *et al* 2003; Hydrbring-Sandberg *et al* 2004; Dreschel & Granger 2005) and is generally accepted as an important indicator of welfare status in many vertebrate species (Lane 2006). Cortisol increases substantially within a few hours of presumed acute stressors, such as veterinary procedures (Van Vonderen *et al* 1998) and transport (Bergeron *et al* 2002). The transition from a domestic environment to kennelling is accompanied by a rise in cortisol (Hennessy *et al* 1997), as would be expected if a change in housing were stressful. The increase is greater if the dog has no prior experience of kennelling (Hiby 2005; Hiby *et al* 2007; Rooney *et al* unpublished data 2007). This acute response may be adaptive, since Bodnariu (2005) found that dogs with C/C ratios above 50 (molar ratio $\times 10^{-6}$), one week after admission to rescue kennels, were among the fastest learners of a simple association task; although high glucocorticoid levels are often associated with impaired learning, enhancing effects have also been noted (Wolf 2003). Even such high levels, if not prolonged, may therefore not reflect a significant decrement in QoL. Instead the levels may reflect a healthy adaptive response to the new environment.

Cortisol has also been proposed to be a marker for chronic stress in dogs (Beerda *et al* 1999b, 2000). Hiby *et al* (2007) found that urinary cortisol tended to increase in dogs that had come from domestic environments during their first 10 days in rescue kennels, possibly indicating a build-up of stress caused by this unfamiliar environment. However, in two out of three populations of dogs that had been kennelled for several years, urinary cortisol levels were below those typical of dogs in domestic environments (Figure 1), possibly indicating long-term physiological down-regulation due to the restricted environment, although the differences

Figure 1



Mean urinary cortisol:creatinine (C/C) ratios (molar ratios $\times 10^{-6} \pm$ standard error) in six populations of dogs housed in military kennels, plotted against the number of days for which each had been kennelled (-7 = one week prior to kennelling). Black bars: one population of male Labrador retrievers, not habituated to kennelling (n = 15) (Rooney *et al* unpublished data 2007). Grey bars: two populations of gundog breeds, not habituated to kennelling, n = 6 (left) and n = 14 (right). White bars: three populations of German shepherds and Belgian Malinois kennelled long-term; kennel area 5.4 ± 0.0 m² (left, n = 24; Hiby 2005), 7.3 ± 2.5 m² (centre, n = 45), and 18.6 ± 1.2 m² (right, n = 47) (both Gaines & Rooney, unpublished data 2007). Assuming that the six populations of dogs are comparable, transfer to kennelling appears to cause acute stress, indicated by an approximately three-fold increase in C/C ratio, but the chronic stress caused by a year or more of kennelling in a restricted space (area < 10m²) is associated with a reduction in baseline C/C ratio compared to dogs kept in domestic premises.

observed are confounded by breed. In the third population, with C/C ratios comparable to those measured in pet dogs, kennels were larger in area than in the other two, supporting the idea that long-term spatial restriction may suppress baseline C/C ratios, as observed in pigs (Sutherland *et al* 2006). The interpretation of C/C as an indicator of QoL therefore warrants further investigation.

Animal welfare implications

Although it is unclear precisely how dogs that are experiencing chronic stress evaluate their situation, it is reasonable to assume that they are sufficiently aware for their QoL to be significantly impaired. Dogs' responses to acute short-term stressors are fairly well understood, but based on the evidence collated here, we suggest that their responses to chronic stress are complex and insufficiently well characterised at present.

Concluding remarks

This review of approaches to assessing QoL in companion and kennelled dogs indicates the complexity of the task. Objective approaches could provide a way to validate proxy approaches as well as providing information in their own

right. To our knowledge, proxy and objective approaches have not been used together, or integrated. We believe that integration of the approaches would be beneficial because both are designed to describe and quantify aspects of the otherwise unmeasurable construct that is canine QoL.

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References

- Appleby MC and Sandøe P** 2002 Philosophical debate on the nature of well-being: implications for animal welfare. *Animal Welfare* 11: 283-294
- Barnard CJ and Hurst JL** 1996 Welfare by design: the natural selection of welfare criteria. *Animal Welfare* 5: 405-433
- Beerda B, Schilder MBH, Janssen NSCRM and MEI JA** 1996 The use of saliva cortisol, urinary cortisol, and catecholamine measurements for a noninvasive assessment of stress responses in dogs. *Hormones and Behaviour* 30: 272-279
- Beerda B, Schilder MBH, Van HEEff JARAM and De Vries HW** 1997 Manifestations of chronic and acute stress in dogs. *Applied Animal Behaviour Science* 52: 307-319
- Beerda B, Schilder MBH, Van HEEff JARAM, De Vries HW and MEI JA** 1998 Behavioural, saliva cortisol and heart rate responses to different types of stimuli in dogs. *Applied Animal Behaviour Science* 58: 365-381
- Beerda B, Schilder MBH, Van HEEff JARAM, De Vries HW and MEI JA** 1999a Chronic stress in dogs subjected to social and spatial restriction. I: Behavioral responses. *Physiology & Behavior* 66: 233-242
- Beerda B, Schilder MBH, Bernadina W, Van HEEff JARAM, De Vries HW and MEI JA** 1999b Chronic stress in dogs subjected to social and spatial restriction. II: Hormonal and immunological responses. *Physiology & Behavior* 66: 243-254
- Beerda B, Schilder MBH, Van HEEff JARAM, De Vries HW and MEI JA** 2000 Behavioural and hormonal indicators of enduring environmental stress in dogs. *Animal Welfare* 9: 49-62
- BergerEn R, ScEtt SL, ÉmEnd J-P, Mercier F, CEEk NJ and Schaefer AL** 2002 Physiology and behavior of dogs during air transport. *Canadian Journal of Veterinary Research* 66: 211-216
- Bergner M, BEbbitt RA, Carter WB and GibsEn BS** 1981 The Sickness Impact Profile: development and final revision of a health status measure. *Medical Care* 19: 787-805
- BEdnariu A** 2005 *The effects of stress on cognitive abilities in kennelled dogs*. MSc thesis, Royal (Dick) School of Veterinary Studies, University of Edinburgh, UK
- CEppinger RP, Glendinning J, TErEp E, Matthay C, Sutherland M and Smith C** 1987 Degree of behavioral neoteny differentiates canid polymorphs. *Ethology* 75: 89-108
- Craven M, SimpsEn JW, Ridyard AE and Chandler ML** 2004 Canine inflammatory bowel disease: retrospective analysis of diagnosis and outcome in 80 cases (1995–2002). *Journal of Small Animal Practice* 45: 336-342
- Dreschel NA and Granger DA** 2005 Physiological and behavioural reactivity to stress in thunderstorm-phobic dogs and their caregivers. *Applied Animal Behaviour Science* 95: 153-168
- Fraser D, Weary DM, PajEr EA and Milligan BN** 1997 A scientific conception of animal welfare that reflects ethical concerns. *Animal Welfare* 6: 187-205
- Freeman LM, Rush JE and Farabaugh AE** 2005 Development and evaluation of a questionnaire for assessing health-related quality of life in dogs with cardiac disease. *Journal of the American Veterinary Medical Association* 226: 1864-1868
- Garner JP, Meehan CL, Famula TR and Mench JA** 2006 Genetic, environmental, and neighbor effects on the severity of stereotypies and feather picking in Orange-winged Amazon parrots (*Amazona amazonica*): an epidemiological study. *Applied Animal Behaviour Science* 96: 153-168
- Gill TM and Feinstein AR** 1994 A critical appraisal of the quality of quality of life measurements. *Journal of the American Medical Association* 272: 619-626
- GEEdwin D, Bradshaw JWS and Wickens SM** 1997 Paedomorphosis affects agonistic visual signals of domestic dogs. *Animal Behaviour* 53: 297-304
- Graham PA, Maskell IE, Rawlings JM, Nash AS and Markwell PJ** 2002 Influence of a high fibre diet on glycaemic control and quality of life in dogs with diabetes mellitus. *Journal of Small Animal Practice* 43: 67-73
- Hagerty MR, Cummins R, Ferriss AL, Land K, MichalEs AC, PetersEn M, Sharpe A, Sirgy J and VEgel J** 2001 Quality of life indexes for national policy: review and agenda for research. *Social Indicators Research* 55: 1-96
- Hammel SP, HETtinger HA and NEVe RE** 2006 Postoperative results of unilateral arytenoids laterilization for treatment of idiopathic laryngeal paralysis in dogs: 39 cases (1996–2002). *Journal of the American Veterinary Medical Association* 228: 1215-1220
- Hennessy MB, Davis HN, Williams MT, MellEtt C and DEuglas CW** 1997 Plasma cortisol levels of dogs at a county animal shelter. *Physiology & Behavior* 62: 485-490
- Hare B and TEMaselle M** 2005 Human-like social skills in dogs? *Trends in Cognitive Sciences* 9: 439-444
- Hiby EF** 2005 *The welfare of kennelled domestic dogs*. PhD thesis, University of Bristol, UK
- Hiby EF, REEney NJ and Bradshaw JWS** 2007 Behavioural and physiological responses of dogs entering re-homing kennels. *Physiology & Behavior* 89: 385-391
- Hubrecht RC, Serpell JA and PEEle TB** 1992 Correlates of pen size and housing conditions on the behaviour of kennelled dogs. *Applied Animal Behaviour Science* 34: 365-383
- Hydbring-Sandberg E, vEn Walter LW, Höglund K, Svartberg K, SwensEn L and FERkman B** 2004 Physiological reactions to fear provocation in dogs. *Journal of Endocrinology* 180: 439-448
- JEnes CA, Refsal KR, Lippert AC, Nachreiner RF and Schwacha MM** 1990 Changes in adrenal cortisol secretion as reflected in the urinary cortisol/creatinine ratio in dogs. *Domestic Animal Endocrinology* 7: 559-572
- KEbelt AJ, HemsWErth PH, Barnett JL and Butler KL** 2003 Sources of sampling variation in saliva cortisol in dogs. *Research in Veterinary Science* 75: 157-161
- Lane J** 2006 Can non-invasive glucocorticoid measures be used as reliable indicators of stress in animals? *Animal Welfare* 15: 331-342
- MasEn G** 1991 Stereotypies: a critical review. *Animal Behaviour* 41: 1015-1037
- MasEn GJ and Latham NR** 2004 Can't stop, won't stop: is stereotypy a reliable animal welfare indicator? *Animal Welfare* 13: S57-S69
- Mellanby RJ, Herrtage ME and DEBsEn JM** 2003 Owners' assessments of their dog's quality of life during palliative chemotherapy for lymphoma. *Journal of Small Animal Practice* 44: 100-103

- Michalos AC** 2004 Social indicators research and health-related quality of life research. *Social Indicators Research* 65: 27-72
- Milner HR** 2006 The role of surgery in the management of canine anal furunculosis. A review of the literature and a retrospective evaluation of treatment by surgical resection in 51 dogs. *New Zealand Veterinary Journal* 554: 1-9
- Snelling SR and Edwards GA** 2003 A retrospective study of unilateral arytenoids lateralisation in the treatment of laryngeal paralysis in 100 dogs (1992–2000). *Australian Veterinary Journal* 81: 464-468
- Streiner DL and Norman GR** 1995 *Health Measurement Scales: A Practical Guide to Their Development and Use* pp 104-162. Oxford University Press: Oxford, UK
- Sutherland MA, Niekamp SR, Rodriguez-Zas SL and Salak-Johnson JL** 2006 Impacts of chronic stress and social status on various physiological and performance measures in pigs of different breeds. *Journal of Animal Science* 84: 588-596
- Svartberg K** 2006 Breed-typical behaviour in dogs — historical remnants or recent constructs? *Applied Animal Behaviour Science* 96: 293-313
- Tyson EJ** 2005 *Behavioural and physiological measures of stress in dogs (Canis familiaris) in a rescue shelter*. MSc thesis, Royal (Dick) School of Veterinary Studies, University of Edinburgh, UK
- Van Vonderen IK, Kooistra HS and Rijnberk A** 1998 Influence of veterinary care on the urinary corticoid:creatinine ratio in dogs. *Journal of Veterinary Internal Medicine* 12: 431-435
- Wayne RK and Vilà C** 2001 Phylogeny and origin of the domestic dog. In: Ruvinsky A and Sampson J (eds) *The Genetics of the Dog* pp 1-13. CABI Publishing: Wallingford, UK
- Wiseman-Orr ML, Nolan AM, Reid J and Scott EM** 2004 Development of a questionnaire to measure the effects of chronic pain on health-related quality of life in dogs. *American Journal of Veterinary Research* 65: 1077-1084
- Wojciechowska JI, Hewson CJ, Stryhn H, Guy NC, Timmons V and Patronek GJ** 2005a Development of a discriminative questionnaire to assess nonphysical aspects of quality of life of dogs. *American Journal of Veterinary Research* 66: 1453-1460
- Wojciechowska JI, Hewson CJ, Stryhn H, Guy NC, Timmons V and Patronek GJ** 2005b Evaluation of a questionnaire regarding nonphysical aspects of quality of life in sick and healthy dogs. *American Journal of Veterinary Research* 66: 1461-1467
- Wolf OT** 2003 HPA axis and memory. *Best Practice & Research: Clinical Endocrinology and Metabolism* 17: 287-299
- Yazbek KV and Fantoni DT** 2005 Validity of a health-related quality of life scale for dogs with signs of pain secondary to cancer. *Journal of the American Veterinary Medical Association* 226: 1354-1358
- Yearley JH, Hancock DD and Mealey KL** 2004 Survival time, lifespan, and quality of life in dogs with idiopathic Fanconi syndrome. *Journal of the American Veterinary Medical Association* 225: 377-383