

Application of a welfare assessment tool (Shelter Quality Protocol) in 64 Italian long-term dogs' shelters: welfare hazard analysis

L Arena^{*†‡}, GV Berteselli[†], F Lombardo[†], L Candeloro[†], P Dalla Villa[†] and F De Massis[†]

[†] Istituto Zooprofilattico Sperimentale di Abruzzo e Molise 'G. Caporale', Campo Boario, 64100 Teramo, Italy

[‡] Facoltà di Medicina Veterinaria, Università di Teramo, SP18, 64100 Teramo, Italy

* Contact for correspondence: laurarena@hotmail.it

Abstract

The confined environment of the dog shelter, particularly over extensive time-periods can impact severely on welfare. Surveillance and assessment are therefore essential components of the welfare protocol. The aim of this study was to generate a descriptive analysis of a sample of Italian long-term shelters and identify potential hazards regarding the welfare of shelter dogs. This was achieved through application of the Shelter Quality Protocol (SQP) to link income/outcome variables and the inclusion of sixty-four long-term shelters in Italy. Descriptive and logistic regression analyses were conducted. Key findings showed feeding regime, type of diet and access to outdoor area to be significantly associated with inadequate body condition score (BCS). The probability of observing skin lesions was shown to be influenced by bedding inadequacy and bedding type. Limiting beds to one per dog and utilising clean bedding materials was significantly associated with a reduced probability of observing dirty/wet dogs. Protection from adverse weather conditions and inadequate bedding were significantly associated with the manifestation of polypnea. Non-existent dog training facilities, outdoor access or leash walking were all found to significantly increase the likelihood of fearful or aggressive attitudes to people. Outdoor access also, in conjunction with feeding regime, was associated with the presence of diarrhoea. The SQP proved useful in identifying welfare hazards, both as regards shelter environment and shelter management. Identification of these hazards creates the opportunity for interventions to be applied, minimising the risks and improving the welfare of long-term shelter dogs.

Keywords: animal welfare, assessment, domestic dog, hazard analysis, protocol, shelter

Introduction

Many thousands of stray and abandoned dogs are held around the world in rescue shelters (Bollen & Horowitz 2008), for a variety of reasons and in either temporary or permanent confinement (Taylor & Mills 2007).

Animal shelters should have the common goal of providing a safe and comfortable environment for homeless animals, while attempting to either re-home them or reunite them with their owners.

In Italy, as is the case in several other countries (eg Germany and Greece) or regions (eg the Catalan region of Spain), laws are in place forbidding the euthanasia of animals solely because they are without an owner. In such places shelters, thus, operate a no-kill policy (Dalla Villa *et al* 2013) which can result in dogs spending the remainder of their lives in shelters (Cannas *et al* 2014). In such circumstances, shelters must ensure adequate housing and management to meet the animals' ethological needs, guaranteeing both the highest quality of life in the case of long-term confinement, or adequate preparation to allow successful adoptions (Miller & Zawistowski 2015).

Generally speaking, confined shelter conditions, especially long term, may impact severely on the welfare of dogs (Hewson *et al* 2007).

Several factors influence the welfare of shelter dogs (Kiddie & Collins 2014, 2015; Cozzi *et al* 2016), including time spent (Wells *et al* 2002) and the human-animal interaction (Coppola *et al* 2006; Normando *et al* 2009). The main challenges include an unfamiliar housing environment, an altered daily routine, changes in feeding regime, unfamiliar sights, sounds and smells, social deprivation, presence of unfamiliar animals and humans, the absence of an attachment figure and the absence of environmental enrichment (Wells 2004; Taylor & Mills 2007). These factors can be considered stressors and animals will often seek to return to homeostasis through both physiological and behavioural responses.

When adaptation is impossible, the animals' health and welfare run the risk of being compromised (Broom 2007). Individual animals respond to stressors in different ways. Many factors act to influence animals' responses to stressors: species, age, previous experiences, health, and

Table 1 Number of shelters selected per each Italian region and regions' geographical areas.

Italian region	Geographical area	Selected shelters (n)
Abruzzi	Centre	5
Apulia	South	6
Basilicata	South	1
Calabria	South	3
Campania	South	6
Emilia-Romagna	North	7
Friuli-Venezia-Giulia	North	1
Lazio	Centre	5
Liguria	North	3
Lombardy	North	6
Marche	Centre	3
Molise	South	1
Piedmont	North	6
Sardinia	South	0
Sicily	South	2
Tuscany	Centre	4
Trentino-Alto-Adige	North	1
Umbria	Centre	2
Val d'Aosta	North	0
Veneto	North	2
Total		64

physiological status. For example, one animal may perceive a challenge/stressor as an insult to welfare while the same challenge/stressor would not be an issue for another animal, of the same species and in the same context (Broom 2001). It is therefore crucial to carry out surveillance and assessment of animal welfare for each individual dog instead of groups of dogs.

Increasingly, the scientific community is keen to provide reliable, easy-to-apply tools to assess the welfare and coping ability of dogs in confined shelter environments (Haverbeke *et al* 2015; Barnard *et al* 2016).

Istituto Zooprofilattico Sperimentale dell'Abruzzo e del Molise developed a protocol for the assessment of long-term shelter dogs, the Shelter Quality Protocol (SQP) (Barnard *et al* 2016). The SQP was designed following the criteria of reliability, validity and feasibility (Taylor & Mills 2007) in assessing the overall welfare level of shelter dogs. It is a protocol conducted via direct observation of the animal's response to its environment and identifies important aspects of the shelter environment and shelter management to assess welfare hazards (Barnard *et al* 2016). It was inspired by the approach of the Welfare Quality®

consortium (Blokhuis *et al* 2010) who based their multi-functional approach protocols (Welfare Quality® 2009) on farm animals with measures applying to four welfare principles: 'Good feeding', 'Good housing', 'Good health' and 'Appropriate behaviour.' Each principle is composed of different welfare criteria (Botreau *et al* 2009) which, in turn, include different welfare measures (Welfare Quality® 2009). Since welfare is the outcome of multifactorial effects, multiple variables need to be considered when applying the SQP (Barnard *et al* 2016). For example, the criterion 'Absence of prolonged hunger' is composed of the welfare measures: 'Body condition' and 'Feeding.' The last measure includes 'Type of diet', 'Presence of special diets' and 'Feeding regime.' Three different types of measures were included: management-based measures (MBMs), resource-based measures (RBMs) and animal-based measures (ABMs).

The use of ABMs (or outcomes) is weighted more heavily to estimate the actual welfare status of the animals in terms of their behaviour, health or physical condition. Such measures have inherent advantages over MBM measures and RBMs (or income factors); whilst these are more objective and repeatable, they only indicate a risk of welfare problems rather than provide an actual measure of welfare (Rousing *et al* 2000). Nevertheless, some RBMs and MBMs were maintained because they provide valuable information which complements the ABMs. Identifying a link between incomes and outcomes can provide objective, scientific evidence of the predictive capacity of specific welfare measures, by delivering a cross-sectional epidemiological approach. Moreover, the interaction between incomes and outcomes allows exploration of a welfare hazard analysis (European Food Safety Authority [EFSA] 2012).

The SQP provides three different assessment levels: measures taken at shelter level — all MBMs; and measures taken at pen level — both RBMs and ABMs which were assessed observing a random sample of pens and all animals confined therein. Special attention was focused on the measures taken at the individual level, all ABMs, assessed through observation of a sub-sample of dogs housed in the pre-selected sample of pens. These shed light on the expression of individual dogs' responses to shelter challenges.

Although the protocol has proven to be valid, reliable and practical (Barnard *et al* 2016), a number of modifications were deemed necessary for improvement when feedback from training courses, seminars and conferences was considered, following its on-field application.

During an earlier study, the first version of the SQP was revised and a number of modifications generated.

Moreover, its reliability was confirmed through an inter-observer agreement between two different assessors evaluating a sample of ten long-term dogs' shelters. This agreement was evaluated using the Cohen's Kappa and a general good agreement was achieved by the two assessors, ranging from substantial (0.61–0.80) to almost perfect (0.81–0.99): body condition $k = 0.83$; lameness $k = 0.82$; skin condition $k = 0.84$; shelter from wind $k = 0.93$; safety of bedding $k = 0.64$ (Berteselli *et al* 2019).

The refined version of SQP was used for the present study which aimed to apply this latest version of the SQP in a representative sample of 64 Italian shelters. A descriptive analysis of the assessment results from shelters allowed exploration of the variation of measures across the shelters. Additionally, we analysed the hazard characterisation for the welfare of long-term sheltered dogs, ie the relationship between incomes and outcomes.

Materials and methods

Shelter selection, sample size and operative procedures for animal welfare assessment

A convenience sample of 64 Italian shelters were assessed using the SQP. Shelters were selected from 18 of Italy's 20 regions. The number of shelters studied per region was determined by the overall number of shelters per region (Table 1). This information was provided by the Italian Ministry of Health (http://www.salute.gov.it/portale/temi/p2_6.jsp?lingua=italiano&id=3093&area=cani&menu=abbandono). No shelters were assessed in Valle d'Aosta as a result of the low numbers of facilities in this region (one shelter) or Sardinia because of logistical constraints (distance).

All dog shelter managers were contacted by telephone by one investigator. Shelter selection was determined via the following inclusion criteria: (i) the facility was a long-term rescue centre containing at least 30 long-term residents at the time of contact; and (ii) availability to participate in the study. The assessments were carried out between January and September 2016 and the assessor was a veterinarian with specialisation in applied ethology and animal welfare as well as experience in applying the SQP.

Prior to conducting the SQP assessment, the study aims and practical procedures were communicated to the shelter manager and the number of dogs held at the facility noted. Hospitalised dogs were not included in the assessment and not considered in calculations of sample size.

Three levels of assessment (shelter, pen, individual) were carried out and a sample of pens and dogs selected for each level.

The sample size of dogs to be assessed at individual level, within each shelter, varied according to the numbers per shelter (see Table 2). Dogs were only included in the study if they were: (i) over six months of age; and (ii) resident in the shelter for two months or more. A maximum of three dogs per pen were randomly selected. The number of pens included in the sample was determined by the overall number of dogs in the shelter and pen type (single, pair or multiple housing pens). Pens selection reflected the different facilities in the shelter.

Firstly, MBMs were recorded at the shelter level (eg shelter demographics, feeding, dog exercise routine etc). Secondly, to conduct the SQP at pen level, the assessor stood in front of the pen, 2 m from the fence with no animal interaction (unless required by the protocol). The assessor then recorded the measures at pen level in the following order: (i) RBMs; and (ii) ABMs. Examples of RBMs are: space

Table 2 Number of dogs to be included in the sample size in relation to the number of dogs housed in the shelters.

Total number of housed dogs	Number of animals to assess
30–59	30
60–89	40
90–139	50
140+	60

allowance, bedding adequacy (presence of bedding, number per dog, cleanliness and safety) and presence of sharp edges or dangerous protuberances within the pen/along the fence. Examples of ABMs recorded at pen level include the presence of dogs coughing and diarrhoea within the pen. Diarrhoea is determined by the presence of liquid/mild faeces and/or dogs observed with faeces on the fur/perineal area. Thirdly, the individual ABMs were recorded (eg dog cleanliness and BCS). Among the ABMs, a short behavioural test was carried out to assess the dogs' reaction to unfamiliar people. The test was divided into two parts in order to record dogs' reactions. In the first step, the assessor approached the outer barrier, standing at the front and paying no attention to the dog for 30 s. In the second, the assessor crouched and spoke gently to the dog for 30 s.

Behaviour towards other dogs is not assessed in this protocol since the presence of an unknown observer could influence the behavioural assessment of kennelled working dogs (Gaines *et al* 2007). The behaviour of dogs towards their pen-mates and subsequent evaluation, may be influenced by feelings of happiness, curiosity, frustration, fear or aggressivity brought on by the presence of the unknown person. For this reason, the behaviour of shelter dogs toward conspecifics has previously been assessed using shelter employees familiar with their dogs (Goold & Newberry 2017). Dog behaviour towards conspecifics could be evaluated specifically (Valsecchi *et al* 2011), but the tests are beyond our methodology and study remit.

Finally, once the reaction to unfamiliar people had been assessed, the assessor recorded dogs' emotional state, pen-by-pen, via an Emotional State Profile sheet. The assessment was over when the last pen had been assessed.

Table 3 summarises the protocol structure, the different measures and the level of assessment. For more detailed procedures, see Shelter Quality Protocol (De Massis 2017).

Statistical analysis

A descriptive analysis was designated to explore the variation of measures across shelters. Prevalence of ABMs, mean percentages and ranges of RBMs and MBMs were calculated. An exploratory univariate analysis was performed to evaluate the association between income/outcome variables (MBMs and RBMs with ABMs) and between individual ABMs (ie lameness with BCS and age). This was included in logistic regression models (by setting a liberal P -value ≤ 0.5).

Table 3 Shelter Quality Protocol measures associated with welfare principles and criteria.

Principle	Welfare criteria	Welfare measure (type)	Level of assessment
Good feeding	Absence of prolonged hunger	Body condition score (ABM)	Individual
		Feeding (MBM)	Shelter
	Absence of prolonged thirst	Water supply (RBM)	Pen
Good housing	Comfort around resting	Bedding (RBM)	Pen
		Sharp edges (RBM)	Pen
		Cleanliness of animals (ABM)	Individual
	Thermal comfort	Thermoregulation (ABM)	Pen
		Shelter from adverse weather conditions (RBM)	Pen
Ease of movement	Space allowance (RBM)	Pen	
Good health	Absence of injuries	Skin condition (ABM)	Individual
		Lameness	Individual
	Absence of disease	Evidence of pain (ABM)	Pen
		Signs of diarrhoea (ABM)	Pen
		Coughing (ABM)	Pen
	Absence of pain induced by management procedures	Mortality (MBM)	Shelter
		Surgeries and control pain (MBM)	Shelter
Appropriate behaviour	Expression of social behaviours	Social housing (MBM)	Shelter
	Expression of other behaviours	Abnormal behaviour (ABM)	Pen
		Barking (ABM)	Pen
		Exercise (MBM)	Shelter
	Good human-animal relationship	Reaction to human (ABM)	Individual
		Training and rehabilitation (MBM)	Shelter
	Positive emotional state	Emotional state (ABM)	Pen

Type of measures defined in brackets: management-based measure (MBM); resources-based measure (RBM); animal-based measures (ABM). Measures were assessed according to three differing levels of assessment: the shelter (evaluate the shelter as a unit and all the animals within); the pen (evaluate the pen as a unit, taking into account all the dogs housed in the pen); the individual (evaluate each animal as a unit).

Logistic regression was performed for all measures with a significant χ^2 test result for relatedness, in addition to those income-outcome associations which are of note and previously been explored in the literature (Hewson *et al* 2007; Kiddie & Collins 2015; Miller & Zawistowski 2015; Barnard *et al* 2016).

Nine outcome measures (ABMs) were therefore included in this analysis as dependent variables; the measures of BCS and reaction toward people were divided and analysed as separate variables (too thin and too heavy BCS and fearful and aggressive reaction).

Since logistic regression analyses require dichotomous variables, the scorings were coded as: coat cleanliness (0-clean/1-dirty/wet), skin condition (1-presence/0-absence of skin issues), body condition too heavy (1-Y/0-N), body condition too thin (1-Y/0-N), signs of diarrhoea (1-Y/0-N), lameness (1-Y/0-N), presence of repetitive-compulsive behaviours (1-Y/0-N), signs of panting (1-Y/0-N) and shivering (1-Y/0-N), aggressive reaction toward humans (1-Y/0-N) and fearful reaction toward humans (1-Y/0-N). Each was associated with multiple income factors as independent variables (RBMs and MBMs). Statistical analyses were carried out using R V.2.15.3.

Table 4 Number of dogs' entries (first entry and return after adoptions) and exits (adoptions and returns to owners), their prevalence, ranges and percentage of unavailable data for 2015.

Factor	Percentage of shelters with unavailable data	Dogs (n; %)	Mean dogs per shelter	Number of dogs (range)
Income	7.8% (5 shelters)	9,096	154	0–567
Return to owners	51.5% (33 shelters)	2,463	79	0–425
Adoptions	7.8% (5 shelters)	5,019 (55% of incomes)	85	5–240
Return to the shelter after adoption	12.5% (8 shelters)	187 (3.7% of adopted dogs)	3	0–26

The percentage of dogs returned to shelters after an adoption was formulated using the number of adopted dogs, however the percentage is possibly under- or over-estimated because not all the shelters provided the required information. The % of adoptions was calculated using the total number of incomes. It was not possible to calculate the % of dogs returned to the owner using the number of admissions because of the great gap between the number of respondents.

Table 5 Number, mean number, range and prevalence of natural deaths and euthanasia (both for clinical and behavioural problems) in relation to the shelter population in 2015 and percentage of unavailable data for the same year.

Factor	Percentage of shelters with unavailable data	Dogs (n; %)	Mean dogs per shelter	Number of dogs (range)
Shelter population	3% (2 shelters)	10,602	171	21–950
Euthanasia for health reasons	3% (2 shelters)	276 (2.6%)	4	0–45
Euthanasia for behavioural reasons	1.5% (1 shelter)	8 (0.08%)	0.1	0–5
Natural deaths	3% (2 shelters)	742 (7%)	12	0–116

Results

Descriptive analysis

At shelter level

Sixty-four shelters participated voluntarily in this study. The shelters were managed by animal protection associations (n = 38), municipalities (n = 14) and private managers (n = 12). The total number of dogs in the study shelters (n = 64) was 11,409 (mean 178 dogs per shelter, min 22, max 980), housed in 4,316 different pens (mean 69 pens per shelter, min 12, max 378). Pen types included: 31% single-housing pens (total 1,352, mean 22, min 0, max 113), 32% paired pens (total 1,385, mean 22, min 0, max 164), 24% multiple ≤ 5 (total 1,057, mean 17, min 0, max 224), and 12% multiple > 5 (total 522, mean 8, min 0, max 162).

The number of dogs entering and departing the shelter, as registered by the manager, during the previous year (2015) is shown in Table 4.

Shelter mortality rates, due to natural deaths or euthanasia (both for health problems in the case of seriously ill or incurable dogs and behavioural problems, proven dangerous dogs; Italian Law 281 1991), are reported in Table 5.

Dogs had access to outdoor fenced areas: daily in 73.5% of shelters, weekly in 10.9% of them and no/irregular access in 15.6%.

All shelter dogs were walked on a leash: daily in 26.5% of the shelters, weekly in 25% of them and not at all/irregularly in 48.5% of shelters.

Dog trainers were present in 63.5% of shelters and 46% had at least one behavioural rehabilitation specialist for problematic dogs.

Reported data on the MBM feeding can be seen in Table 6.

In relation to the measure 'surgeries and control of pain', 81.2% of shelters had hospital pens. The percentage of shelters with standardised operating procedures for post-surgical monitoring and protocols of analgesia were, respectively, 90.6 and 84.4%.

At pen level

For this study, a total of 1,482 pens were assessed (mean 23, min 8, max 48 pens assessed per shelter).

Table 7 reports data on the adequacy of the RBMs recorded at pen level in terms of space allowance, presence of sharp edges, bedding, drinkers and shelter from adverse weather conditions.

ABM measures were also assessed at pen level (see Table 3). In 3.5% of the pens, dogs expressed active repetitive behaviours and other compulsive behaviours. Signs of diarrhoea were observed in 5.4% of the assessed pens. The prevalence of pens with at least one dog showing coughing and evidence of pain was 1.1 and 2.6%, respectively. Panting and shivering/huddling were observed, respectively, in 7.4 and 0.2% of dogs housed in the assessed pens and in 10.8 and 0.6% of pens.

At individual level

For the purposes of the present study, a total number of 2,864 dogs were assessed individually.

Table 6 Prevalence of shelter in relation to diet type, presence of special diets and feeding regimen.

		Mean (% of shelters)
Type of diet	Dry pelleted	53.2
	Wet/canned	43.8
	Cooked	1.5
	Mixed food	1.5
Presence of special diet	For puppies	90.6
	For hospitalised	76.5
	For geriatric	67.2
Feeding regimen	Once a day	56.2
	Twice a day	26.6
	<i>Ad libitum</i>	17.2

Table 7 Mean prevalence and ranges of recorded resource-based measures at pen level.

	Mean (% pens)	Range (%)
Adequate space allowance	89.5	5.1–100
Presence of sharp edges	15	0–100
Adequate bedding	72.4	0–100
Safe bedding	82.9	8.3–100
Presence of at least one bed per dog	81.5	0–100
Clean/dry bedding	88	3.4–100
Adequate drinkers	95.5	58.2–100
Working drinkers	99	83.7–100
Safe drinkers	98.8	87.4–100
Clean water	96.9	30–100
Adequate shelter from adverse weather conditions	89.5	68–100
Shelter from excessive exposure to the sun	96.3	0–100
Shelter from strong wind	97.3	60–100
Shelter from rain	92.6	0–100
Air circulation	99.7	94.7–100

Among these, the prevalence of adults (from 3 to 6 years) was 53.8%, young dogs (up to 3 years) 10.6% and geriatric (greater than or equal to 7 years of age) 35.6%.

Most dogs presented an adequate body condition (91%), the remainder were either too thin (4.2%) or too fat (4.8%). Regarding animal cleanliness, 83.1% were determined to be dry/clean.

The prevalence of observed dogs with lesions was 7.7%. Among these, 50% showed wounds, 26.3% alopecia, 17.9%

swelling and 5.8% multiple skin lesions. The prevalence of dogs with ectoparasites was 1.7%. The prevalence of dogs with lameness was 4%. After carrying out a brief test to assess the reaction toward humans, the 66.2% of dogs showing a sociable reaction or no signs of fear or aggression were recorded. The remainder consisted of dogs showing fear (23.2%) and aggression (10.6%), both offensive and defensive aggression.

Statistical analysis and welfare hazard identification

The logistic regression analysis highlighted the relationship between various welfare outcomes (ABMs set as dependent variables) and a series of predictors (RBMs and MBMs set as independent variables). Relationships between the ABMs was also investigated (eg BCS and lameness). This analysis was performed for those measures that showed a significantly related result for the χ^2 test and for various other associations which revealed no statistical significance in order to check previously published results (Hewson *et al* 2007; Kiddie & Collins 2015; Miller & Zawistowski 2015; Barnard *et al* 2016).

Inadequate bedding materials and shelter from adverse weather conditions were both predictors for the presence of animals panting ($P < 0.001$).

The likelihood of recording signs of diarrhoea increased when dogs were fed once per day ($P < 0.01$) or *ad libitum* ($P < 0.05$). Also, no/irregular exercise in an outdoor fenced area was a predictor of a high incidence of diarrhoea ($P < 0.05$).

No association between RBMs and MBMs with active repetitive behaviours emerged.

When analysing the BCS of animals, results showed there to be a significantly greater probability of observing a dog with too thin a body condition when dogs were only given access to an external fenced area weekly ($P < 0.001$) and a statistical tendency when dogs were not lead-walked or walked irregularly by shelter personnel ($P = 0.05$). Diet type can also be considered a predictor of too thin a BCS, especially when animals were fed a canned/wet diet ($P < 0.001$) and mixed food ($P < 0.05$). Feeding cooked food was associated with a high probability of observing dogs with too heavy a BCS ($P < 0.0001$). *Ad libitum* feeding was positively correlated with too heavy a BCS ($P < 0.05$) whereas there was a low probability of observing too heavy a BCS when feeding took place once a day ($P < 0.01$).

Too thin a BCS was related to a high incidence of lameness ($P < 0.0001$).

When analysing the presence of lameness, geriatric age class was found to be a predictive variable ($P < 0.0001$).

Quality and type of bedding were predictors of skin condition. In particular, there was a greater probability of observing dogs with poor skin condition ($P < 0.01$) when bedding was inadequate, whereas there was a lower probability when a basket was provided as opposed to other types of bedding material ($P < 0.01$).

The analysis of dog cleanliness showed there to be a significant probability of finding dogs with a dirty/wet coat when insufficient bedding was present per dog ($P < 0.05$) and when bedding was dirty/wet ($P < 0.0001$).

Level of exercise was a predictor for abnormal reaction toward humans: when dogs were denied access to outdoor fenced areas or afforded access only sporadically, there was a greater probability of observing aggressive responses ($P < 0.01$). Absence of personnel for dog training was also related to the presence of fearful reactions ($P < 0.01$). The presence of young dogs significantly decreased the probability of observing various forms of aggression toward humans ($P < 0.01$).

Regression coefficients and P -values from the regression models are reported in Table 8 (see supplementary material to papers published in *Animal Welfare*: <https://www.ufaw.org.uk/the-ufaw-journal/supplementary-material>).

Discussion

To our knowledge, this is the first prevalence study of data collected from long-term, Italian shelters and dog welfare involving a large number of facilities and animals throughout the country.

Our findings suggest that, generally speaking, welfare in the tested shelters was sub-optimal. This is of significance since, in Italy, shelters host large numbers of dogs. There is, therefore, a need to address ways in which welfare might be improved when financial resources are stretched to the extent that only allows for very basic animal husbandry.

On average, this study found the rate of adoption to be lower than the rate of entry to shelters. Additionally, a large number of facilities here were unable to provide data on entry and exit rates of dogs. This should be considered a red flag since the principal aim of shelters should be to achieve a high number of successful adoptions.

The consensus is that exercise and walking are crucial for the health and welfare of dogs and is of particular importance to shelter dogs (Bauman *et al* 2001; Kiddie & Collins 2015) since they may suffer social as well as sensory deprivation (Morgan & Tromborg 2007; Taylor & Mills 2007). However, only 26% of the shelters assessed had a daily dog-walking routine and 75% allowed their dogs to spend time in an outdoor fenced area each day. Activity with dogs, such as walking on a leash, is also important for human-dog interaction; it may increase the quality of life for shelter dogs, and increase the probability of adoption (Braun 2011; Menor-Campos *et al* 2011). Social enrichment is beneficial in helping dogs cope with the shelter environment (Valsecchi *et al* 2007; Kiddie & Collins 2015) and this is supported by our findings here, which showed absent or irregular exercise in outdoor fenced areas to be associated with greater prevalence of aggressive dogs. Our results are in accordance with those of other studies which showed a relationship between increased dog age and greater risk of aggression (Bennett & Rohlf 2007; Casey *et al* 2014). Aggressive dogs show a lower probability of being adopted and a greater probability of returning to the shelter due to failed adoption (Mondelli *et al* 2004; Shore 2005; Gates *et al* 2018). However, since aggressive dogs have a greater likelihood of spending many years in the shelter, perhaps even their entire life, this high incidence of aggressiveness

among adult or geriatric dogs may be related to this factor and not be an issue of dog age *per se*.

We found a correlation between absence of outdoor exercise in a fenced area and diarrhoea which, since stress has an association with diarrhoea (Simpson 1998; Bybee *et al* 2011; Kelley *et al* 2012), may provide an indication of elevated stress levels in these dogs.

Dogs are highly social and isolation is one of the most important stressors in the shelter environment (Miller & Zawistowski 2015). A number of studies have suggested that pair and group housing can improve animal welfare since it encourages social, locomotor and exploratory behaviours through a more stimulating environment (Mertens & Ushelm 1996; Petak 2013; Grigg *et al* 2017). Nevertheless, this study found that housing of dogs in single pens was common among Italian facilities. In a shelter, isolation is only recommended as a solution for clinical or behavioural issues (eg to prevent the transmission of infectious diseases or aggressive events between pen-mates).

Fifty-six percent of the shelters operated a 'once a day' and 17.2% operated an '*ad libitum*' feeding regime. Both regimes are sub-optimal for the health and welfare of dogs. Bland and colleagues (2009) found that obese household dogs tended to be more often fed both 'once daily' and '*ad libitum*', while Robertson (2003) and Barnard *et al* (2016) found a relationship between obesity and 'once a day' feeding. Results, here, from the logistic regression support these findings. Moreover, both these feeding regimes were related to the presence of diarrhoea. This finding warrants further investigation.

Mixed, canned and cooked food appears to be associated with above or below average bodyweight. Stavisky *et al* (2011) showed a cooked diet to be significantly associated with a greater risk of diarrhoea, although this was not a finding of the present study. Here, a cooked diet was linked with too heavy a BCS in shelter dogs, which may be a result of an imbalanced diet. Dry pellets seem to improve dogs' quality of life as they cover nutritional needs better than other diets (Kiddie & Collins 2015).

In our study, 69% of pens contained pairs or groups of dogs. When coupled with '*ad libitum*' feeding, this can lead to conflict and feed monopolisation, which can generate high levels of stress (Miller & Zawistowski 2015).

Lameness was associated with an inadequate BCS. Obesity is a risk factor for the outbreak of lameness, in particular for osteoarthritis, in dogs. Although the relationship between obesity and osteoarthritis in dogs is unclear (Marshall *et al* 2010), excessive bodyweight may cause additional mechanical stress on joints, thus promoting their degeneration and resulting in osteoarthritis (Kealy *et al* 1997). On the other hand, too thin a BCS, may result in loss of muscle mass and lameness-induced activity reduction.

Regarding shelter facilities, certain deficiencies were highlighted. For example, 20% of shelters had no hospital pens which are fundamental for the biosecurity and welfare of injured/sick dogs (Miller & Zawistowski 2015).

At the pen level, structural resources were also inadequate. However, in contrast to previous findings (Barnard *et al* 2016), no relationship was found between inadequate provision of space and welfare parameters. Nonetheless, space adequacy is an important parameter to consider in legislative frameworks for shelters, as adequate space allowance promotes generalised activity and species-typical behaviours, such as exploratory behaviours (Hetts *et al* 1992; Hubrecht *et al* 1992; Normando *et al* 2014).

Twenty-eight percent of the shelters in our study had inadequate bedding which is a risk factor for the presence of polypnea, skin conditions (presence of lesions with adequacy and type of bedding) and dog cleanliness (dirty/wet coat with number of bedding and bedding cleanliness). In addition to being a health concern, dogs with dirty and wet coats may be unattractive to adopters, resulting in increased periods of stay for shelter dogs (Cannas *et al* 2014; Barnard *et al* 2016). Since sheltered dogs spend much of their time resting or sleeping in the pen, bedding type and quality should always be taken into consideration in relation to their welfare (Normando *et al* 2014). Our study suggests that baskets are the best bedding type, as they are associated with a low prevalence of skin lesions. Kennels for sleeping have been provided to improve dog pens (Hubrecht *et al* 1992; Berteselli *et al* 2019), and these may also make the dog feel more secure and be used for play. Polyethylene bedding may increase dog welfare as it is durable, waterproof, easy to clean, warm and comfortable (Eisele 2001).

The presence of polypnea was also related to pen installations which did not provide adequate shelter from adverse weather. Maintaining an acceptable body temperature is essential for animal welfare and shelters must ensure all their dogs are provided with adequate thermal comfort throughout the year. Extreme shelter weather conditions, such as low or high temperature, can result in increased stress hormones (Miller & Zawistoski 2015).

Behavioural measures have been used to assess welfare of shelter dogs (Wells *et al* 2002; Dalla Villa *et al* 2013; Kiddie & Collins 2014). The shelter environment tends to generate or exacerbate behavioural problems, such as fear, hyperactivity, excessive barking, aggression and repetitive behaviours (Wells & Hepper 2000; Diesel *et al* 2008).

In our study, the prevalence of pens with dogs expressing active repetitive behaviours and other compulsive behaviours was higher (3.5% above the total of pens' observations, ie 3.5% hosted at least one dog expressing active repetitive behaviours or other compulsive behaviours) than was observed by Barnard *et al* (2016) which was less than 1%. Repetitive behaviours develop in situations where an animal may be frustrated, stressed, fearful, restrained or lacking stimulation and higher incidences are usually seen in environments where other indicators of poor welfare also occur (Mason 1991). However, they may be a coping mechanism (Mason & Latham 2004) and should never be used as the only measure of welfare, especially at the population level (Mason 1991; Mason & Latham 2004). Although we found no significant relationships, the welfare hazard analysis — the SQP — does provide a means to assess of these behaviours.

Fear reactions and aggression towards humans are the main undesirable behaviours reported by adopters and represent a breakdown in communication between dogs and humans (Wells & Hepper 2000; Barrera *et al* 2010). Their presence may be the result of stress in the shelter environment (Hennessy *et al* 1997; Hiby *et al* 2006; Barrera *et al* 2010) and dogs showing fear or aggression may have reduced chances for adoption and therefore be more likely to remain in shelters (Barnard *et al* 2016). In our study, most of the assessed dogs (66% of observations) were sociable when approached by a stranger.

Health measures recorded at the individual level were generally high in our study, although lameness was significantly related to age (geriatric dogs). Geriatric dogs, also experience other health problems (Pati *et al* 2015) and the probability of adoption decreases significantly with age (Lepper *et al* 2002; Normando *et al* 2006; Sietou *et al* 2014; Žák *et al* 2015). Older subjects are also more likely to be returned following adoption (Mondelli *et al* 2004) and are at greater risk of euthanasia (Brown *et al* 2013). However, in no-kill dog shelters these animals can spend the rest of their life kennelled. The SQP has the potential to explore ways to improve the health and welfare of older dogs and compare them to other age categories.

Animal welfare implications and conclusion

The Shelter Quality Protocol (SQP) is an innovative quantitative approach to companion animal welfare assessment, particularly for long-term sheltered dogs. The SQP identifies possible hazards and thereby also has the potential to improve shelter management and environment. The score obtained by the application of SQP can also provide important information to potential owners regarding the quality of dogs' lives and the level of welfare which shelters provide. Our study highlights the great variability that exists among long-term dog shelters in Italy where, in some instances, the standard of welfare is poor.

The SQP could also be applied to commercial breeding facilities or other situations in which dogs are confined (eg military or working dogs). Finally, the SQP could be an important tool for Competent Authorities, NGOs and shelter managers.

Acknowledgements

This study is part of a project (IZSAM 04/13 RC) financed by the Italian Ministry of Health, co-ordinated by the Istituto Zooprofilattico Sperimentale dell'Abruzzo e del Molise 'G. Caporale' (Teramo, Italy). The authors extend their thanks to all the experts involved in the project for their scientific and valuable contribution, and to Fabio Bellucci, David Brunetti, Anna Cestaro, Alessandro Guerrini, Vincenzo Mizzone and Chiara Tarantino for their participation in the dogs' welfare assessment for Campania, Lazio and Tuscany shelters; to Enzo Ruggieri for his help in data collection. Special thanks also go to ADICA Onlus, ANIMARE Onlus, ANTA Onlus, APACA Onlus, APPA Onlus, ARPAD, BIOS Onlus, Dog Village Animal Protection Association, ENPA and Other Italian Animals Onlus. Last but not least, thanks to all the shelter managers and staff who volunteered so enthusiastically to open their facilities.

References

- Barnard S, Padenera C, Candeloro L, Ferri N, Velarde and Dalla Villa P** 2016 Development of a new welfare assessment protocol for practical application in long-term dog shelters. *Veterinary Record* 178: 18. <http://dx.doi.org/10.1136/vr.103336>
- Barrera G, Jakovcevic A, Elgier AM, Mustaca A and Bentosela M** 2010 Responses of shelter and pet dogs to an unknown human. *Journal of Veterinary Behavior: Clinical Application and Research* 5: 339-344. <https://doi.org/10.1016/j.jveb.2010.08.012>
- Bauman AE, Russell SJ, Furber SE and Dobson AJ** 2001 The epidemiology of dog walking: an unmet need for human and canine health. *Medical Journal of Australia* 175. <https://doi.org/10.1097/00005768-200105001-01332>
- Bennett PC and Rohlf VI** 2007. Owner-companion dog interactions: Relationships between demographic variables, potentially problematic behaviours, training engagement and shared activities. *Applied Animal Behaviour Science* 102(1): 65-84. <https://doi.org/10.1016/j.applanim.2006.03.009>
- Berteselli G, Arena L, Candeloro L, Dalla Villa P and De Massis F** 2019 Inter-observer agreement and sensitivity to climatic conditions in sheltered dogs' welfare evaluation performed with welfare assessment protocol (Shelter Quality Protocol). *Journal of Veterinary Behavior: Clinical Applications and Research* 29: 45-52. <https://doi.org/10.1016/j.jveb.2018.09.003>
- Bland IM, Guthrie-Jones A, Taylor RD and Hill J** 2009 Dog obesity: owner attitudes and behavior. *Preventive Veterinary Medicine* 92: 333-340. <https://doi.org/10.1016/j.prevetmed.2009.08.016>
- Blokhuis HJ, Veissier I, Miele M and Jones RB** 2010 The Welfare Quality® project and beyond: safeguarding farm animal well-being. *Acta Agriculturae Scandinavica Animal Science* 6: 129-140. <https://doi.org/10.1080/09064702.2010.523480>
- Bollen KS and Horowitz J** 2008 Behavioral evaluation and demographic information in the assessment of aggressiveness in shelter dogs. *Applied Animal Behaviour Science* 112: 120-135. <http://dx.doi.org/10.1016/j.applanim.2007.07.007>
- Botreau R, Veissier I and Perny P** 2009 Overall assessment of animal welfare: strategy adopted in Welfare Quality®. *Animal Welfare* 18: 363-370
- Braun G** 2011 Taking a shelter dog for walks as an important step in the resocialization process. *Journal of Veterinary Behavior: Clinical Applications and Research* 6: 100. <https://doi.org/10.1016/j.jveb.2010.08.004>
- Broom DM** 2001 Coping, stress and welfare. In: Broom DM (ed) *Coping with Challenge: Welfare in Animals including Humans* pp 1-9. Dahlem University Press: Berlin, Germany
- Broom DM** 2007 Welfare in relation to feelings, stress and health. *REDVET. Revista Electrónica de Veterinaria VIII, 12b*
- Brown WP, Davidson JP and Zuefle ME** 2013 Effects of phenotypic characteristics on the length of stay of dogs at two no kill animal shelters. *Journal of Applied Animal Welfare Science* 16: 2-18. <https://doi.org/10.1080/10888705.2013.740967>
- Bybee SN, Scorza AV and Lappin MR** 2011 Effect of the probiotic *Enterococcus faecium* SF68 on presence of diarrhea in cats and dogs housed in an animal shelter. *Journal of Veterinary Internal Medicine* 25: 856-860. <http://dx.doi.org/10.1111/j.1939-1676.2011.0738.x>
- Cannas S, Rampini F, Levi D, Dalla Costa E, Talamonti Z, Minero M and Palestrini** 2014 Shelter dogs and their destiny a retrospective analysis to identify predictive factors: a pilot study. *Macedonian Veterinary Review* 37: 151-156. <http://dx.doi.org/10.14432/j.macvetrev.2014.07.018>
- Casey RA, Loftus B, Bolster C, Richards GJ and Blackwell EJ** 2014 Human-directed aggression in domestic dogs (*Canis familiaris*): Occurrence in different contexts and risk factors. *Applied Animal Behaviour Science* 152: 52-63. <http://dx.doi.org/10.1016/j.applanim.2013.12.003>
- Coppola CL, Grandin T and Enns RM** 2006 Human interaction and cortisol: can human contact reduce stress for shelter dogs? *Physiology & Behavior* 87: 537-541. <http://dx.doi.org/10.1016/j.physbeh.2005.12.001>
- Cozzi A, Mariti C, Ogi A, Sighieri C and Gazzano A** 2016 Behavioral modification in sheltered dogs. *Dog Behavior* 2(3): 1-12
- Dalla Villa P, Barnard S, Di Fede E, Podaliri M, Candeloro L, Di Nardo A, Siracusa C and Serpell JA** 2013 Behavioural and physiological responses of shelter dogs to long-term confinement. *Veterinaria Italiana* 49: 231-241. <http://dx.doi.org/10.12834/VetIt.2013.492.231.241>
- De Massis F, Arena L, Berteselli GV, Ferri N, Lombardo F, Messori S and Dalla Villa P** 2017 *Shelter Quality Protocol*. http://www.izs.it/IZS/Engine/RAServeFile.php/f/pdf_publicazioni/ProtocolloShelterQuality_EN_rev2410
- Diesel G, Pfeiffer DU and Brodbelt D** 2008 Factors affecting the success of rehoming dogs in the UK during 2005. *Preventive Veterinary Medicine* 84: 228-241. <https://doi.org/10.1016/j.prevetmed.2007.12.004>
- EFSA** 2012 EFSA Panel on Animal Health and Welfare (AHAW). Statement on the use of animal-based measures to assess the welfare of animals. *EFSA Journal* 10(6): 2767-2795. <https://doi.org/10.2903/j.efsa.2012.2767>
- Eisele PH** 2001 A practical dog bed for environmental enrichment for geriatric beagles with applications for puppies and other small dogs. *Contemporary Topics in Laboratory Animal Science* 40: 36-38
- Gaines SA, Rooney NJ and Bradshaw JWS** 2007 The effects of the presence of an observer, and time of day, on welfare indicators for working police dogs. *Animal Welfare* 16: 169
- Gates CM, Sarah Zito S, Thomas J and Dale A** 2018 Post-adoption problem behaviours in adolescent and adult dogs rehomed through a New Zealand animal shelter. *Animals (Basel)* 8(6): 93. <https://doi.org/10.3390/ani8060093>
- Goold C and Newberry R C** 2017 Aggressiveness as a latent personality trait of domestic dogs: Testing local independence and measurement invariance. *PLoS ONE* 12(8): e0183595. <https://doi.org/10.1371/journal.pone.0183595>
- Grigg EK, Nibblett BM, Robinson JQ and Smits JE** 2017 Evaluating pair versus solitary housing in kennelled domestic dogs (*Canis familiaris*) using behaviour and hair cortisol: a pilot study. *Veterinary Record Open* 4: e000193. <http://dx.doi.org/10.1136/vetreco-2016-000193>
- Haverbeke A, Pluijmakers J and Diederich C** 2015 Behavioral evaluations of shelter dogs: literature review, perspectives, and follow-up within the European member states' legislation with emphasis on the Belgian situation. *Journal of Veterinary Behavior: Clinical Applications and Research* 10: 5-11. <http://dx.doi.org/10.1016/j.jveb.2014.07.004>

- Hennessy M, Williams M, Mellott C and Douglas C** 1997 Plasma cortisol levels of dogs at a county animal shelter. *Physiology & Behavior* 62: 485-490. [https://doi.org/10.1016/S0031-9384\(97\)80328-9](https://doi.org/10.1016/S0031-9384(97)80328-9)
- Hetts S, Clark JD, Calpin JP, Arnold CE and Mateo JM** 1992 Influence of housing conditions on beagle behaviour. *Applied Animal Behaviour Science* 34: 137-155. [http://dx.doi.org/10.1016/S0168-1591\(05\)80063-2](http://dx.doi.org/10.1016/S0168-1591(05)80063-2)
- Hewson CJ, Hiby EF and Bradshaw JWS** 2007 Assessing quality of life in companion and kennelled dogs: a critical review. *Animal Welfare* 16: 89-95
- Hiby EF, Rooney NJ and Bradshaw JWS** 2006 Behavioural and physiological responses of dogs entering re-homing kennels. *Physiology & Behavior* 89: 385-391. <http://dx.doi.org/10.1016/j.physbeh.2006.07.012>
- Hubrecht RC, Serpell JA and Poole TB** 1992 Correlates of pen size and housing conditions on the behaviour of kennelled dogs. *Applied Animal Behaviour Science* 34: 365-383. [https://doi.org/10.1016/S0168-1591\(05\)80096-6](https://doi.org/10.1016/S0168-1591(05)80096-6)
- Italian Law 281** 1991 Legge Quadro in materia d'affezione e prevenzione al randagismo. *Gazzetta Ufficiale*, n 203, 30 agosto 1991. http://www.salute.gov.it/imgs/C_17_normativa_911_allegato.pdf. [Title translation: Italian national framework on companion animals and prevention of stray dogs]
- Kealy RD, Lawler DF, Ballam JM, Lust G, Smith GK, Biery DN and Olsson S** 1997 Five-year longitudinal study on limited food consumption and development of osteoarthritis in coxofemoral joints of dogs. *Journal of the American Veterinary Medical Association* 210: 222-225
- Kelley R, Levy K, Mundell P and Hayek MG** 2012 Effects of varying doses of a probiotic supplement fed to healthy dogs undergoing kenneling stress. *International Journal of Applied Research in Veterinary Medicine* 10: 205-216
- Kiddie JL and Collins LM** 2014 Development and validation of a quality of life assessment tool for use in kennelled dogs (*Canis familiaris*). *Applied Animal Behaviour Science* 158: 57-68. <http://dx.doi.org/10.1016/j.applanim.2014.05.008>
- Kiddie JL and Collins LM** 2015 Identifying environmental and management factors that may be associated with the quality of life of kennelled dogs (*Canis familiaris*). *Applied Animal Behaviour Science* 167: 43-55. <http://dx.doi.org/10.1016/j.applanim.2015.03.007>
- Lepper M, Kass PH and Hart LA** 2002 Prediction of adoption versus euthanasia among dogs and cats in a California animal shelter. *Journal of Applied Animal Welfare Science* 5: 29-42. https://doi.org/10.1207/S15327604JAWS0501_3
- Marshall WG, Hazewinkel HA, Mullen D, De Meyer G, Baert K and Carmichael S** 2010 The effect of weight loss on lameness in obese dogs with osteoarthritis. *Veterinary Research Communications* 34: 241-253. <http://dx.doi.org/10.1007/s11259-010-9348-7>
- Mason GJ** 1991 Stereotypies: a critical review. *Animal Behaviour* 41: 1015-1037. [https://doi.org/10.1016/S0003-3472\(05\)80640-2](https://doi.org/10.1016/S0003-3472(05)80640-2)
- Mason GJ and Latham NR** 2004 Can't stop, won't stop: is stereotypy a reliable animal welfare indicator? *Animal Welfare* 13: 57-69
- Menor-Campos DJ, Molleda-Carbonell JM and López-Rodríguez R** 2011 Effects of exercise and human contact on animal welfare in a dog shelter. *Veterinary Record* 169: 388. <http://dx.doi.org/10.1136/vr.d4757>
- Mertens PA and Unshelm J** 1996 Effects of group and individual housing on the behavior of kennelled dogs in animal shelters. *Anthrozoös* 9: 40-51. <https://doi.org/10.2752/089279396787001662>
- Miller L and Zawistowski S** 2015 Housing, husbandry and behavior of dogs in animal shelters. In: Weiss E, Mohan-Gibbons H and Zawistowski S (eds) *Animal Behavior for Shelter Veterinarians and Staff* pp 145-159. Wiley Blackwell: New Jersey, USA. <https://doi.org/10.1002/9781119421313.ch7>
- Mondelli F, Prato Previde E, Verga M, Levi D, Magistrelli S and Valsecchi P** 2004 The bond that never developed: Adoption and relinquishment of dogs in a rescue shelter. *Journal of Applied Animal Welfare Science* 7: 253-266. https://doi.org/10.1207/s15327604jaws0704_3
- Morgan KN and Tromborg CT** 2007 Sources of stress in captivity. *Applied Animal Behaviour Science* 102: 262-302. <https://doi.org/10.1016/j.applanim.2006.05.032>
- Normando S, Contiero B, Marchesini G and Ricci R** 2014 Effects of space allowance on the behaviour of long-term housed shelter dogs. *Behavioural Process* 103: 306-314. <https://doi.org/10.1016/j.beproc.2014.01.015>
- Normando S, Corain L, Salvadorretti M, Meers L and Valsecchi P** 2009 Effects of an enhanced human interaction program on shelter dogs' behaviour analysed using a novel nonparametric test. *Applied Animal Behaviour Science* 116: 211-219. <http://dx.doi.org/10.1016/j.applanim.2008.10.005>
- Normando S, Stefanini C, Meers L, Adamelli S, Coultis D and Bono G** 2006 Some factors influencing adoption of sheltered dogs. *Anthrozoös* 19: 211-224. <https://doi.org/10.2752/089279306785415556>
- Pati S, Panda, SK, Acharya AP, Senapati S, Behera M and Behera SS** 2015 Evaluation of geriatric changes in dogs. *Veterinary World* 8(3): 273-278. <http://dx.doi.org/10.14202/vet-world.2015.273-278>
- Petak I** 2013 Communication patterns within a group of shelter dogs and implications for their welfare. *Journal of Applied Animal Welfare Science* 16(2): 118-139. <https://doi.org/10.1080/10888705.2013.741001>
- Robertson ID** 2003 The association of exercise, diet and other factors with owner-perceived obesity in privately owned dogs from metropolitan Perth, WA. *Preventive Veterinary Medicine* 58: 75-83. [https://doi.org/10.1016/S0167-5877\(03\)00009-6](https://doi.org/10.1016/S0167-5877(03)00009-6)
- Rousing T, Bonde M and Sørensen JT** 2000 Indicators for the assessment of animal welfare in a dairy cattle herd with a cubicle housing system. In: Blokhuis HJ, Ekkel ED and Wechsler B (eds) *Improving Health and Welfare in Animal Production* pp 45-52. Wageningen Publications: Wageningen, The Netherlands
- Shore ES** 2005 Returning a recently adopted companion animal: adopters' reasons for and reactions to the failed adoption experience. *Journal of Applied Animal Welfare Science* 8(3): 187-198. http://dx.doi.org/10.1207/s15327604jaws0803_3
- Sietou C, Fraser IM and Fraser RW** 2014 Investigating some of the factors that influence 'consumer' choice when adopting a shelter dog in the United Kingdom. *Journal of Applied Animal Welfare Science* 17: 136-147. <https://doi.org/10.1080/10888705.2014.883924>

- Stavisky J, Radford AD, Gaskell R, Dawson S, German A, Parsons B, Clegg S, Newman J and Pinchbeck G** 2011 A case-control study of pathogen and lifestyle risk factors for diarrhoea in dogs. *Preventive Veterinary Medicine* 99: 185-192. <http://dx.doi.org/10.1016/j.prevetmed.2011.02.009>
- Taylor KD and Mills DS** 2007 The effects of the kennel environment on canine welfare: a critical review of experimental studies. *Animal Welfare* 16: 435-447
- Valsecchi P, Barnard S, Stefanini C and Normando S** 2011 Temperament test for re-homed dogs validated through direct behavioral observation in shelter and home environment. *Journal of Veterinary Behavior: Clinical Applications and Research* 6(3): 161-177. <https://doi.org/10.1016/j.jveb.2011.01.002>
- Valsecchi P, Pattacini O, Beretta V, Bertozzi J, Zannoni S, Viggiani R and Accorsi PA** 2007 Effects of a human social enrichment program on behavior and welfare of sheltered dogs. *Journal of Veterinary Behavior: Clinical Applications and Research* 2: 88-89. <https://doi.org/10.1016/j.jveb.2007.04.017>
- Welfare Quality®** 2009 *Welfare Quality® assessment protocol for pigs (sows and piglets, growing and finishing pigs)*. Welfare Quality® Consortium: Lelystad, The Netherlands
- Wells DL** 2004 A review of environmental enrichment of kennelled dogs (*Canis familiaris*). *Applied Animal Behaviour Science* 85: 307-317. <http://dx.doi.org/10.1016/j.applanim.2003.11.005>
- Wells DL, Graham L and Hepper PG** 2002 The influence of length of time in a rescue shelter on the behaviour of kennelled dogs. *Animal Welfare* 11: 317-325
- Wells DL and Hepper PG** 2000 Prevalence of behaviour problems reported by owners of dogs purchased from an animal rescue shelter. *Applied Animal Behaviour Science* 69: 55-65 [http://dx.doi.org/10.1016/S0168-1591\(00\)00118-0](http://dx.doi.org/10.1016/S0168-1591(00)00118-0)
- Žák J, Voslárová E, Vecerek V and Bedánová I** 2015 Sex, age and size as factors affecting the length of stay of dogs in Czech shelters. *Acta Veterinaria Brno* 84: 407-413. <https://doi.org/10.2754/avb201584040407>