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ANIMAL WELFARE SCIENCE UPDATE

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The aim of the animal welfare science update is to keep you informed of developments in animal welfare science relating to the work of the RSPCA. The update provides summaries of the most relevant scientific papers and reports received by the RSPCA Australia office in the past quarter. **Click** here **to subscribe.**

COMPANION ANIMALS

Friendlier cats have shorter stays in shelters

The length of stay (LOS) of cats in rescue shelters varies depending on a variety of factors. Understanding and addressing these factors may improve animal welfare by increasing adoption rates and reducing LOS.

This study examined how perceptions of cat behaviour (as a proxy for socialisation) affected LOS in shelter cats of different ages. Staff at 343 United States shelters were invited to participate and 31 responded. Shelter staff were asked to classify the behaviour of the 25 most recently adopted cats from their shelter. Cats were omitted from the analyses if other factors, such as health conditions, could have affected LOS. A total of 645 cats were included in the final analyses. Cats were grouped into three behavioural categories: interactive, approachable or unapproachable. Interactive cats approached people at initial meeting, vocalised, played and accepted contact and handling. Approachable cats did not solicit contact but did not move away. Unapproachable cats hid or moved away preventing contact.

The mean LOS varied significantly between behavioural categories. On average, cats classified as unapproachable spent three times as long in the shelter compared to interactive cats. Mean LOS of interactive cats was 36.9 days, 50.8 days for approachable cats and 118.7 days for unapproachable cats. While LOS increased for older approachable and unapproachable cats, age had no effect on the LOS of interactive cats. While behavioural categorisation may have been inconsistent between different shelter staff and the authors acknowledge their sampling may not be representative, the results suggest that behavioural modification could decrease LOS.

Brown WP, Stephan VL (2021) The influence of degree of socialisation and age on length of stay of shelter cats. Journal of Applied Animal Welfare Science 24(3):238-245.
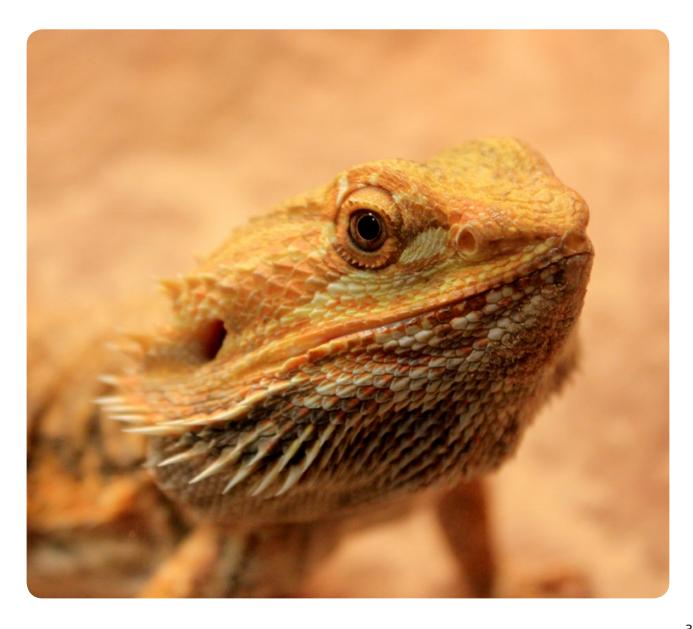
Love your lizard – the emotional attachment to pet reptiles

Reptiles are popular pets but commonly suffer as the result of poor husbandry, poor nutrition, poor health and high mortality. It has been suggested that owners' lack of emotional attachment to pet reptiles may be the underlying cause of these animal welfare issues. The assumption is that highly attached owners provide better care and resources to their pets whereas less attached owners provide less care and fewer resources.

This study aimed to investigate the extent of reptile owners' emotional attachment to their pet lizards, snakes and tortoises. A Lexington Attachment to Pets Scale (LAPS) survey was conducted online. Participants were asked to rate each item on a scale ranging from 'strongly agree' to 'strongly disagree'. Survey participants who answered at least 80% of the items were included in the analyses (n=2381). The majority of participants (n=1859) had both pet dog(s) and reptile(s) and completed LAPS on both.

The study found evidence that owners feel emotionally attached to their pet reptiles, particularly lizards. The authors suggest lizards were rated higher than tortoises and snakes possibly due to lizards' 'cute' facial features or greater interaction between owners and lizards. Of the participants who had both dog(s) and reptile(s), owners were more emotionally attached to their dogs. While the online survey participants may not be representative, this study suggests that poor welfare in pet reptiles is not necessarily the result of lack of emotional attachment. Rather, poor welfare may be the result of lack of knowledge, lack of knowledge application or resource limitations.

Haddon C, Burman OHP, Assheton P et al. (2021) Love in cold blood: Are reptile owners emotionally attached to their pets? Anthrozoös 34(5):739-749.

Pre-existing conditions as barriers to dog adoption

It can be difficult for rescue shelters to find homes for dogs with pre-existing health and behavioural issues. Shelters may be able to improve the rehoming rates of dogs with pre-existing issues if they are able to characterise and address potential adopters' concerns.

This study, conducted in the United States, investigated attitudes towards adopting dogs with pre-existing health and behavioural issues. In an online survey, participants (n=752) were shown stock images of six different dogs of a range of sizes and breeds. Each picture was randomly allocated a description ranging from minor to major medical or behaviour issues. The descriptions included: (1) a dog who was friendly with people, dogs and cats, (2) a dog with diabetes, (3) a dog with allergies, (4) a dog with separation anxiety, (4) a dog who pulls on the leash and jumps up on people and (5) a dog with a history of abuse. To evaluate attitudes towards these dogs, participants were asked how appealing the dog was to adopt and their perception of resource demands. Demographic information such as participant age and marital status was also collected.

Overall, participants viewed dogs with pre-existing medical or behavioural issues as less appealing to adopt. In order of most to least appealing to adopt was the friendly dog, abused dog, dog with allergies, dogs that jumped/pulled, dog with separation anxiety and dog with diabetes. Women appeared to have a better appreciation for the resource demands of caring for a dog with behavioural problems compared to men. Younger people, married/cohabiting people and those who currently had a dog or grew up with a dog, were more interested in adopting. Using this information, shelters may be able to address barriers to adoption.

King CA, Smith TJ, Holman E et al (2021) Medical, behavioural and abuse status characteristics: predictors of perceived adoptability, appeal, and resource demands of shelter dogs. Anthrozoös 34(4):507-524.

Flat-faced cats at risk of breathing, eye and dental issues

Brachycephalic (flat-faced) animals are at risk of a range of health problems. For example, protruding eyes (exophthalmos) predispose to corneal ulceration and inflammation of the cornea (keratitis). Distorted tear ducts result in chronically weepy eyes (epiphora) and tear staining. Excessive facial folds are prone to skin infections (skin fold dermatitis). Misaligned teeth affect ability to chew and increase the risk of dental disease. Narrow nasal passages make breathing difficult.

The majority of studies on health problems associated with brachycephaly focus on dogs. This study, conducted in Germany, characterises abnormalities seen in Persian cats, the most brachycephalic of the cat breeds. A total of 69 Persian cats (38 males, 31 females) were recruited from breeding clubs. They were compared with healthy Domestic Shorthair (DSH) cats (n=10). All cats underwent clinical examination and a Computed Tomography (CT) scan to obtain three-dimensional skull reconstructions and measurements.

Skull measurements confirmed that Persian cats have a shorter skull, narrower airways and more mis-aligned teeth compared to DSH cats. In over a third of the Persian cats, the frontal sinuses were completely absent or reduced to almost nothing. The degree of brachycephaly correlated significantly with the extent to which the eyeball was sitting outside the bony eye socket (i.e., exophthalmos). On clinical examination, 21/69 Persian cats had tear staining, 12/69 had respiratory noise at rest and 8/69 had dental disease. While none of the Persian cats showed clinical indicators of corneal ulcers at the time of examination, the authors acknowledge that breeders selected which cats to present for the study which may have introduced bias. Recommendations are made for further investigations (e.g., computational flow dynamic simulation of nasal airflow) and 'outbreeding' of Persian cats to reduce brachycephaly.

Sieslack J, Farke D, Failing K et al (2021) Correlation of brachycephaly grade with level of exophthalmos, reduced airway passages and degree of dental malalignment' in Persian cats. PLoS ONE 16(7), e0254420.

FARM ANIMALS

6-week-old calves are also sensitive to the pain of castration

Castration is routinely performed on calves without anaesthesia or pain-relief (analgesia). In the United States, administration of analgesia at castration is voluntary. Surveys of veterinarians in the United States over the past decade found that only 32.5 to 47.4% administer analgesia most of the time or always when performing castration on calves. Producers used pain mitigation 13.1% of the time.

This study, conducted in the United States, aimed to test the assumption that younger calves are less sensitive to the pain of castration than older calves. They used electroencephalography (EEG) and substance P (SP) as pain indicators. EEG has been used to measure pain responses in humans and animals. SP is a neuropeptide that plays a critical role in pain transmission pathways. Thirty male Holstein calves aged 6-weeks (n=10), 3 months (n=10) and 6 months (n=10) were subject to sham castration followed 24 hours later by surgical castration. EEG recordings and blood samples for SP were taken before, during and after the sham and actual surgical castration.

The results indicate that calves, including those aged 6 weeks, experience pain when surgically castrated without anaesthesia or analgesia. At surgical castration, 6-week-old calves showed increased beta waves on EEG which is indicative of pain perception (nociception). These EEG results were not seen during the sham procedure. Unexpectedly, SP concentrations were lower after surgical castration compared to after the simulated procedure. One possible explanation may be increased breakdown (catabolism) of SP with post-castration inflammation. Nevertheless, the EEG findings show that even young calves experience pain associated with castration and the study supports the use of pain mitigation strategies for routine procedures like castration regardless of age.

Bergamasco L, Edwards-Callaway LN, Bello NM et al (2021) Unmitigated surgical castration in calves of different ages: Electroencephalographic and neurohormonal findings. Animals 11, 1791.

An effective alternative to beak trimming for turkeys

Turkeys routinely have their beaks trimmed with the aim to reduce feather pecking and cannibalism. Beak trimming is an animal welfare concern because it is painful and can affect turkeys' ability to use, close and move their beaks normally. Blunting discs are a potential alternative to beak trimming. The discs mimic the natural blunting of the beak tip that would occur if turkeys were pecking at rough sand, grit and rock.

This study, conducted in Germany, investigated whether blunting discs could be used as alternatives to beak trimming turkeys. Half the study population (n=300) were infrared beak trimmed and the other half (n=300) were not beak-trimmed but instead provided blunting discs at the bottom of their feed pan. Performance indicators (e.g., weight, mortality, rejected parts at slaughter), animal welfare indicators (e.g., plumage quality, skin lesions) and beak measurements were recorded. The structure of the beaks was also examined microscopically (histology) from beak tissue samples collected post-mortem.

Beak-trimmed turkeys showed histological evidence of disordered nerve tissue and scar tissue indicative of pain and altered function. Non-beak trimmed turkeys had no histological changes, except one turkey with beak tip inflammation. There was no significant difference in injury rate or performance indicators between beak-trimmed and non-beak trimmed turkeys. Overall, this study demonstrated that blunting discs are an effective, more humane alternative to beak trimming in preventing injuries that occur due to feather pecking. The authors recommend that their use be further investigated to improve turkey welfare.

Grün S, Damme K, Müller M et al (2021) Welfare and performance of three turkey breeds—comparison between infrared beak treatment and natural beak abrasion by pecking on a screed grinding wheel. Animals 11, 2395.

Early piglet socialisation reduces the incidence of injuries post-weaning

Weaning is a stressful time for piglets. At three to four weeks of age, they are suddenly separated from their mothers and find themselves in an unknown environment with unfamiliar piglets, experience a change in diet, and are at risk of aggressive interactions from other piglets which can result in injuries (e.g., skin and tail lesions). Tail docking is a painful husbandry procedure that is routinely practiced to reduce the risk of tail biting injuries. More humane and better alternatives are currently being researched to replace conventional weaning and tail docking methods.

This study, conducted in Germany, compared the risk of skin and tail lesions in piglets in relation to the farrowing system, weaning system and tail docking. In the same building, piglets were housed in either conventional single-housing in farrowing crates (FC) (n=349), single-housing in free farrowing pens (FF) (n=340) or group housing (GH) (n=417). Piglets were then weaned using conventional weaning methods (Conv) (n=486) or allowed to remain with their mother and littermates in the farrowing system (Reaf) (n=620). Tails were docked or left undocked by batch. Skin and tail lesions were compared across all groups of piglets.

The results indicated that early socialisation in group housing resulted in lower incidence of skin lesions post-weaning without reducing overall piglet performance. Reduced regrouping (for piglets who were allowed to remain with their mother and littermates) appeared to reduce the incidence of tail lesions and losses in undocked piglets. The authors surmise that group housing piglets appears to be an effective strategy to reduce skin lesions possibly due to decreasing the amount and time piglets spend fighting between each other.

Lange A, Hahne M, Lambertz C et al (2021) Effects of different housing systems during suckling and rearing period on skin and tail lesions, tail losses and performance of growing and finishing pigs. Animals 11, 2184.

Hens prefer light similar to natural sunlight

Light intensity and UV radiation can influence how hens use outdoor environments. Standard light intensity for poultry housed indoors is approximately 10 to 20 lux. In contrast, sunlight intensity can be up to 130,000 lux. Little is known about hens' preference for different light intensities and levels of UV radiation.

This study, conducted at the University of New England in New South Wales, investigated hens' light and UV preferences. The study consisted of laying hens (n=108) approximately 50 weeks old who had been kept in indoor caged systems and never been outside or seen natural sunlight before. Six Light Preference Testing Apparatus (LPTA) boxes were set up in a testing room, with half of them illuminated by standard indoor lighting (~20 lux at bird height) in the room and the other half, in addition to the lighting in the room, illuminated with three different treatments within the human/poultry visible spectrum including either: infrared, UVA or, UVA and UVB. Each treatment was applied at either low, medium and high light intensity. Hen preference testing involved habituating hens to move freely about the LPTA for three hours. The time hens spent in the standard versus treatment light and their behaviour was recorded.

Even though the hens had never seen sunlight before, in general they exhibited preferences for the treatment light groups that approximated natural sunlight in comparison to the control group standard indoor lighting. Hens were observed to perform more foraging, pecking and preening behaviours at low light intensity UVA and UVB. When given the choice between standard indoor lighting versus UVA and UVB, hens preferred UVA and UVB except when at high light intensity. These preference findings suggest hens may benefit from sunlight access but protection (e.g., shade and shelter) is also important for when sunlight is very intense such as during the peak of the day.

Rana MS, Cohen-Barnhouse AM, Lee C et al (2021) Preference testing for UV light spectrum and intensity in laying hens. Poultry Science 100(6), 101063.

Improvements needed in farm animal pain management

Cattle, sheep and pigs are routinely subjected to painful procedures without any anaesthetic or pain relief (analgesia). Painful procedures include ear tagging, nose ring placement, branding, dehorning, castration, tail docking and mulesing. There is a widespread misconception that farm animals, particularly the very young, do not feel pain as other animals do. Failure to recognise, prevent and treat pain in farm animals results in significant physical and mental suffering.

This review paper brings together the literature on pain in farm animals. The authors discuss pain assessment, analgesic options and cost-benefit analyses. Pain in farm animals can be assessed in several ways including facial expressions and behaviour scoring. Validated pain scoring systems include the Sheep Grimace Scale, Piglet Grimace Scale, Cow Pain Scale and UNESP-Botucatu Unidimensional Bovine Composite Pain Scale. Technology such as accelerometers and pedometers can be used in pain assessment e.g., lameness. In the future, these systems may be automated using artificial intelligence.

There are a range of anaesthetic and analgesic protocols for use in farm animals including local anaesthetics applied topically or injected (e.g., nerve blocks) and non-steroidal anti-inflammatories (NSAIDs) which may also be delivered in various ways. In some cases, non-invasive or less-invasive alternatives to painful husbandry procedures are available such as genetic selection or improved housing conditions. Recommendations include the need for better pain mitigation strategies, use of less-invasive techniques, pain assessment, stronger laws about minimising pain in farm animals and improved farm animal pain education and training for vets and farmers.

Steagall PV, Bustamante H, Johnson CB et al (2021) Pain management in farm animals: Focus on cattle, sheep and pigs. Animals 11, 1483.

ANIMALS IN SPORT, ENTERTAINMENT, PERFORMANCE RECREATION AND WORK

A simple Five Domains infographic to assess horse welfare

The Five Domains model incorporates physical and mental factors that contribute to animal welfare covering nutrition, environment, health, behaviour and emotional state. Understanding and adopting The Five Domains can help improve animal welfare.

This study evaluated horse owners' understanding of The Five Domains model and tested their response to a simple educational infographic. Using an online questionnaire, information was collected from UK horse owners (n=259) including demographics, level of equine education, current management practices, knowledge of equine welfare, and perceptions of animal welfare including emotional well-being. Participants were then shown an intervention in the form of a simple one-page infographic explaining The Five Domains in the context of horse welfare. Immediately after the intervention, participants were asked the same questions to see if the infographic had influenced their perceptions of animal welfare.

The majority (60%) of participants were not aware of The Five Domains. The intervention appeared to have a significant impact on their assessment of horse welfare. Post-intervention, owners scored their horses lower on health, behaviour/human interactions and overall welfare. This suggests that the infographic prompted horse owners to consider animal welfare differently. However, post-intervention scores for horse emotional well-being were significantly higher compared to pre-intervention. Despite almost all participants (98%) agreeing that horses can experience emotions, these together with previous findings, suggest that objective assessment of horses' emotional state remains a challenge for owners.

Fletcher KA, Cameron LJ, Freeman M (2021) Contemplating the Five Domains model of animal welfare assessment: UK horse owner perceptions of equine well-being. Animals 30:259-268.

Links between the diet of working horses and abnormal oral behaviours

Horses may express abnormal behaviours due to frustration and stress. These behaviours can develop in response to suboptimal conditions and an inability to express natural behaviours. Abnormal behaviours include repetitive patterns (stereotypies) and redirected behaviours. Examples of oral stereotypies include sham chewing, licking, tongue-rolling and crib-biting. Examples of redirected oral behaviours include eating bedding and eating faeces (coprophagy).

This study, conducted on working horses in Malaysia, investigated the links between diet and abnormal oral behaviours. The horses (n=207) were housed individually at seven different facilities. They were used for leisure, equestrian sports, patrolling and endurance events. Three to five times a day, the horses were fed a diet mainly consisting of concentrates (4-6 kg/day) with a small amount of hay (2- 3kg/day). Behavioural observations were recorded as well as dietary analyses to quantify key components including dry matter (DM), crude protein (CP), crude fibre (CF) and ether extract (EE).

All horses in the study performed more than one abnormal oral behaviour. Sham chewing was the most common oral stereotypy. Eating bedding was the most common redirected oral behaviour. All horses in the study were fed lower than the minimum DM stipulated by the National Research Council (2007). Dietary components varied between the different types of working horses. Lower CP, CF and EE were found to be associated with higher probability of abnormal oral behaviours. This confirms previous findings that diets high in concentrate and low in roughage put horses at risk of abnormal behaviours. Other stressors such as long-work hours, infrequent feeding, hunger and housing may also have contributed to abnormal behaviours.

Hanis F, Chung ELT, Kamalludin MH et al (2021) Do nutrient composition of feedstuffs affect the proportion of oral stereotypies and redirected behaviours among horse working groups? Journal of Veterinary Behaviour 46:7-14.

What is normal? Factors influencing views on horse welfare

Horses commonly experience compromised welfare. A range of human factors contribute to these welfare issues. Issues can arise when people differ in their understanding of what constitutes 'normal' horse health and behaviour.

This review paper examines the human factors that contribute to horse welfare issues including anthropomorphism, cultural biases, social norms, beliefs and interpretations. Anthropomorphism involves assumptions that non-human animals feel the same way about things as humans. For example, humans may feel more secure when sheltered and housed. However, being kept in confinement compromises horse welfare. People may assume that horses like tactile contact due to humans' desire for touch but horses may react differently. Cultural views can also affect horse welfare. For example, the cultural view that equates feeding with caring may lead to overfeeding, obesity and associated health issues. Social norms and long-standing horse husbandry beliefs can pose a risk to animal welfare. For example, the routine use of bits can lead to pain in the head, jaw and neck. These norms, beliefs and practices are rarely questioned.

It can be difficult to interpret behavioural signs of stress in horses. For example, depending on the context, yawning and play behaviour may be indicative of a horse trying to cope with chronic stress. Owners may also struggle to detect subtle indicators of chronic pain in horses. For example, aggression or reluctance to work may be misinterpreted as a temperament issue rather than pain associated with digestive issues, back problems or lameness. There are also concerns that people who spend a lot of time around horses with compromised welfare may see their state as normal due to over-exposure. In addition, there may be reluctance to recognise welfare issues. The authors recommend the use of animal welfare indicators that are less open to misinterpretation.

Hausberger M, Lesimple C, Henry S (2021) Detecting welfare in a non-verbal species: social/cultural biases and difficulties in horse welfare assessment. Animals 11, 2249.

Stronger codes and laws needed to protect animals used in film and television

Animals often feature in film and television. However, little information is available about the welfare of animals used in the Australian film and television industries.

This review examines animal welfare incidents in the Australian film and television industries. In the absence of a standardised reporting system and no official reports, the authors searched media articles. Articles documented incidents of animals being dropped, thrown, handled roughly, crushed, chased, hunted, overcrowded, scared, killed inhumanely and eaten. There are numerous deficiencies and inconsistencies in codes of practices and legislation pertaining to use of animals in media. For example, there is no national animal welfare legislation in Australia and only New South Wales (NSW), the Australian Capital Territory (ACT) and Victoria (VIC) have specific codes of practice for the use of animals in the media. In the US, the industry funded American Humane Association (AHA) monitors over 1000 Screen Actors Guild (SAG) productions per year, but monitoring is at the discretion of the production. In the UK, companies keeping or training animals for exhibition must be licensed but licensing conditions are not comprehensive.

The authors make several recommendations to reduce animal welfare risks in film and television. All animals must be legally protected, productions must be required to notify authorities of animal use, on-set and off-set monitoring must take place, veterinary oversight is essential and comprehensive codes of practice must stipulate minimum requirements for animal care and management. In addition, the portrayal of animals in film and television should consider potential animal welfare implications such as driving wildlife trade or inappropriate pet choice. Overall, given the risks of using live animals in film and television, the authors recommend that producers use alternatives such as Computer-Generated Images (CGI).

Hitchens PL, Booth RH, Stevens K et al (2021) The welfare of animals in Australian filmed media. Animals 11, 1986. [Author B Jones is from RSPCA Australia]

Forming habitual behaviours to improve equine welfare

Many equine care tasks represent routinely performed behaviours. Behaviours that are routinely performed can become habitual behaviours or habits (i.e., automatic responses to particular cues). Habits can be either beneficial for animal welfare (e.g., positive human-animal interaction) or harmful (e.g., habitual hitting). Human behaviour change psychology suggests that effective behaviour change can occur via the forming of many simple, easy 'tiny habits' that by repetition and 'cue-reward-routine' become a 'habit loop'.

This study, conducted in the United Kingdom, investigates whether a pro-animal welfare habitual behaviour intervention (PAWHBInt) could develop and maintain behavioural change. For 30 days, a target group of 48 equine (horses or donkeys) carers (46 females, 2 males) were asked to scratch the equines in their care and link the scratching to a routine daily task (cue). A simple action plan, reminders and a daily log were provided. Participants were interviewed immediately after the PAWHBInt and a month later to gauge whether the scratching had become habitual.

After the PAWHBInt, scratching their equines became habitual for the majority of participants. Scratching was seen as a positive experience for some participants and their equines. Some participants commented that their equines "all demand it...whoever I am next to wants a cuddle, wants a scratch". Other participants commented that their equine "made it very plain that scratching is something she and the other horses do and she and I interact differently." This study indicates the potential for habit formation to develop and maintain pro-animal welfare behaviours. It also highlights the importance of linking the desired behaviour to existing routine behaviours, repetition and positive reward.

White J, Sims R (2021) Improving equine welfare through human habit formation. Animals 11, 2156.

ANIMALS IN RESEARCH AND TEACHING

Using human skin removed during elective surgery as an alternative to animal testing

The 3Rs (replacement, reduction and refinement) provide a framework for animal research. The 3Rs have been incorporated into animal research legislation in some countries. In Brazil, alternatives to animal testing have been mandated by law since 2019. As per this legislation, the Brazilian cosmetic industry must use validated alternative methods to test the safety of products including those that are to be applied to human skin (topical).

This proof-of-concept study, conducted in Brazil, investigates the use of ex vivo human skin removed during elective plastic surgery (skin explants) for topical cosmetic safety testing. Skin of standardised thickness was collected from 17 donors. The skin explants were processed aseptically and placed in culture. The skin explants were treated in triplicate with a range of topical products to test skin corrosion and skin irritation. Tissue viability was measured post-treatment.

The results indicated that skin explants are a viable model for skin irritation and corrosion safety testing. Test results using the skin explants corresponded to test results using other testing methods (e.g., reconstructed skin models). Advantages of the explants include presence of all cell types, intact barrier function, sustainability (use of material that would otherwise be discarded) and low cost. Disadvantages include limited availability, variability and tissue viability.

Eberlin S, Facchini G, da Silva GH et al (2021) Ex vivo human skin: An alternative test system for skin irritation and corrosion assays. Alternatives to Laboratory Animals doi:10.1 177/2F02611929211038652.

Cell and computer-based models are alternatives to animal testing

Nanoparticles are widely used in the biotechnology, agriculture and food industries. Every year, millions of animals are used in nanoparticle safety testing and the numbers are growing. As per the 3Rs (reduction, refinement and replacement), ethical research requires the pursuit of alternatives to animal use.

This review brings together the literature on alternatives to animals in the context of nanoparticle (NP) safety testing. Cell-based (in vitro) and computer-based (in silico) models represent alternatives to animal testing. There are many cell lines commonly used in safety and toxicity testing including different types of stem cells and somatic cells. Tissue engineering offers different models such as 2D and 3D scaffold-based techniques, cell spheroids and scaffold-free cell cultures in suspension. In silico models based on bioinformatics and computer simulations, can be used to assess a wide variety of NPs. For example, molecular docking studies simulate complex interactions between small molecules such as NP and large molecules such as proteins or enzymes. Computer-based Quantitative Structure-Activity Relationship (QSAR) assays are frequently used to predict the biological activity and toxicity of substances using machine learning. Some countries use QSAR instead of animal testing to predict toxic hazards. Molecular Dynamics (MD) simulation is also widely used in nanotoxicology.

In vitro and in silico models offer a range of advantages over animal testing. In addition to ethical advantages, they are faster and less expensive. However, there are currently limitations including lack of an intrinsic circulatory system, difficulties corresponding cells to whole organs and assessing accuracy. Nevertheless, there are numerous validated alternatives to animal testing and further developments are required to reduce the number of animals used.

Huang, H-J, Lee Y-H, Hsu Y-H et al (2021) Current strategies in assessment of nanotoxicity: Alternatives to in vivo animal testing. International Journal of Molecular Science 22, 4216.

WILD ANIMALS

Standardised testing needed for wildlife shooting and darting

Ballistic methods such as shooting and darting are widely used in wildlife management. For example, shooting is commonly used for culling, hunting and euthanasia of injured wildlife. Shooting poses animal welfare risks including animals being 'struck-and-lost', traumatic injury and delayed time to death. Darting is used to mark wildlife and for the remote delivery of immobilising drugs, medications and fertility control agents. Darting poses animal welfare risks such as traumatic injuries and infection. Risks increase when sub-optimal ballistic methods are used.

This review proposes a standardised evidence-based testing protocol to reduce the animal welfare risks of wildlife shooting and darting. The protocol considers human factors (e.g., shooter proficiency and position, ability to predict animal behaviour), kinetic energy of the projectile, projectile behaviour and animal-based indicators (e.g., proportion of animals rendered insensible within a specified time period, proportion of animals displaying injuries). The proposed protocol draws on learnings from standardised protocols for kill-trap testing and ballistic method case studies. The

authors recommend integrating pre-animal testing and animal testing with clear cut-off points to ensure unacceptable methods do not proceed. The shooting of adult harp seals in Canada, which had undesirable animal welfare outcomes, is used as a case study to illustrate 'how not to' apply untested or unfamiliar ballistic methods, i.e., no bench top or other assessments conducted.

The proposed standardised testing protocol for wildlife shooting and darting consists of: (1) pre-animal testing of accuracy, kinetic energy, projectile behaviour, equipment and personnel under field conditions, (2) testing on cadavers, (3) small-scale pilot studies on animals with clear cut-off points, and (4) broad-scale use with reporting of adverse animal welfare outcomes.

Hampton JO, Arnemo JM, Barnsley R et al (2021) Animal welfare testing for shooting and darting free-ranging wildlife: A review and recommendations. Wildlife Research doi:10.1071/WR20107.

Camera traps used to assess the welfare of free-roaming wild horses for the first time

Assessing the welfare of free-roaming wildlife is challenging. Challenges include difficulty locating and observing wild animals, particularly in remote and inaccessible areas.

This is the first study to use remote camera traps to non-invasively assess the welfare of free-roaming horses. A total of 47 cameras were deployed in the Blue Mountains National Park, New South Wales. The area is known to be home to a small number of free-roaming wild horses. For 15 months, cameras were deployed across grasslands (n=23), woodlands (n=17), riparian habitat (n=13) and disturbed open woodland (n=5). Still images and videos were collected. Observation events were assessed for a stratified-random subset of camera days. As per the Five Domains model of animal welfare, assessment included indicators of nutrition (e.g., body condition score), physical environment (e.g., sweating), health (e.g., coat condition) and behaviour (e.g., Qualitative Behavioural Assessment QBA).

The study assessed animal welfare indicators in 16 individual free-roaming horses in open grassland

habitat. On both still images and video, the most frequently assessable indicators included body condition score, body posture, coat condition and the presence/absence of excessive sweating. On video, the most frequently assessable indicators included presence or absence of weakness, QBA, presence or absence of shivering and gait at walk. Limitations included the need for a clear line of sight and distance from the camera. The images and video footage represent snapshots in time. These snapshots may not reflect overall time budgets or the motivations underlying certain behaviours. Nevertheless, this study demonstrates how the welfare of free-roaming wild animals can be assessed using camera traps. The authors recommend extensive field surveys for strategic camera placement and optimisation of camera settings.

Harvey AM, Morton JM, Mellor DJ et al (2021) Use of remote camera traps to evaluate animal-based welfare indicators in individual free-roaming wild horses. Animals 11, 2101.

A new tool to assess camel welfare

Globally, a growing number of camels are kept for agricultural, cultural and recreational purposes. Camels are renowned for their adaptations to deal with harsh conditions which may lead to erroneous conclusions that harsh conditions do not negatively affect their welfare. For example, camels commonly suffer from welfare issues including restricted feed access, insufficient mineral salts, overstocking, disease, heat stress, extreme confinement by hobbles, painful husbandry procedures such as the fitting of nose pegs. Currently, little guidance is available on how to assess and improve camel welfare.

This review considers available literature and proposes a system for assessing camel welfare in intensive and semi-intensive systems. The authors draw on well-recognised models of animal welfare including the Five Freedoms and Five Domains and incorporate aspects of the European Animal Welfare Indicators Project (AWIN) and Welfare Quality® protocols. They selected animal, resource and management-based animal welfare indicators using their experience and taking into account validity, reliability and feasibility. The proposed system for assessing camel welfare considers feeding, housing, health and behaviour. Animal welfare indicators fall into three categories: caretaker, herd and individual animal indicators.

Caretaker level indicators are measured via interview and on-farm observation. Herd and individual animal level indicators are measured via a range of proposed tests, some have been validated in other species but still require validation in camels (e.g., the 'bucket test' for thirst which was developed in horses). Further work is required to validate animal welfare indicators for camels and their relationship to emotional states.

Padalino B, Menchetti L (2021) The first protocol for assessing welfare of camels. Frontiers in Veterinary Science 7, 631876.

Animal welfare is a key concern in wildlife trade

Worldwide, billions of animals are harmed and killed in the legal and illegal wildlife trades. The literature about wildlife trade generally focuses on conservation implications. Wildlife trade is rarely viewed through an animal welfare lens.

This review argues that animal welfare must be considered in the context of wildlife trade. Trade involves capture, transport, injury, insufficient food and water, confinement, and direct and indirect killing. For example, birds are stuffed into packages to be smuggled, snakes are starved and skinned alive for their skin and rhinoceros are shot for their horns. Animals continue to suffer once they reach their destination. For example, in the European Union, 75% of pet reptiles and amphibians suffer poor welfare and die within the first year. The wildlife trade compromises all Five Domains of animal welfare including health, function, environmental conditions and behavioural expression.

The authors recommend ways to improve the welfare of animals in wildlife trade. Recommendations include acknowledging the value of wild animals as sentient individuals, and strengthening policy, legislation and law enforcement. They recommend that animal welfare regulations be included in the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). As highlighted by the COVID-19 pandemic, the capture, transport, keeping, marketing and slaughter of wild animals poses direct zoonotic disease risks to people. Hence, improving the welfare of wild animals will also help safeguard human health.

Wyatt T, Maher J, Allen D et al (2021) The welfare of wildlife: An interdisciplinary analysis of harm in the legal and illegal wildlife trades and possible ways forward. Crime, Law and Social Change doi:10.1007/s10611-021-09984-9.

TRANSPORTATION OF ANIMALS

Skin tent test, faecal soiling and abnormal oral behaviours are potential animal welfare indicators in young dairy calves in lairage

Over two million dairy calves, aged four to seven days, are sent for slaughter in New Zealand annually. Animal welfare concerns include transport, handling and mixing of such young, vulnerable animals. Calves find themselves in unfamiliar environments, exposed to stressors including pathogens and noxious agents. At present, animal welfare indicators are not routinely monitored in young calves sent to slaughter. Mortality rates are recorded but these are insufficient to assess calf welfare.

This study, conducted across 12 New Zealand meat processing facilities, sought to identify potential animal welfare indicators to incorporate into future assessment systems. Across 102 pens, calves were assessed at a distance at a group level (n=5910) and individually up close (1m away) (n=504). Data recorded included animal behaviours, the presence/absence and severity of injuries, respiratory rate and a skin tent test for dehydration.

The majority of calves in lairage were Friesian or Jersey crossbred males (291/504, 69%). When observed up close, many (22%) had an elevated respiratory rate (>36 breaths/minute) possibly indicating stress. Over 20% of calves had: a delayed skin tent test (≥3 seconds) indicating dehydration, faecal soiling indicating diarrhoea possibly of infectious origin and runny noses and eyes possibly due to exposure to wind, irritants and/or noxious agents. Close to 30% of calves exhibited abnormal oral behaviours such as sucking or licking objects or other calves (cross-sucking). These behaviours reflect poor animal welfare including hunger, boredom, frustration and lack of opportunity to engage in natural suckling behaviour. Indicators appeared to be affected by time in lairage and time since the calving season started.

The authors recommend these animal welfare indicators be incorporated into future assessment systems. Further research is required to understand the influence of farm management and transport on the health and welfare of young calves sent for slaughter.

Palmer AL, Beausoleil NJ, Boulton AC et al (2021) Prevalence of potential indicators of welfare status in young calves at meat processing premises in New Zealand. Animals 11, 2467.

HUMANE KILLING

Can hundreds of millions of male layer chicks be humanely killed?

Annually hundreds of millions of male layer chicks are killed. Maceration (crushing) is a method commonly used, however, alternative killing methods are sought. Possible alternatives currently include carbon dioxide (CO_2), nitrogen (N_2) and low atmospheric pressure stunning (LAPS™).

This study, conducted at Texas A&M University in the Unites States, compared the use of CO_2, N_2 and LAPS™ for the killing of male layer chicks. Male chicks (n=480) at one day old were randomly allocated into 16 groups with 30 chicks in each group. Chicks were then exposed to either: normal atmospheric air and then killed by decapitation (control), CO_2, N_2, or LAPS™. Video observations of chicks in the slaughter chamber were collected to assess movement, vocalisations, loss of balance (ataxia), loss of posture, convulsions, time to unconsciousness and time to death. Blood samples were also taken after death and once chicks had stopped moving for one minute. Blood samples were analysed for stress hormones (corticosterone) and hormones associated with decreased fear-related behaviour in poultry (serotonin).

The authors found CO_2 and LAPS™ to be effective alternative killing methods for male layer chicks. N_2 was found to be unsuitable as it took too long to reach lethal concentrations resulting in delayed time to unconsciousness and death (631 seconds). Whereas, in comparison, chicks began to lose posture within 50.8 seconds in CO_2 and 58.8 seconds in LAPS™ and death was achieved in 341.0 to 356.5 seconds respectively. Corticosterone in chicks exposed to CO_2 and LAPS™ did not vary from the controls. Corticosterone was highest in chicks exposed to N_2 possibly indicative of stress, anxiety and discomfort. Chicks exposed to CO_2 and N_2 were observed convulsing with severe wing flapping which may indicate some form of consciousness and distress. Chicks exposed to CO_2 had the highest serotonin levels, but further research is required to understand the welfare implications.

Wang X, Zhao D, Milby AC et al (2021) Evaluation of euthanasia methods on behavioural and physiological responses of newly hatched male layer chicks. Animals 11, 1802.

RSPCA

ANIMAL WELFARE IN A CHANGING CLIMATE

Animal Welfare Seminar 2022
16–17 February (online)

ARTICLES OF INTEREST

COMPANION ANIMALS

Andersen SS, Meyer I, Forkman B et al (2021) Regulating companion dog welfare: A comparative study of legal frameworks in western countries. Animals 11(6), 1660.

Andrukonis A, Protopopova A, Xiang Y et al (2021) Behavioral correlates of urinary output in shelter cats. Applied Animal Behaviour Science 241,105397.

Arena L, Menchetti L, Diverio S et al (2021) Overweight in domestic cats living in urban areas of Italy: Risk factors for an emerging welfare issue. Animals 11(8), 2246.

Carr D, Friedmann E, Gee NR et al (2021) Dog walking and the social impact of the COVID-19 pandemic on loneliness in older adults. Animals 11(7), 1852.

Chiu LJV, Li J, Lhermie, G et al (2021), Analysis of the demand for pet insurance among uninsured pet owners in the United States. Veterinary Record, 189.

Collinson A, Brennan ML, Dean RS et al (2021) Priorities for research into the impact of canine surgical sterilisation programmes for free-roaming dogs: An international priority setting partnership. Animals 11(8), 2250.

Dolan ED, Doyle E, Tran HR et al (2021) Pre-mortem risk factors for mortality in kittens less than 8 weeks old at a dedicated kitten nursery. Journal of Feline Medicine and Surgery 23(8):730-737.

Ekstrand K, Flanagan AJ, Lin LE (2021) Animal transmission of SARS-CoV-2 and the welfare of animals during the COVID-19 pandemic. Animals 11(7), 2044.

Fernández-Martín S, González-Cantalapiedra A, Muñoz F (2021) Glucosamine and Chondroitin Sulfate: Is there any scientific evidence for their effectiveness as disease-modifying drugs in knee osteoarthritis preclinical studies? —A systematic review from 2000 to 2021. Animals 11(6), 1608.

Friedmann E, Krause-Parello CA, Payton M et al (2021) A leash on life: An exploratory study on the effects of a shelter-dog walking program for veterans on dogs' stress. Anthrozoös 33:225-241.

Fusi J, Peric T, Probo M et al (2021) How stressful is maternity? Study about Cortisol and Dehydroepiandrosterone-sulfate coat and claws concentrations in female dogs from mating to 60 days post-partum. Animals 11(6), 1632.

Hawes LM, Hupe TM, Gandenberger J et al (2021) Detailed assessment of pet ownership rates in four underserved urban and rural communities in the United States. Journal of Applied Animal Welfare Science doi:10.1080/10888705.2021.1871736.

Hawkins RD, Hawkins EL, Tip L (2021) "I can't give up when I have them to care for": People's experiences of pets and their mental health. Anthrozoös 34(4):543-562.

Ines M, Ricci-Bonot C, Mills DS (2021) My Cat and Me—A study of cat owner perceptions of their bond and relationship. Animals 11(6), 1601.

Jezierski T, Camerlink I, Peden RSE et al (2021) Changes in the health and behaviour of pet dogs during the COVID-19 pandemic as reported by the owners. Applied Animal Behaviour Science 241, 105395.

Jezierski T, Camerlink I, Peden RSE (2021) Changes in the health and behaviour of pet dogs during the COVID-19 pandemic as reported by the owners. Applied Animal Behaviour Science, 105395.

Junttila S, Huohvanainen S, Tiira K (2021) Effect of sex and reproductive status on inhibitory control and social cognition in the domestic dog (*Canis familiaris*) Animals 11(8), 2448.

Karn-Buehler J, Kuhne F (2021) Perception of stress in cats by German cat owners and influencing factors regarding veterinary care. Journal of Feline Medicine and Surgery doi:10.1177/1098612X211041307.

Kluess HA, Jones RL, Lee-Fowler T (2021) Perceptions of body condition, diet and exercise by sports dog owners and pet dog owners. Animals 11(6), 1752.

Kogan LR, Currin-McCulloch J, Bussolari C, et al (2021) The psychosocial influence of companion animals on positive and negative affect during the COVID-19 pandemic. Animals 11(7), 2084.

Kogan LR, Grigg EK (2021) Laser light pointers for use in companion cat play: Association with guardian-reported abnormal repetitive behaviors. Animals 11(8), 2178

Machado DS, Bragana AFF, Travnik, IC et al (2021) Should cats be allowed outdoors? A research survey on animal welfare risks for free-ranging cats in Brazil. Animal Welfare 30(3):331-339.

MacLean E, Fine A, Herzog H, Strauss E, Cobb ML (2021) the new era of canine science: Reshaping our relationships with dogs. Frontiers in Veterinary Science 8, 762.

Natale A, Mazzotta E, Mason N et al (2021) SARS-Cov-2 natural infection in a symptomatic cat: diagnostic, clinical and medical management in a one health vision. Animals 11(6), 1640.

Powell L, Duffy DL, Kruger KA et al (2021) Relinquishing owners underestimate their dog's behavioral problems: Deception or lack of knowledge? Frontiers in Veterinary Science 8, 1044.

Quain A (2021) The Gift: Ethically indicated euthanasia in companion animal practice. Veterinary Sciences 8(8), 141.

Riggio G, Piotti P, Diverio S et al (2021) The dog–owner relationship: Refinement and validation of the Italian C/DORS for dog owners and correlation with the LAPS. Animals 11(8), 2166.

Santos NR, Beck A, Maenhoudt C et al (2021) Profile of dogs' breeders and their considerations on female reproduction, maternal care and the peripartum stress—An international survey. Animals 11(8), 2372.

Sargisson RJ, McLean IG (2021) Commentary: Efficacy of dog training with and without remote electronic collars vs. a focus on positive reinforcement. Frontiers in Veterinary Science 8, 629746.

Scanlon L, Hobson-West P, Cobb K et al (2021) Assessment of health and welfare in a small sample of dogs owned by people who are homeless. Veterinary Record e776.

Schatz KZ, Engelke E, Pfarrer C (2021). Comparative morphometric study of the mimic facial muscles of brachycephalic and dolichocephalic dogs. Anatomia, Histologia, Embryologia 00:1–13.

Shih HY, Paterson MBA, Pachana NA et al (2021) Volunteers' demographics that affect the human-dog interaction during walks in a shelter. Frontiers in Veterinary Science 8, 1023. [Author Mandy Paterson is from RSPCA QLD)

Shih HY, Phillips CJC, Mills DS et al (2021) Dog pulling on the leash: Effects of restraint by a neck collar vs. a chest harness. Frontiers in Veterinary Science 8, 1002. [Author Mandy Paterson is from RSPCA QLD]

Shu H, Gu X (2021) Effect of a synthetic feline facial pheromone product on stress during transport in domestic cats: a randomised controlled pilot study. Journal of Feline Medicine and Surgery doi:10.1177/1098612X211041305.

Stellato AC, Flint HE, Dewey CE et al (2021) Risk-factors associated with veterinary-related fear and aggression in owned domestic dogs. Applied Animal Behaviour Science 241,105374.

van der Laan JE, Vinke CM, van der Borg JAM et al (2021) Restless nights? Nocturnal activity as a useful indicator of adaptability of shelter housed dogs. Applied Animal Behaviour Science 241, 105377.

Williams JM, Padilla Cardoso M, Zumaglini S et al (2021) "Rabbit Rescuers": A school-based animal welfare education intervention for young children. Anthrozoös doi:10.1080/08927936.2021.1944561.

Wolf PJ, Kreisler RE, Levy JK (2021) Cats are not fish: A ricker model fails to account for key aspects of trap–neuter–return programs. Animals 11(7), 1928.

Wu H, Bains RS, Morris A et al (2021) Affordability, feasibility, and accessibility: Companion animal guardians with (dis)abilities' access to veterinary medical and behavioral services during COVID-19. Animals 11(8), 2359.

FARM ANIMALS

Aquaculture

Aaqillah-Amr MA, Hidir A, Azra MA et al (2021) Use of pelleted diets in commercially farmed decapods during juvenile stages: A review. Animals 11(6), 1761.

Alnes IB, Jensen KH, Arne Skorping A et al (2021) Ontogenetic change in behavioral responses to structural enrichment from fry to parr in juvenile Atlantic Salmon (Salmo salar L.). Frontiers in Veterinary Science doi:10.3389/fvets.2021.638888.

Barreto MO, Planellas SR, Yang Y et al (2021) Emerging indicators of fish welfare in aquaculture. Reviews in Aquaculture doi:10.1111/raq.12601

Brandão ML, Dorigão-Guimarães F, Bolognesi MC et al (2021) Understanding behaviour to improve the welfare of an ornamental fish. Journal of Fish Biology 99(3):726-739.

Calado R, Mota VC, Madeira D et al (2021) Summer is coming! Tackling ocean warming in Atlantic salmon cage farming. Animals 11(6), 1800.

Jarvis S, Ellis MA, Turnbull JF (2021) Qualitative behavioral assessment in juvenile farmed Atlantic salmon (Salmo salar): Potential for on-farm welfare assessment. Frontiers in Veterinary Science doi:10.3389/fvets.2021.702783

Kolarevic J, Calduch-Giner J, Åsa M. Espmark AM et al (2021) A novel miniaturized biosensor for monitoring Atlantic salmon swimming activity and respiratory frequency. Animals 11(8), 2403.

Laursen DC, Meijboom FLB (2021) Pausing for reflection to make progress: An assessment framework for ethical discussions on innovations in fisheries. Journal of Fish Biology 99(1):4-8.

Li D, Liu C, Song Z et al (2021) Automatic monitoring of relevant behaviors for crustacean production in aquaculture: A review. Animals 11(9), 2709.

McKenzie DJ, Geffroy B, Farrell AP (2021) Effects of global warming on fishes and fisheries Journal of Fish Biology 98(6):1489-1492.

Meyer KA, Branigan PR, Cassinelli JD (2021) Effects of baffles on raceway cleaning, fin erosion, in-hatchery survival, and post-release angler catch of catchable-sized hatchery Rainbow Trout. North American Journal of Aquaculture doi:10.1002/naaq.10216.

Rector ME, Weitzman J, Filgueira R et al (2021) Environmental indicators in salmon aquaculture research: A systematic review. Reviews in Aquaculture doi:10.1111/raq.12590.

Rey S, Treasurer J, Pattillo C et al (2021) Using model selection to choose a size-based condition index that is consistent with operational welfare indicators. Journal of Fish Biology 99(3):782-795.

Sievers M, Korsøen O, Warren-Myers F et al (2021) Submerged cage aquaculture of marine fish: A review of the biological challenges and opportunities. Reviews in Aquaculture doi:10.1111/raq.12587.

Teletchea F (2021) Fish domestication in aquaculture: 10 unanswered questions. Animal Frontiers 11(3):87–91.

Zupa W, Alfonso S, Gai F et al (2021) Calibrating accelerometer tags with oxygen consumption rate of rainbow trout (*Oncorhynchus mykiss*) and their use in aquaculture facility: A case study. Animals 11(6), 1496.

Cattle

Abdulai G, Sama M, Jackson J (2021) A preliminary study of the physiological and behavioral response of beef cattle to unmanned aerial vehicles (UAVs). Applied Animal Behaviour Science 241, 105355.

Aleri JW, Lyons A, Laurence M et al (2021) A descriptive retrospective study on mortality and involuntary culling in beef and dairy cattle production systems of Western Australia (1981–2018). Australian Veterinary Journal Volume 99(9):395-401.

Ali BM (2021) The effect of cow longevity on dynamic productivity growth of dairy farming. Livestock Science 250, 104582.

Antanaitis R, Juozaitienė V, Jonike V et al (2021) Relationship between temperament and stage of lactation, productivity and milk composition of dairy cows. Animals 11(7), 1840.

Bakony M, Kiss, G, Kovács L et al (2021) The effect of hutch compass direction on primary heat stress responses in dairy calves in a continental region. Animal Welfare 30(3):315-324(10).

Beaver A, Strazhnik E, Keyserlingk MAG et al (2021) The freestall reimagined: Effects on stall hygiene and space usage in dairy cattle. Animals 11(6), 1711.

Broadway PR, Mauget SA, Burdick Sanchez MC et al (2020) Correlation of ambient temperature with feedlot cattle morbidity and mortality in the Texas panhandle. Frontiers Veterinary Science doi:10.3389/fvets.2020.00413.

Brown AJ, Scoley G, O'Connell N et al (2021) Pre-weaned calf rearing on northern Irish dairy farms: Part 1. A description of calf management and housing design. Animals 11(7), 1954.

Bučková K, Šárová R, Moravcsíková A et al (2021) The effect of pair housing on dairy calf health, performance, and behavior. Journal of Dairy Science 104(9):10282-10290.

Caplen G, Held SDE (2021) Changes in social and feeding behaviors, activity, and salivary serum amyloid A in cows with subclinical mastitis. Journal of Dairy Science 104(10):10991-11008.

Cardoso CS, von Keyserlingk MAG, Pinheiro Machado Filho LC et al (2021) Dairy heifer motivation for access to a shaded area. Animals 11(9), 2507.

Conboy MH, Winder CB, Medrano-Galarza C et al (2021) Associations between feeding behaviors collected from an automated milk feeder and disease in group-housed dairy calves in Ontario: A cross-sectional study. Journal of Dairy Science 104(9):10183-10193.

Cooke RF, Lamb GC, Vasconcelos JLM et al (2021) Effects of body condition score at initiation of the breeding season on reproductive performance and overall productivity of *Bos taurus* and *Bos indicus* beef cows. Animal Reproduction Science 232, 106820.

Dachrodt L, Arndt H, Bartel A et al (2021) Prevalence of disorders in preweaned dairy calves from 731 dairies in Germany: A cross-sectional study. Journal of Dairy Science 104(8):9037-9051.

Eriksson HK, Daros RR, von Keyserlingk MAG et al (2021) Standing behavior and sole horn lesions: A prospective observational longitudinal study. Journal of Dairy Science 104(10):11018-11034.

Gaviglio A, Corradini AF, Marescotti ME et al (2021) A theoretical framework to assess the impact of flooding on dairy cattle farms: Identification of direct damage from an animal welfare perspective. Animals 11(6), 1586.

Hirata M, Hamada M, Kawagoe I et al (2021) Movement orders in spontaneous group movements in cattle: 6-year monitoring of a beef cow herd with changing composition. Journal of Ethology 39, 275–286.

Hubbard AJ, Foster MJ, Daigle CL (2021) Impact of social mixing on beef and dairy cattle—A scoping review. Applied Animal Behaviour Science 241, 105389.

Hubbard AJ, Foster MJ, Daigle CL (2021) Social dominance in beef cattle — A scoping review. Applied Animal Behaviour Science 241, 105390.

Humphry RW, Henry MK, Reeves A et al (2021) Estimating antimicrobial usage based on sales to beef and dairy farms from UK veterinary practices. Veterinary Record 189(1), e28.

Hunter LB, Haskell MJ, Langford FM et al (2021) Heart rate and heart rate variability change with sleep stage in dairy cows. Animals 11(7), 2095.

Hunter LB, O'Connor C, Haskell MJ et al (2021) Lying posture does not accurately indicate sleep stage in dairy cows. Applied Animal Behaviour Science 242, 105427.

Kneipp M, Green AC, Govendir M et al (2021) Risk factors associated with pinkeye in Australian cattle. Preventive Veterinary Medicine 194, 105432.

Lindner EE, Gingerich KN, Miller-Cushon EK (2021) Effects of early social contact on dairy calf response to initial social grouping and regrouping. Journal of Dairy Science 104(9):10090-10099.

Lora I, Massignani M, Stefani A et al (2021) Potential benefits to dairy cow welfare of using a ceftiofur–ketoprofen combination drug for the treatment of inflammatory disease associated with pyrexia: A field clinical trial on acute puerperal metritis. Animals 11(6), 1597.

Lv J, Zhao ZW, Su H et al (2021) Effects of group size on the behaviour, heart rate, immunity, and growth of Holstein dairy calves. Applied Animal Behaviour Science 241, 105378.

Mazza F, Scali F, Formenti N et al (2021) The relationship between animal welfare and antimicrobial use in Italian dairy farms. Animals 11(9), 2575.

McDonagh J, Tzimiropoulos G, Slinger KR et al (2021) Detecting dairy cow behavior using vision technology. Agriculture 11(7), 675.

Mijares S, Calvo-Lorenzo M, Betts N et al (2021) Characterization of fed cattle mobility during the COVID-19 pandemic. Animals 11(6), 1749.

Moreira LC, Rosa GJM, Schaefer DM (2021) Beef production from cull dairy cows: A review from culling to consumption. Journal of Animal Science 99(7), skab192.

Nakajima N, Mitsuishi H, Yayota M (2021) Temperament trait changes in Japanese Black Cows under grazing and confined conditions. Frontiers in Veterinary Science doi:10.3389/fvets.2021.705764.

Orihuela A, Mota-Rojas D, Strappini A et al (2021) Neurophysiological mechanisms of cow–calf bonding in buffalo and other farm animals. Animals 11(7), 1968.

Osawe OW, Läpple D, Hanlon A et al (2021) Exploring farmers' attitudes and determinants of dairy calf welfare in an expanding dairy sector. Journal of Dairy Science 104(9):9967-9980.

Owusu-Sekyereab E, Hansson H, Telezhenkod E (2021) Dairy farmers' heterogeneous preferences for animal welfare-enhancing flooring properties: A mixed logit approach applied in Sweden. Livestock Science 250, 104591.

Perttu RK, Ventura BA, Rendahl AK et al (2021) Public Views of dairy calf welfare and dairy consumption habits of American youth and adults. Frontiers in Veterinary Science doi:10.3389/fvets.2021.693173.

Ramón-Moragues A, Carulla P, Mínguez C et al (2021) Dairy cows activity under heat stress: A case study in Spain. Animals 11(8), 2305.

Reis NS, Ferreira IC, Mazocco LA et al (2021) Shade modifies behavioral and physiological responses of low to medium production dairy cows at pasture in an integrated crop-livestock-forest system. Animals 11(8), 2411.

Ritter C, Russell ER, Weary DM et al (2021) Views of American animal and dairy science students on the future of dairy farms and public expectations for dairy cattle care: A focus group study. Journal of Dairy Science 104(7):7984-7995.

Robbers L, Jorritsma R, Nielen M et al (2021) A scoping review of on-farm colostrum management practices for optimal transfer of immunity in dairy calves. Frontiers in Veterinary Science doi:10.3389/fvets.2021.668639.

Sandelin A, Hälli O, Härtel H et al (2021) Effect of farm and animal-level factors on youngstock mortality and growth on calf rearing farms. Preventive Veterinary Medicine 193, 105416.

Schenkenfelder J, Winckler C (2021) Animal welfare outcomes and associated risk indicators on Austrian dairy farms: A cross-sectional study. Journal of Dairy Science 104(10):11091-11107.

Schutz J, Rudolph J, Steiner A et al (2021) Immunization against gonadotropin-releasing hormone in female beef calves to avoid pregnancy at time of slaughter. Animals 11(7), 2071.

Silva SR, Araujo JP, Guedes C et al (2021) Precision technologies to address dairy cattle welfare: Focus on lameness, mastitis, and body condition. Animals 11(8), 2253.

Skjølstrup NK, Lastein DB, Jensen CS et al (2021) The antimicrobial landscape as outlined by Danish dairy farmers. Journal of Dairy Science 104(10):11147-11164.

Smid AMC, Inberg PHJ, de Jong S et al (2021) Perspectives of Western Canadian dairy farmers on providing outdoor access for dairy cows. Journal of Dairy Science 104(9):10158-10170.

Uddin J, Phillips CJC, Auboeuf M et al (2021) Relationships between body temperatures and behaviours in lactating dairy cows. Applied Animal Behaviour Science 241, 105359.

Ujita A, Seekford Z, Kott M et al (2021) Habituation protocols improve behavioral and physiological responses of beef cattle exposed to students in an animal handling class. Animals 11(8), 2159.

van Dyke R, Connor M, Miele A (2021) An investigation into the perceptions of veterinarians towards perioperative pain management in calves. Animals 11(7), 1882.

Ventura G, Lorenzi V, Mazza F et al (2021) Best farming practices for the welfare of dairy cows, heifers and calves. Animals 11(9), 2645.

Volkmann N, Stracke J, Rauterberg SL et al (2021) Determination of static space requirements for finishing bulls based on image analysis. Animal Welfare 30(3):307-314(8).

Wisnieski L, Amrine DE, Renter DG (2021) Predictive modeling of bovine respiratory disease outcomes in feedlot cattle: A narrative review. Livestock Science 251, 104666.

Whalin L, Weary DM, von Keyserlingk MAG (2021) Understanding behavioural development of calves in natural settings to inform calf management. Animals 11(8), 2446.

Yoshihara Y, Oya K (2021) Characterization and assessment of vocalization responses of cows to different physiological states. Journal of Applied Animal Research 49(1):347-351

Pigs

Bus JD, Bousman IJMM, Webb LE et al (2021) The potential of feeding patterns to monitor the welfare of growing-finishing pigs. Proceedings of the 8th International Conference on the Assessment of Animal Welfare at Farm and Group level. 16-19 August 2021.

Cao M, Zong C, Zhuang Y et al (2021) Modeling of heat stress in sows Part 2: Comparison of various thermal comfort indices. Animals 11(6), 1498.

Capoferri R, Parati K, Puglisi R et al (2021) Comparison between single- and group-housed pregnant sows for direct and indirect physiological, reproductive, welfare indicators and gene expression profiling. Journal of Applied Animal Welfare Science 24(3):246-259.

Dalmau A, Sanchez-Matamoros A, Molina JM et al (2021) Intramuscular vs. intradermic needle-free vaccination in piglets: relevance for animal welfare based on an aversion learning test and vocalizations. Frontiers in Veterinary Science 8, 715260.

Dos Santos JV, de Souza Farias S, Pereira TL et al (2021) Preference for and maintenance of interest in suspended enrichment toys in confined growing pigs. Journal of Veterinary Behavior 45:68-73.

EFSA Panel on Animal Health and Welfare (2021) African swine fever and outdoor farming of pigs. EFSA Journal 19(6), e06639.

Guzman-Peno SA, Luna D, Salazar LC et al (2021) Effect of switching sows' positions during lactation on suckling behaviour and performance of co-mingling piglets. Applied Animal Behaviour Science 241, 105391.

Hakansson F, Bolhuis JE (2021) Tail-biting behaviour pre-weaning: Association between other pig-directed and general behaviour in piglets. Applied Animal Behaviour Science 241, 105385.

Hall KJ, Fleming PA (2021) In the spotlight: Can lights be used to mitigate fox predation on a free-range piggery? Applied Animal Behaviour Science 242, 105420.

Hansen MF, Baxter EM, Rutherford KMD et al (2021) Towards facial expression recognition for on-farm welfare assessment in pigs. Agriculture 11(9), 847.

Heinola K, Kauppinen T, Niemi JK et al (2021) Comparison of 12 different animal welfare labeling schemes in the pig sector. Animals 11(8), 2430.

Henry M, Jansen H, Amezcua MR et al (2021) Tail-biting in pigs: A scoping review. Animals 11(7), 2002.

Horback K, McVey C, Pierdon M (2021) Association patterns across multiple gestation cycles within a dynamic sow pen. Applied Animal Behaviour Science 242, 105426.

Krugmann KL, Mieloch FJ, Krieter J et al (2021) Can tail and ear postures be suitable to capture the affective state of growing pigs? Journal of Applied Animal Welfare Science 24(4):411-423.

Liu X, Song P, Yan H et al (2021) A comparison of the behavior, physiology, and offspring resilience of gestating sows when raised in a group housing system and individual stalls. Animals 11(7), 2076.

Luna D, Gonzalez C, Byrd CJ et al (2021) The effect of demonstrator social rank on the attentiveness and motivation of pigs to positively interact with their human caretakers. Animals 11(7), 2140.

Marsh L, Hutchinson MR, McLaughlan C et al (2021) Evaluation of miRNA as biomarkers of emotional valence in pigs. Animals 11(7), 2054.

Ming D, Wang W, Huang C et al (2021) Effects of weaning age at 21 and 28 days on growth performance, intestinal morphology and redox status in piglets. Animals 11(8), 2169.

Neu J, Gores N, Kecman J et al (2021) Behavioral observation procedures and tests to characterize the suitability of sows for loose-housed farrowing systems. Animals 11(9), 2547.

Niemi JK, Edwards SA, Dimitris K et al (2021) Cost-effectiveness analysis of seven measures to reduce tail biting lesions in fattening pigs. Frontiers in Veterinary Science 8, 682330.

Pandey S, Kalwa U, Kong T et al (2021) Behavioral monitoring tool for pig farmers: Ear tag sensors, machine intelligence, and technology adoption roadmap. Animals 11(9), 2665.

Pierdon MK, Berdahl SE (2021) Effect of topical spray containing lidocaine on piglet behaviour post castration. Journal of Applied Animal Welfare Science 1-10, doi:10.1080/10888705.2021.1946397.

Povse MP, Mesarec N, Skok J et al (2021) Agonistic interactions between littermates reappear after mixing multiple litters at weaning in pigs. Agriculture 11(9), 844.

Scaillierez AJ, Boumans IJMM, van Nieuwamerongen SE et al (2021) Can artificial light enlighten pig welfare? Proceedings of the 8th International Conference on the Assessment of Animal Welfare at Farm and Group level. 16-19 August 2021.

Tzanidakis C, Simitzis P, Arvanitis K et al (2021) An overview of the current trends in precision pig farming technologies. Livestock Science 249:4530.

Upadhaya S, Kim I (2021) The impact of weaning stress on gut health and the mechanistic aspects of several feed additives contributing to improved gut health function in weanling piglets—A review. Animals 11(8), 2418.

Vargas LB, Caldara FR, de Castro Lippi IC et al (2021) Environmental enrichment strategies for weaned pigs: Welfare and behavior. Applied Animal Welfare Science doi:10.1080/10888705.2021.1967753.

Vitali M, Nannoni E, Sardi L et al (2021) Knowledge and perspectives on the welfare of Italian heavy pigs on farms. Animals 11(6), 1690.

Vitali M, Santolini E, Bovo M et al (2021) Behavior and welfare of undocked heavy pigs raised in buildings with different ventilation systems. Animals 11(8), 2338.

Poultry

Anderson MG, Campbell AM, Crump A et al (2021) Effect of environmental complexity and stocking density on fear and anxiety in broiler chickens. Animals 11(8), 2383.

Bartels T, Berk J, Cramer K (2021) Research Note: A sip of stress. Effects of corticosterone supplementation in drinking water on feather corticosterone concentrations in layer pullets. Poultry Science 100(9), 101361.

Campbell DLM, Whitten JM, Slater E et al (2021) Rearing enrichments differentially modified hen personality traits and reduced prediction of range use. Animal Behaviour 179:97-109.

Cavusoglu E, Petek M (2021) Effects of season, plumage colour, and transport distance on body weight loss, dead-on-arrival, and reject rate in commercial end-of-lay hens. Animals 11(6), 1827.

Chen S, Yan C, Xiao J et al (2021) Domestication and feed restriction programming organ index, dopamine, and hippocampal transcriptome profile in chickens. Frontiers in Veterinary Science 8, 701850.

De Jong IC, Blaauw XE, van der Eijk JAJ et al (2021) Providing environmental enrichments affects activity and performance, but not leg health in fast- and slower-growing broiler chickens. Applied Animal Behaviour Science 241, 105375.

Diarra S, Lameta S, Amosa F et al (2021) Alternative bedding materials for poultry: Availability, efficacy, and major constraints. Frontiers in Veterinary Science 8, 669504.

Eda M (2021) Origin of the domestic chicken from modern biological and zooarchaeological approaches. Animal Frontiers 11(3):52–61.

Fernandes AM, de Lucca Sartori D, de Oliveira Morais FJ et al (2021) Analysis of cluster and unrest behaviors of laying hens housed under different thermal conditions and light wavelength. Animals 11(7), 2017.

Ferreira VHB, Guesdon V, Calandreau L (2021) How can the research on chicken cognition improve chicken welfare: A perspective review. World's Poultry Science Journal 77(3):679-698.

Forslind S, Blokhuis HJ, Riber AB (2021) Disturbance of resting behaviour of broilers under different environmental conditions. Applied Animal Behaviour Science 242, 105425.

Guo Y, Wang Y, Liu Z et al (2021) Effects of rearing systems on production performance, antioxidant capacity and immune status of meat ducks at different ages. Animal 15(7), 100199.

Habig C, Henning M, Baulain U et al (2021) Keel bone damage in laying hens—its relation to bone mineral density, body growth rate and laying performance. Animals 11(6), 1546.

Herbert GT, Redfearn WD, Brass E et al (2021) Extreme crowding in laying hens during a recurrent smothering outbreak. Veterinary Record 188(12), e245.

Keßler F, Grumpel-Schluter A, Looft C et al (2021) Investigation of the morphology of adrenal glands in hens kept in two different housing systems—A pilot study. Animals 11(7), 2124.

Krysiak K, Konkol D, Korczynski M (2021) Overview of the use of probiotics in poultry production. Animals 11(6), 1620.

Liao S, Lu P, Shen S et al (2021) Effects of different swimming pool conditions and floor types on growth performance and footpad dermatitis in indoor-reared white Roman geese. Animals 11(6), 1705.

Liu ZL, Xue JJ, Huang XF et al (2021) Effect of stocking density on growth performance, feather quality, serum hormone, and intestinal development of geese from 1 to 14 days of age. Poultry Science 100(11), 101417.

Mohsin M, Abbas RZ, Yin G et al (2021) Probiotics as therapeutic, antioxidant and immunomodulatory agents against poultry coccidiosis. World's Poultry Science Journal 77(2):331-345.

Morgan NK (2021) Managing gut health without reliance on antimicrobials in poultry. Animal Production Science 57(11):2270-2279.

Narinc D, Aydemir E (2021) Chick quality: an overview of measurement techniques and influencing factors. World's Poultry Science Journal 77(2):313-329.

Olgun O, Abdulqader AF, Karabacak A (2021) The importance of nutrition in preventing heat stress at poultry. World's Poultry Science Journal 77(3):661-678.

Pepper CM, Dunlop MW (2021) Review of litter turning during a grow-out as a litter management practice to achieve dry and friable litter in poultry production. Poultry Science 100(6):1071.

Phibb DV, Groves PJ, Muir WI (2021) Leg health of meat chickens: Impact on welfare, consumer behaviour, and the role of environmental enrichment. Animal Production Science 61(12):1203-1212.

Sans ECO, Tuyttens FAM, Taconeli CA et al (2021) Welfare of broiler chickens reared under two different types of housing. Animal Welfare 30(3):341-353.

Sun Z, Gao M, Wang G et al (2021) Research on evaluating the filtering method for broiler sound signal from multiple perspectives. Animals 11(8), 2238.

Sztandarski P, Marchewka J, Wojciechowski F et al (2021) Associations between weather conditions and individual range use by commercial and heritage chickens. Poultry Science 100(8), 101265.

Taff CC, Zimmer C, Scheck D et al (2021) Plumage manipulation alters associations between behaviour, physiology, the internal microbiome and fitness. Animal Behaviour 178:11-36.

Thofner ICN, Dahl J, Christensen JP (2021) Keel bone fractures in Danish laying hens: Prevalence and risk factors. PLoS ONE 16(8), e0256105.

Rabbits

Jaén-Téllez JA, Sánchez-Guerrero MJ, Valera M (2021) Influence of stress assessed through infrared thermography and environmental parameters on the performance of fattening rabbits. Animals 11(6), 1747.

Sheep/Goats

Agenbag B, Swinbourne AM, Petrovskia K et al (2021) Lambs need colostrum: A review. Livestock Science 251, 104624.

Bélanger-Naud S, Cinq-Mars D, Julien C et al (2021) A survey of dairy goat kid-rearing practices on Canadian farms and their associations with self-reported farm performance. Journal of Dairy Science 104(9):9999-10009

Eyre L, Huggett ZJ, Slingera KR et al (2021) The association between foot temperature and hoof lesions in sheep. Livestock Science 251, 104606.

Maurmann I, Greiner BAE, von Korn S et al (2021) Lying behaviour in dairy goats: Effects of a new automated feeding system assessed by accelerometer technology. Animals 11(8), 2370.

Plummer C, White PJ, Kimble B et al (2021) Preliminary investigation into a novel sustained-release formulation of meloxicam in sheep (*Ovis aries*)—Pharmacokinetic profile. Animals 11(9), 2484.

Small A, Marini D, Colditz I (2021) Local anesthetic delivered with a dual action ring and injection applicator reduces the acute pain response of lambs during tail docking. Animals 11(8), 2242.

Williams M, Davis CN, Jones DI et al (2021) Lying behaviour of housed and outdoor-managed pregnant sheep. Applied Animal Behaviour Science 241, 105370.

General

Bergschmidt A, March S, Wagner K et al (2021) A results-oriented approach for the animal welfare measure of the European Union's rural development programme. Animals 11(6), 1570.

Bradford BJ, Cooper CA, Tizard ML et al (2021) RNA interference-based technology: what role in animal agriculture? Animal Production Science 57:1-15.

Callahan MM, Satterfield T, Zhao J (2021) Into the animal mind: Perceptions of emotive and cognitive traits in animals. Anthrozoös 34(4):597-614.

Campbell DLM, D. Marini, Lea LM, Keshavarzi H et al (2021) The application of virtual fencing technology effectively herds cattle and sheep. Animal Production Science 61(13):1393-1402.

Cucchi T, Arbuckle B (2021) Animal domestication: From distant past to current development and issues. Animal Frontiers 11(3):6-9.

Dawkins MS (2021) Animal welfare and efficient farming: Is conflict inevitable? Animal Production Science 57(2):201-208.

DeGroot A, Coe JB, Kelton D et al (2021) Comparison of food-animal veterinarians' and producers' perceptions of producer-centered communication following on-farm interactions. Veterinary Record 189(4), e139.

Endenburg N, Takashima G, van Lith HA et al (2021) Animal welfare worldwide, the opinion of practicing veterinarians. Journal of Applied Animal Welfare Science 24(3):215-237.

Grossi G, Goglio P, Vitali A et al (2021) Livestock and climate change: Impact of livestock on climate and mitigation strategies. Animal Frontiers 9(1):69-76.

Hockenhull J, Squibb K, Cameron A (2021) How has the COVID-19 pandemic affected the way we access and interact with the countryside and the animals within it? Animals 11(8), 2281.

Johnson C, Schreer G, Jacobs Bao K (2021) Effect of anthropomorphizing food animals on intentions to eat meat. Anthrozoös 34(4):563-578.

Johnson JS (2021) Heat stress: Impact on livestock well-being and productivity and mitigation strategies to alleviate the negative effects. Animal Production Science 58(8):1404-1413.

Lundmark Hedman F, Veggeland F, Vågsholm I et al (2021) Managing animal welfare in food governance in Norway and Sweden: Challenges in implementation and coordination. Animals 11(7), 1899.

Narayan E, McElligott AG (2021) Editorial: Animal welfare assessment: Edition 2. Frontiers in Veterinary Science 8, 736827.

Neethirajan S (2021) The use of artificial intelligence in assessing affective states in livestock. Frontiers in Veterinary Science 8, 715261.

Neethirajan S, Kemp B (2021) Digital phenotyping in livestock farming. Animals 11(7), 2009.

Rogers LJ (2021) Brain lateralization and cognitive capacity. Animals 11(7), 1996.

Rowland T, Pike TW, Burman OHP (2021) A network perspective on animal welfare. Animal Welfare 30(3):235-248.

Santaca M, Agrillo C, Petrazzini MEM (2021) The challenge of illusory perception of animals: The impact of methodological variability in cross-species investigation. Animals 11(6), 1618.

Santo RE, Kim BF,2, Goldman SE et al (2021) Considering plant-based meat substitutes and cell-based meats: A public health and food systems perspective. Frontiers in Sustainable Food Systems 4, 134.

Travain T, Valsecchi P (2021) Infrared thermography in the study of animals' emotional responses: A critical review. Animals 11(9), 2510.

Valkova L, Voslarova E, Vecerek V et al (2021) Traumatic injuries detected during post-mortem slaughterhouse inspection as welfare indicators in poultry and rabbits. Animals 11(9), 2610.

Windsor PA (2021) Progress with livestock welfare in extensive production systems: Lessons from Australia. Frontiers in Veterinary Science 8, 674482.

ANIMALS IN SPORT, ENTERTAINMENT, PERFORMANCE, RECREATION AND WORK

Andersen PH, Broomé S, Rashid M et al (2021) Towards machine recognition of facial expressions of pain in horses. Animals 11(6), 1643.

Atalaia T, Prazeres J, Abrantes J et al (2021) Equine rehabilitation: A scoping review of the literature. Animals 11(6), 1508.

Bell C, Rogers S (2021) Attitudes of the equestrian public towards equine end-of-life decisions. Animals 11(6), 1776.

Campbell MLH (2021) An ethical framework for the use of horses in competitive sport: Theory and function. Animals 11(6), 1725.

Fernandez EJ, Upchurch B, Hawkes NC (2021) Public feeding interactions as enrichment for three zoo-housed elephants. Animals 11(6), 1689.

Fletcher KA, Cameron, LJ, Freeman M et al (2021) Contemplating the Five Domains model of animal welfare assessment: UK horse owner perceptions of equine well-being. Animal Welfare 30(3):259-268(10.

Gehlen H, Puhlmann J, Merle R et al (2021) Evaluating horse owner expertise and professional use of auxiliary reins during horse riding. Animals 11(7), 2146.

Gozalo-Marcilla M, Ringer SK (2021) Recovery after general anaesthesia in adult horses: A structured summary of the literature. Animals 2021, 11(6), 1777.

Hall BA, McGill DM, Sherwen SL et al (2021) Cognitive enrichment in practice: A survey of factors affecting its implementation in zoos globally. Animals 11(6), 1721.

Hall NJ, Johnston AM, Bray EE et al (2021) Working dog training for the twenty-first century. Frontiers in Veterinary Science 8, 834.

Isaksen KE, Linney L, Williamson H et al (2021) TeamMate: A longitudinal study of New Zealand working farm dogs. III. Factors affecting the risk of dogs being lost from the workforce. Animals 11(6), 1602.

Krueger K, Esch L, Farmer K et al (2021) Basic needs in horses? —A literature review. Animals 11(6), 1798.

Nogueira LB, Palme R, Mendonça-Furtado O (2021) Give them a toy or increase time out of kennel at lawn areas: What is the influence of these interventions on police dogs' welfare? Animals 11(8), 2264.

Rooney NJ, Wonham KL, McIndoe KS et al (2021) Weekly and daily tooth brushing by care staff reduces Gingivitis and Calculus in racing greyhounds. Animals 11(7), 1869.

Trindade PHE, Taffarel MO, Loureiro Luna SPL (2021) Spontaneous behaviors of post-orchiectomy pain in horses regardless of the effects of time of day, anesthesia, and analgesia. Animals 11(6), 1629.

van Loon JPAM, Macri L (2021) Objective assessment of chronic pain in horses using the horse chronic pain scale (HCPS): A scale-construction study. Animals 11(6), 1826.

ANIMALS IN RESEARCH AND TEACHING

Schmidt T, Ferrara F, Pobloth A et al (2021) Large farm animals used for research purposes: A survey on purchase, housing and hygiene management. Animals 11(8), 2158.

WILD ANIMALS

Audino T, Grattarola C, Centelleghe C et al (2021) SARS-CoV-2, a threat to marine mammals? A study from Italian seawaters. Animals 11(6), 1663.

Borgmans G; Palme R, Sannen A et al (2021) The effect of long term captivity on stress levels in Anolis Carolinensis lizards. Journal Of Applied Animal Welfare Science 24(3):321-330.

Brown AO, Frankham FJ, Stuart BH et al (2021) Reptile volatilome profiling optimisation: A pathway towards forensic applications. Forensic Science International: Animals and Environments 1, 100024. [Author Amber Brown was the recipient of the RSPCA's 2019 Alan White Scholarship]

Parrott ML, Wicker LV, Lamont A et al (2021) Emergency response to Australia's Black Summer 2019–2020: The role of a zoo-based conservation organisation in wildlife triage, rescue, and resilience for the future. Animals 11(6), 1515.

TRANSPORTATION OF ANIMALS

Miranda-de la Lama GC, Bermejo-Poza R, Formoso-Rafferty N et al (2021) Long-distance transport of finisher pigs in the Iberian Peninsula: Effects of season on thermal and enthalpy conditions, welfare indicators and meat pH. Animals 11(8), 2410.

Teixeira DL, Lykke L, Boyle L (2021) The effect of a novel transport system on the welfare and meat quality of slaughter pigs. Journal of Applied Animal Welfare Science 24(3):260-271.

Wagner BK, Martin DG, Rudd DM et al (2021) Oxytocin alters leukogram composition in *Bos indicus* cattle exposed to short-duration transportation. Animal Production Science 61(13):1315-1320.

HUMANE KILLING

Imlan JC, Kaka U, Goh YM et al (2021) Effects of slaughter positions on catecholamine, blood biochemical and electroencephalogram changes in cattle restrained using a modified mark IV box. Animals 11(7), 1979.

Kay WR, Mawson PR (2021) An efficient method for the euthanasia of cane toads (*Rhinella marina*) under Northern Australian field conditions. Animals 11(8), 2239.

Xu L, Yang H, Wan X et al (2021) Effects of high-frequency electrical stunning current intensities on pre-slaughter stunning stress and meat lipid oxidation in geese. Animals 11(8), 2376.

MISCELLANEOUS

Atwoli L, Baqui AH, Benfield T et al (2021) Call for emergency action to limit global temperature increases, restore biodiversity and protect health. Veterinary Record 189(5), e875.

Endenburg N, Takashima G, van Lith HA et al (2021) Animal welfare worldwide, the opinion of practicing veterinarians. Journal of Applied Animal Welfare Science 24(3):215-237.

Sneddon JN, Evers W, Lee JA (2021) Giving to animal charities: A nine-country study. Anthrozoös doi:10.1080/08927936.2021.1938409.

Jacobs J, Reese LA (2021) Compassion fatigue among animal shelter volunteers: Examining personal and organizational risk factors. Anthrozoös doi:10.1080/08927936.2021.1926719.

Jones NAR, Webster MM, Salvanes AGV (2021) Physical enrichment research for captive fish: Time to focus on the DETAILS. Journal of Fish Biology 99(3):704-725.

Pejman N, Kallas Z, Reig L et al (2021) Should animal welfare be included in educational programs? Attitudes of secondary and university students from eight EU countries. Journal of Applied Animal Welfare Science doi:10.1080/10888705.2021.1969931.

Potocka A (2021) The moral foundations of care and authority and the perception of animal mind in relation to violence against animals. Anthrozoös doi:10.1080/08927936.2021.1963547.

Randler C, Adan A, Antofie M et al. (2021) Animal welfare attitudes: Effects of gender and diet in university samples from 22 countries. Animals 11, 7.

Widdicombe IJ, Dowling-Guyer S (2021) I am Homo Sapien: Perceptions of evolutionary theory, animal identity, and human–animal relationships among us law and policy students. Anthrozoös 34(5):633-657.

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