



One welfare impacts of COVID-19 – A summary of key highlights within the one welfare framework[☆]

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ABSTRACT

One Welfare describes the interconnection between animal welfare, human wellbeing and their physical and social environment. The SARS-CoV-2 virus is the cause of COVID-19 and emerged as a human pathogen in 2019 although is thought to have a zoonotic source. The original wildlife reservoir and any potential intermediate hosts have not yet been identified. The combination of the virus zoonotic condition together with the impacts of disease control measures has exposed clear interconnections between animals, people and their environment from both a health and a welfare perspective. The One Welfare Framework comprises five sections that can help understand the different One Welfare levels on which the COVID-19 pandemic has impacted the world. This paper uses the One Welfare Framework to provide an overview of examples, within each of the five sections, where evidence is and/or can be made available to document COVID-19 impacts on One Welfare. The paper identifies a number of areas where further research and evidence gathering is required to better understand the different One Welfare impacts. Based on evidence summarised in this paper the author recommends that those responsible for managing the COVID-19 impacts and for planning the future recovery phase of the pandemic should consider adopting a holistic approach, including both health and welfare, by adopting “One Health, One Welfare” policies.

1. Introduction

The COVID-19 pandemic has impacted the lives of people and animals across the world. The SARS-CoV-2 virus is the cause of COVID-19. This virus emerged as a human pathogen in 2019 and is thought to have a zoonotic source, although the original wildlife reservoir has not yet been identified it has been demonstrated that farmed mink are highly susceptible to SARS-CoV-2 infection and, in some cases, they have transmitted the virus back to humans (OIE, 2020a). There is evidence showing that other animals such as tigers, lions, snow leopards, pumas, cats, dogs, ferrets (OIE, 2020a) or gorillas (USDA, 2021) have also been infected.

The virus disease control measures that have been implemented at global level include social distancing, quarantine periods as well as restrictions on elements that affect our daily lives such as temporary or permanent closure during defined periods of certain public and recreational services, schools, offices, non-essential businesses or compulsory requirements to wear face mask, among others. The combination of measures has changed not only our way of life but also the way we

interact with other people, animals and the environment around us (Bowen et al., 2020; Oliva and Johnston, 2020). This was acknowledged by the WHO Director General, explaining how the pandemic “is a reminder of the intimate and delicate relationship between people and planet. Any efforts to make our world safer are doomed to fail unless they address the critical interface between people and pathogens, and the existential threat of climate change, that is making our Earth less habitable.” (WHO, 2020).

There have been challenges all over the world in many different areas. Simple daily routines, such as walking a dog or caring for livestock have been affected by sickness, social distancing and/or quarantine restrictions (Bowen et al., 2020). Wider issues such as transport, education and training, animal care or safeguarding the average food and feed supply, vital for both people and animals, were and still are being affected (Marchant-Forde Jeremy and Boyle Laura, 2020; Vidaurreta et al., 2020; Zhuo et al., 2020). World leaders had to prioritise key issues such as food security and livelihoods of the most vulnerable, as well as setting up expert groups to understand and mitigate the pandemic’s impact on society, by improving our understanding on the virus origin, spread and control measures (EU, 2020; CA, 2020)

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Table 1

WHO Prescriptions for a healthy, green recovery in the context of One Welfare (Adapted from WHO, 2020).

WHO Prescription	One Welfare relevance
1) Protect and preserve the source of human health: Nature.	Nature is intrinsically connected to animal welfare, human wellbeing as well as their environment. Freedom from disease is a key animal welfare provision (FAWC, 1993). Protecting and preserving nature not only preserves health, it also preserves habitats and biodiversity which support not only their health but also our wellbeing and living things within them.
2) Invest in essential services, from water and sanitation to clean energy in healthcare facilities.	Services are key to ensure the welfare of animals, people and their environment. Freedom from thirst is a key animal welfare provision (FAWC, 1993) and as such maintaining essential services supports the welfare of animals dependant on human resources as well as human wellbeing. For a full One Welfare approach it is also important that the provision of such services is done in a way that respects the environment, to ensure a sustainable future.
3) Ensure a quick healthy energy transition.	Sickness or death by air pollution affect human wellbeing as, for example, they cause suffering and grievance on relatives. Furthermore there is an impact on animal welfare, by altering their habitats, availability and/or quality of food supply and causing death (i.e Cox et al., 2017; Gov. of Canada, 2012). Transitions to clean energy benefit health and welfare of all beings.
4) Promote healthy, sustainable food systems.	Animal welfare and sustainable animal production is an intrinsic part of promoting sustainable food systems. The wellbeing of farming communities, alongside that of their livestock, whilst using environment friendly management practices, such as silvopastoral systems (Huertas et al., 2017), can affect productivity and support sustainable food systems. Section 3 of the One Welfare Framework describes the many One Welfare facets relevant to this prescription (García Pinillos, R, 2018). Farm animal welfare also plays a pivotal role in driving animal health, performance and food safety all of which are crucial to the sustainability of animal production systems (Marchant Forde and Boyle, 2020).
5) Build healthy, liveable cities.	Urban cities comprise both wild and kept animals and it is also important to ensure that steps for 'liveable cities' account for them. There are multiple aspects that affect the welfare of animals, such as the way buildings are constructed, respecting wild animal habitats or providing alternatives, such as swift nesting bricks (Swift conservation, 2019). There are also One Welfare aspects to consider in the management of 'liveable cities' such as measures to support and encourage responsible ownership which include, as an example, walking areas or pet friendly tenancy agreements.
6) Stop using taxpayers' money to fund pollution.	The economics of fossil fuels, climate change and pollution harms are closely related to the welfare of animals, humans and the environment. There are multiple examples showing how variations in climate change are having impacts on productivity, such as heat stress resulting in production animals' fertility losses which represent a major source of economic loss to the livestock sector (Aggarwal & Upadhyay, 2012) and, as per prescription 1, how pollution equally affects animals and the environment. Costs for these additional areas should be added to private and social costs generated by health under a One Welfare approach.

(Rastelli et al., 2020; Cox et al., 2017; Gov. of Canada, 2012; Huertas et al., 2017; Swift conservation, 2019).

The environment, both at local and global level, has been subject to both positive effects, such as an improvement of environmental quality with a sharp decrease in air and noise pollution (Kumar et al., 2020; Muhammad et al., 2020; Zambrano-Monserrate et al., 2020) and negative impacts, such as increased waste volumes or used of disinfection chemicals (Kumar et al., 2020; Zambrano-Monserrate et al., 2020), as a result of pandemic control measures. These environmental aspects are intrinsically connected in different ways to animal welfare and human wellbeing.

The concept of One Health was introduced at the beginning of the 2000s, to capture the idea that human health and animal health are interdependent and bound to the health of the ecosystems in which they exist (OIE, 2021). The concept of One Welfare emerged later and was defined in 2018 as "the interrelationships between animal welfare, human wellbeing and the physical and social environment" (García Pinillos, 2018). Both concepts recognise that human and animal health and welfare are interconnected and encourage interdisciplinary collaboration between human and animal professionals.

Ensuring a unified One Health and One Welfare approach that helps address and support animals, people and their shared environment has become crucial under this pandemic as the interconnections have become obvious to all (Decaro et al., 2020; Marty and Jones, 2020). Integrated efforts are necessary to reduce disease and maintain wellbeing. This can be achieved by, for example, joining up efforts to reduce suffering at the animal/human sides, monitoring and supporting ongoing safe food and feed supplies, livelihoods, approaches that preserve nature, etc.

WHO has published prescriptions for a COVID-19 recovery which integrate health aspects, however, they can all be adapted to encompass the One Welfare concept (Table 1), providing a more holistic approach to recovery.

The One Welfare Framework comprises five sections which are intended to capture the different multidimensional aspects of the concept (García Pinillos, 2018). These sections provide a framework to help review and evidence the different One Welfare aspects on which the

COVID-19 pandemic has impacted on the world. This paper provides a preliminary literature review to identify examples within each of the five One Welfare framework sections where evidence is and can be made available to document COVID-19 impacts on One Welfare. An in-depth review as well as further evidence gathering and research into One Welfare aspects and the ongoing and long-term impacts of the pandemic within each section of the One Welfare Framework is needed. This paper has been drafted by the author with the intention to highlight gaps and examples where further evidence is needed to document One Welfare impacts.

2. Methods

This paper undertakes an initial, non-comprehensive, scoping review to provide key examples of One Welfare issues that have arisen during the COVID-19 pandemic for each of the five One Welfare Framework sections across the world.

A search² was carried out in English using multiple key word combinations of COVID and one or more of the following: One Welfare, Animal Welfare (68), Pet (217), Puppies or Puppy (2), Horse (47), Abuse (388 out of which 15 included Animal), Neglect (127 of which 3 included Animal), Farmer (124 of which 13 included welfare), Livestock (83), Transport (1369), Lab (355 out of which 35 including animal), Animal therapy (0), Therapy with animals (0), Feed (82), Biodiversity (114 out of which 61 include animal), Conservation (257 out of which 81 include animal), Wildlife (162 out of which 29 include welfare) and One Health (141 out of which 14 include welfare). In addition, a number of targeted online searches using CAB abstracts, Google Scholar, a university library COVID-19 online publications database and directly within international organisation sites (i.e. OIE, WHO, etc.) where undertaken where the author was aware of a particular topic but had not come across it in the papers reviewed. This included some searches in

² The search was undertaken between the 11–13th January 2021.

Spanish and Portuguese to identify a broader international range of examples using key words such as COVID-19, Cuarentena, Coronavirus, Pandemia and Mascotas.

The objective of the searches was to identify examples of One Welfare areas which have been reported and those that will benefit from further research and literature reviews as new papers and evidence continue to emerge. Where no specific references in scientific papers were found, grey literature or references close to the topic have been included where possible to help highlight interconnections that are not always made explicit.

The eligibility criteria to select papers was the author's judgement to identify topics that relate to the definition of One Welfare (García Pinillos, 2018). Where possible the author tried to reference papers documenting impacts in different countries, however further in depth searches including different country languages could be undertaken for an in depth study of the examples presented.

Data was not charted and no critical appraisal of individual sources of evidence was undertaken as this was outside the scope of this paper.

3. Results

3.1. Section 1: the connections between animal and human abuse and neglect

This section captures situations where animals are subject to abuse and/or neglect. The links between animal and human abuse and interpersonal violence have been documented by a number of studies generically (Arluke et al., 1999; Merz-Perez and Heide, 2004; Tiplady et al., 2012) or focused into particular population sectors such as children (Ascione and Arkow, 1999; Becker and French, 2004) youths (Ascione, 2001) or families (DeGue and Dilillo, 2009; Roguski, 2012).

Measures to control the spread of COVID-19 meant that a great proportion of the world population is in self-isolation, social distancing and spending much more time at home or the family farm during one or more instances of the pandemic (Bowen et al., 2020). This has changed the physical and social environment of individuals and families and, as a result, some of the risk factors that affect domestic violence. This has led to an increase in reported cases of domestic violence (Bradbury-Jones and Isham, 2020; Cambell, 2020; Usher et al. 2020).

Through the ongoing COVID-19 pandemic the media and grey literature have outlined that increased domestic abuse has become more prevalent, whereas there are no such reports about pet abuse in the home. The figures on domestic abuse across different organisations and countries consistently describe an increase with varying rates, such as 60 % (Mahase, 2020) going as high as 700 % (Refuge, 2020).

The continued reporting of increases in domestic violence within different countries across the world has been acknowledged at United Nations (UN) level as a 'shadow pandemic', leading to the UN Director General issuing a statement to call for violence to stop and for Governments to include prevention of domestic violence as part of the COVID-19 response plans (UN Women, 2020).

Control measures such as the closure of bars and other recreational establishments have led to a lack of social activity, job losses or other factors which might have led to increased alcohol consumption at home or aggravation of conduct disorders. These relate to risk factors that have been associated to interpersonal violence and animal abuse, such as alcohol use, antisocial behaviour, obsessive-compulsive disorders and others (Febres et al., 2014; Vaughn et al., 2009).

In contrast to increasing reports of domestic violence, many child welfare organisations are noting a significant drop in reports of child abuse or neglect. This is likely a result of schools and libraries closure (Cambell, 2020), among other establishments and public services. If a child or pet is experiencing abuse, there are less opportunities for adults outside the abuse circle to spot the signs and help, particularly in a lockdown or quarantine situation. This might also be the reason why an increase in pet abuse within the home setting has not been reported.

Recommendations to improve "collaborations between human welfare and animal welfare agencies, expanding community partnerships, and informing the public of the great importance of reporting any concerns of abuse" (Cambell, 2020) have been made and are of paramount relevance, at this time more than ever.

Whilst several Governments and organisations responded to this crisis by creating bespoke sites on domestic abuse and COVID-19 and created social media campaigns such as #youarenotalone (Gov.uk, 2020) we have not seen reciprocal campaigns raising awareness of animal abuse. Attachment to pets might be a reason preventing domestic abuse victims from leaving their abuser. Some Government departments issued specific guidance for domestic violence situations during the COVID-19 pandemic to help provide support to those in need (Spanish Government, 2020) and assisted on increasing the number of domestic violence refuges which accept pets, however it is unknown so far the overall impact and whether these initiatives have really made a difference within the lockdown situation. Some countries deployed funds to support domestic violence services, although the figures varied when compared to the funds for other sectors, such as in England, where funds amounted to up to £100 million for the zoos and aquariums sector (Gov.uk, 2020a) versus £22 to support sexual abuse and domestic violence charities (Gov.uk, 2020b).

A key One Welfare question that arises following the 'shadow pandemic' is whether there has been an increase on animal abuse that correlates with the human cases. Reporting of this has not been so prevalent. Potential causes of this could be:

- Animal welfare NGOs who would routinely pick up these cases had to let off staff or experienced reduced capabilities as a result of the pandemic, due to infected staff, lack of access to offices/resources, and a reduced economical income (ILO, 2020).
- Reduced staffing levels (ILO, 2020) within veterinary and inspectorate services may not have identified welfare cases.
- Lock down restrictions may have restricted cases to confined environments, without anyone able to witness and report the abuse (Cambell, 2020).
- Animal owners might become unable to care for their animals or fear they might become infected and present a risk to their health and abandon them, leading to neglect and mistreatment (Parry, 2020).

Where possible, animal abuse impacts should be documented, alongside those of human abuse in the context of their environments to fully understand the real impacts of the 'shadow pandemic' within section 1 of the One Welfare Framework.

3.2. Section 2: the social implications of improved animal welfare

Animal welfare is intrinsically connected to socioeconomic issues. Both developed and developing countries have reported disruptions in education, employment, religion, politics and other areas of life, with some population sectors have been far worse affected than others. These disruptions affect the Social Determinants of Health (SDOH) which include income, education, employment, and social support (Lowcock et al., 2012). The author considers that, in the context of COVID-19 impacts, the SDOH should be renamed as Social Determinants of Health and Wellbeing (SDOHW) and reviewed to take into account both health and wellbeing, including the interconnections between humans and animals where relevant. For example, recommendations to provide for human wellbeing have extended to provision of basic facilities such as water and light (Umoh et al., 2020). These basic facilities are basic needs for many animal species too and their provision help communities to also care for their animals.

Self-isolation, social distancing and spending much more time at home or the family farm during one or more instances of the pandemic (Bowen et al., 2020) means that some families might need extra support with family caring responsibilities, such as parenting or elderly care,

putting additional pressure on family members. Keeping pets might help to provide companionship and combat loneliness (Oliva and Johnston, 2020) but it can also become an additional responsibility, making it harder to balance the combined family and kept animals responsibilities, be this a family pet, livestock or any other kept animal. As an example of this, a US survey found that 10 % of pet owners might delay or avoid testing themselves for COVID-19, over 10 % would delay their own treatment mostly as a result of the need to secure accommodation for pets (Applebaum et al., 2020a).

Increased dog acquisitions were reported to combat loneliness or in areas where walking outdoors was only permitted for dog owners (Oliva and Johnston, 2020; Vet Record, 2020). Dogs became a pandemic precious commodity for companionship or as a means to go outdoors where this was permitted as an essential activity. Reports of increases in animal adoptions have grown around the world, with terms such as 'pandemic puppies' appearing in the media (Morgan et al., 2020; Vet Record, 2020).

However, acquisitions not always resulted or are likely to result in positive impacts; concerns about the future welfare of dogs that have grown with constant company and the risk to increase separation anxiety are very present among animal behaviour and welfare experts (Morgan et al., 2020; Delanoëje, 2020; Christley et al., 2021). Pets suffering of separation anxiety might have seen a positive improvement to their condition, with owners at home giving them more company and attention, however it is unknown whether this may result in a 'bounce back' effect, and possible recurrence or even aggravation of the condition once confinement measures are relaxed or removed completely. Socialisation of pets might have also been challenging for new pet owners, with veterinary practices unable to continue offering 'puppy parties' or similar events taking place, as they would breach COVID-19 restrictions at times (Hargrave, 2020, 2020a).

Alongside the pandemic puppies also came new caring responsibilities, arrangements to take them to the vet or dog groomer which might have generated some additional stress within lockdown arrangements. Access to veterinary care during the pandemic lockdown could also be challenging for multiple reasons, including family illness, control measures or vets having to assess clinical situations as well as the risks to their own safety (Mills, 2020). With limited veterinary and animal care services (i.e. dog groomers) this may have also affected routine care provision by pet owners in need of such services. Those involved in health care are expected to be at higher risk and the impact of additional stress factors such as self-isolation and quarantines (Kumar et al., 2020) as well as the change in working patterns, from average practice to telemedicine, are unknown.

Responsible ownership has therefore been impacted. Some pet owners, such as those immunocompromised, sick or direct contacts having to self-quarantine, have struggled to provide suitable exercise to pets in need where COVID-19 measures required the closure of parks, short walks or requirements for others to care for their pets (i.e. when the owner was in self-quarantine and unable to go outside) (Christley et al., 2021; de Mansilla, 2020). A study found that impaired quality of life of the owners was associated with a decrease in quality of life of their dog, as well as increased development of new behavioural problems, as judged by their owners (Morgan et al., 2020). On the other hand, some reported that many dogs had more play/training sessions with their owners and were given toys more frequently during lockdown (Christley et al., 2021).

All of these are One Welfare aspects as they affect both the wellbeing of the animal and the people that live around them, within a given environment affected by self-isolation and quarantine measures. A survey study in the US indicated that pet owners experienced unique hardships related to changes in everyday life from the COVID-19 pandemic. They also recommended that these hardships should be considered alongside the potential benefits of pet ownership in order to manage pet owner expectations, prevent pet relinquishment, and more fully understand multifaceted human-companion animal relationships

(Applebaum et al., 2020).

Rescue and rehoming organisations experienced directly opposite effects in different parts of the world. Whilst some saw an increase in the animals rehomed (Telegraph, 2020), others became full of rescued dogs as a result of sick owners unable to care for their pets or the own rescue centre been short of staff or placed in quarantine, hence becoming unable to rehome animals (Independiente, 2020). The number of abandoned animals also saw an increase in many countries; this could be as a result of concerns regarding the risk of virus transmission between companion animals and people (Yin et al., 2020) with an impact on animal welfare as animals were suffering from hunger, thirst and mistreatment. Whilst some reported that abandonment rates did not change (Morgan et al., 2020), others documented how increased rates of abandonment generated community impacts, with a raise on public complaints to the authorities and an increase on public safety issues due to hungry dogs attacking people in some communities (Globo, 2020; Heraldo de Mexico, 2020; Huang et al., 2020; La Razon, 2020).

Pandemic restrictions also affected other kept animal species such as domestic equines, altering working practices, interactions and access to equine care (Davies et al., 2020). A survey undertaken in the UK reported that "*the financial impact of the pandemic combined with restricted access to veterinary professionals resulted in owners expressing concerns that horse health and welfare may be compromised as a result. Horse owners also felt that the reduced opportunities for horse-human interactions were negatively affecting their mental health and welfare.*" (Williams et al., 2020). In addition, a study found that lockdown decreased performance outcome of horse-riders in eventing competitions up to six weeks and recommended that "*emotional stress in Dressage and workload in Cross-Country should be carefully managed by equestrian eventing stakeholders when planning training and competitions after a period of lockdown*" (Demarie et al., 2020). It is also important to manage and prevent any potential sport horse welfare impacts and further evidence and research in this area is desirable. Similar issues might apply to other sporting activities involving animals, such as greyhound racing.

Further evidence and research in relation to socioeconomical One Welfare impacts would be helpful alongside recommendations on how to manage lockdown impacts and recovery stages to ensure that the welfare of pet animals and others, such as sport animals, does not suffer or worsen during the pandemia recovery stages.

3.3. Section 3 animal health and welfare, human well-being, food security and sustainability

This section focuses on farming aspects, being most relevant to farmed animals and food production.

The risks of the COVID-19 pandemic affect all involved in the food production chain, from farm to processing, transport, distribution, retail and ultimately also the consumers (FAO, 2020a, 2002b; Ihle et al., 2020; Pan et al., 2020). Evidence shows that the virus survives in a number of surfaces that are commonly used in farming or food production (WHO, 2020a). This has a direct impact on the environment where both animals and workers interact, altering factors that can affect their wellbeing, such as the risk of infection or the implementation of new handling protocols or cleaning and disinfection procedures. Such changes have led to recommendations and changes in the work environment, issued by global organisations, governments, employers and worker unions. Workers have had to adapt at pace to new rules which require them to be more alert to identify COVID-19 symptoms, adapt to social distancing rules in the workplace and also cope with a reduced workforce (FAO, 2020b). We could add to these feelings of uncertainty, vulnerability and stress (de Campos Silva, 2020; Paul et al., 2020). Handling of animals by distressed workers during the pandemic is likely to have an impact on animal behaviour and welfare; some have suggested that smart systems integrating technology for livestock tracking and geofencing may help prevent the spread of COVID-19, lower farming costs and enable remote monitoring (Ityas and Ahmad, 2020). Further review and research in

these areas is needed.

The shortage of workers led to difficulties in undertaking routine animal care tasks, such as sheep shearing. Sheep remaining in full fleece longer into the summer are at greater risk of flystrike, lice and impaired mobility, while their lambs may find it harder to suckle (NSA, 2020). The pig and poultry industry in particular were among the worst affected, mainly due to their intensive production system nature (Marchant-Forde Jeremy and Boyle Laura, 2020). Examples of incidents within the poultry industry that can have One Welfare impacts are changes on the demand of poultry products, egg packaging and protective personal equipment shortages, labour shortages, salmonella testing capacity impacted due to reductions in postal services and laboratories capacity, etc. (Hafez and Attia, 2020; NFU, 2020).

The livestock industry suffered great economic impacts (Biswal et al., 2020; FAO, 2020b; Rude, 2020), irrespective of whether the actual livestock was affected by the virus directly. For example, a study in Spain reported that, although small ruminants are not sanitary affected by this virus, global data evidenced a lamb price drop ranging from 16.8%–26.9% and a 12.5 % to up to 40 % drop in the goat kid meat market (Vidaurreta et al., 2020). Some have also reported that decreased access to pastoral areas due to COVID-19 measures will impact transhumance, desert locust control, disaster relief or disease control (Griffith et al., 2020; FAO, 2020b). Livestock has various types of value, and the costs have not only been economical, but also supporting livelihoods (Griffith et al., 2020) as well as at the emotional value and animal bond level. The emotional impact of the pandemic on farmers (Hafez and Attia, 2020) and how these impacts on animal welfare is an area that also merits attention as part of any pandemic management and recovery phases. Further research in this area is needed.

Moving from livestock farming to slaughter, the multiple incidents of COVID-19 positive cases amongst workers in meat processing plants resulted in many slaughterhouses closing down. This had an impact on human wellbeing, animal welfare, and the environment (Marchant-Forde Jeremy and Boyle Laura, 2020). The reduction on processing capacity affected transport, with some animals/hauliers travelling longer distances to plants in operation, live animals kept living for longer periods with an impact on stocking densities and space on farm, leading, for example, to increased heat production and associated reduced environmental factors as well as the need for on farm culling of animals (Parry, 2020; Marchant-Forde Jeremy and Boyle Laura, 2020; Vidaurreta et al., 2020). Some reported farmers using abortion as a population control measure or inhumane culling methods that would impact animal welfare, such as ventilation shut down (Hashem et al., 2020). Increased workloads at operational plants with reduced staffing had also an impact on workers wellbeing, likely increasing their risk of injury, and the consequent potential impact on the welfare of live animals handled and stunned (Marchant-Forde Jeremy and Boyle Laura, 2020).

Other animal welfare and human wellbeing aspects include animals staying in slaughterhouse lairage for periods longer than expected, with the consequent impacts on the welfare of animals kept for extended times in mixed unfamiliar groups or unknown environments, as well as the pressure on slaughterhouse and related workers, with added management and care responsibilities. Reports of staff going to work whilst ill due to the lack of sick leave and health insurance (Marchant-Forde Jeremy and Boyle Laura, 2020) or because their sick-pay was not sufficient to pay their bills (Place, 2020) also affected human wellbeing aspects. Some reported that the logistical challenges around religious festivals involving animal slaughter, such as Eid-Ul-Adha, could have impacts resulting in sharp human COVID-19 infection rises due to congested animal selling points serving as a source of infection. Congested selling points have an impact both on human and animal welfare (Mallhi et al., 2020).

During the review period the author noted that the terminology used to refer to slaughterhouses varied and at times terms such as meat processing plants or food processing plants were used, eliminating

almost any reference to animals or meat in the context of the news item describing the incidents (BBC, 2020). Those terms should be included within any future literature reviews.

Moving to the consumer end, evidence available to date makes clear that COVID-19 is not transmitted by food (Shahidi, 2020), however, there is a risk of virus spread due to contact between people in food establishments. Because of this, pandemic control measures requiring the closure of non-essential shops, restaurants, hotels and entertainment facilities have been enforced. This, in addition to farmers and food chain workers becoming sick or quarantined had a direct impact on the food chain, production systems and trade (Hashem et al., 2020; Obayelu et al., 2020). Global guidance was developed focusing on impact mitigation to meet the immediate food needs of vulnerable populations, whilst aiming to support global food trade, domestic supply chains and supporting farming communities, among others (Aday and Aday, 2020; Nakat and Bou-Mitri, 2021). This is relevant to One Welfare because of the indirect impact on the rest of the food chain, resulting in animal welfare issues at the slaughterhouse and/or farm. This pandemic has exposed the frail current food chain and production systems that our societies have developed and how key is to review the status quo and future proof our food sources and livestock production chains, with full consideration of One Welfare.

Many experts have already pre-empted that the post-pandemic phase may result in major reviews of food systems with special emphasis on resilience (Shahidi, 2020). Hendrickson states that “we must reprioritize the main goal of any food system—to provide healthy, nutritious food for all people, now and in the future, in the face of a changing climate and declining natural resources. To do that we must pursue worker rights, animal welfare, farmer viability and ecological sustainability simultaneously because they are all tied together.” (Hendrickson, 2020). Marchant-Forde and Boyle add that “this model needs to be re-shaped to include the animal, human, and environmental elements across the farm to fork chain. Such a One Welfare approach will ensure that food production systems are resilient, flexible, and fair in the face of future challenges” (Marchant-Forde Jeremy and Boyle Laura, 2020). A One Health, One Welfare approach is vital for any post-pandemic reviews, ensuring that not only we care about health, trade and the economics of food, but also about animal welfare, human wellbeing, including labour and consumers, and the environment.

3.4. Section 4: assisted interventions involving animals, humans and the environment

Recognition of animal-human interactions has advanced greatly. Companion animals play a pivotal role here, and this is a key area in which veterinary professionals need to be involved to ensure that the needs of animals used for therapy are being cared for, and make the case to prevent companion animals being ‘used’ as, for example, a replacement for prescription drugs (Herzog, 2020). This will not only preserve the welfare of animals but also ensure that those undergoing therapy do not suffer unnecessarily, e.g. by discovering that their therapy animal becomes an additional burden, rather than providing the expected support.

A number of studies have shown that people are developing severe psychological conditions including depression (50.7 %), anxiety (44.7 %), and insomnia [sleeping disorder (36.1 %)] due to lockdowns (Muhammad et al., 2020; Xian et al., 2020). Some note that previous epidemics have resulted on an increase of psychiatric symptoms therefore, the development of mental symptoms after COVID-19 are expected (Xian et al., 2020). In this context, the role of animals in therapies and the wellbeing benefits of our interconnections with nature become relevant during and after the pandemic (Chaudhury and Banerjee, 2020). It is extremely important that those recommending the use of and involved in delivering assisted interventions involving animals, humans and the environment explore ways to support the mental effects of the pandemic in a way that can support both animal welfare and human wellbeing. Further research in this area is needed.

Table 2
Definitions of the 3Rs (Adapted from NC3Rs, 2020 and OIE, 2020).

	Standard Research	COVID-19 measures when working with free living wildlife or any other animal which might be a source of infection
Replacement	Use methods which avoid or replace the use of animals	Replace work with alternatives that do not require handling or potentially infectious animals (i.e. environmental sampling, remote monitoring)
Reduction	Use methods which minimise the number of animals used per experiment	Reduce the number of animals required to conduct the work where possible.
Refinement	Use methods which minimise animal suffering and improve welfare	Use methods that minimize the need for handling on the individual animal and on that animal's population.

A study reviewed the impacts of the lockdown on the human-animal bond in Spain and found that pet owners gained substantial support from their pets, with an increase observed when the owner's quality of life was more impaired. However, the study also found links between pet behavioural problems, general behavioural changes and aspects of the confinement, with some indication that the increasing emotional needs of owners observed could negatively affect pets that had existing behavioural problems (Bowen et al., 2020).

Elderly homes were specially affected by the pandemic, with many closing their doors to family visitors as a result of the infectious nature of the virus. Older adults within communities also experienced an increased risk of isolation and vulnerability, with stricter confinement measures in many cases. Social workers have been named as a key profession which can help bring the positive benefits of pet companionship into these situations, however it is key to ensure that those working with pets are equipped with the right knowledge and skills (Rauktis and Hoy-Gerlach, 2020). On the other hand many vulnerable people may have faced the opposite challenge, being forced to part from their pet, as a result of having to endure hospital care or being moved to care facilities that do not allow residents to bring their pets with them. The impacts of these environment changes have to be reviewed as part of the management and recovery phases to ensure that a One Welfare approach can be implemented, taking consideration of both positive and negative impacts of the interactions between animal welfare and human wellbeing within the different environments; for this it is crucial that both human and animal practitioners work in a collaborative way.

In the area of research, there have been structural, operational, social/psychological, and communication challenges (Regehr and Goel, 2020). The media reported impacts on laboratory animals, with impacts on human restrictions resulting on animal care shortages and disruptions to research involving animals. Reports indicated that some had to assess the need to keep and care for laboratory animals, having to freeze embryos of valuable or unique strains and/or having to rehome or cull a proportion or all of the research animals, with the consequent emotional impact on staff (Kelly et al., 2020; Grimm, 2020). Although we have not seen detailed reports of such operations, where the culling was undertaken in a humane way the impacts on the welfare of affected animals should be minimal. Further research on laboratory animal care and staff wellbeing impacts is encouraged.

3.5. Section 5: connections between biodiversity, the environment, animal welfare and human wellbeing

This section encompasses wider aspects such as availability and use of natural resources and their connections to climate change and the wellbeing of humans and animals.

Climate change relates to many drivers, such as food and agriculture systems, including trade, and ecosystem disruption, such as

deforestation/land clearance, illegal wildlife trade, etc. It is very important to understand these interconnections, and how different professions can support global efforts to preserve natural resources.

The very origin of the pandemic has drawn attention to One Health and One Welfare aspects within wet markets and the risk they present for wildlife conservation, welfare as well as the connections with local communities livelihoods, unsanitary conditions and public health, including zoonosis infection, risks. As a result, some have called for governments to re-evaluate the modus operandi of global wildlife trade (D'Cruze et al., 2020; Roe et al., 2020) or even ban with immediate effect the commercial trade of wild birds and mammals for consumption, mainly "to ensure a reduction on the risk of future zoonotic transmission while also safeguarding resources for those Indigenous Peoples and local communities who rely on wild meat to meet their nutritional requirements" (Walzer, 2020). In addition to this, it is important to also consider the One Welfare impacts that such ban could have. This include: impact on those who rely on it for their livelihoods (McNamara et al., 2020), the wellbeing of indigenous communities (Zavaleta-Cortijo et al., 2020), the welfare of wildlife animals that may no longer be captured illegally in the absence of a legal trade or the environment where such wild birds and mammals live where ecosystems and biodiversity might also be impacted. It is also essential, as noted by Walzer, 2020, to pair changes of this nature with relevant educational and social marketing measures concerning wildlife usage.

Global organisations such as the World Animal Health Organisation (OIE), International Union for Conservation of Nature (IUCN) and other specialist groups have released guidance for professionals working with free-living wildlife in situ, such as trained biologists, conservationists, researchers, veterinarians, etc so they can continue their vital role under the COVID-19 pandemic minimising transmission from people to free-living wild mammals (OIE, 2020). Conservation programs have suffered for multiple reasons, including a reduction of income funding from tourism, extractive industries enterprises seizing opportunities to encroach on conservation areas (Buckley, 2020; Lindsey et al., 2020) or as a result of the hardships from organisations which fund conservation programs, such as the zoo industry, which suffered severe economic losses across the world as a result of loss of income due to no visitors and the expense of fixed animal care costs, as well as reduced staffing numbers. Some received state support, whilst others had to euthanase part of their collections and consider cost cutting in areas such as staffing or conservation programmes (BBC, 2020a).

Recommendations from global organisations include a number of strategies intended to preserve health which will also result in preserving welfare. A key recommendation directly applicable to welfare is implementing the three Rs in the context of COVID-19 and work with wildlife (OIE, 2020). This can also be applied to any other animal which might be a source of infection. The three Rs is a well-known framework, originally intended to foster more humane animal research in laboratories (NC3Rs, 2020), and as a result preserving their welfare. Applying the three Rs (*Replacement, Reduction and Refinement*) in the context of working with animals that might be a source of infection during the COVID-19 pandemic shows they can also be used to preserve animal health, recognising that a more humane treatment of animals is paired with providing protection to human health as well as their own. The author considers that this provides a holistic "One Health, OneWelfare" perspective to the three Rs implementation and recommends that these steps serve to establish best practices that will last post-pandemic and trigger changes in wildlife work that are there to stay, for the benefit of both wildlife and the workers themselves (Table 2).

The pandemic has had some positive impacts related to biodiversity. Lockdown measures resulted on the closure of various industrial activities, almost ceasing pollution at their end (Rupani et al., 2020; Lokhandwala and Gautam, 2020) as well as a reduction on tourism. These have caused remarkable changes in the appearance of many rivers and beaches in the world, making them look cleaner as a result of clear waters and improved surface water quality (Kumar et al., 2020;

Table 3
Summary examples of key One Welfare impacts and causes during the COVID-19 pandemic'.

One Welfare Framework	One Welfare Impact	Virus infection and Disease Control Measures Causes
Section 1	Increased neglect and violence / abuse of people and animals	Lack of witnesses
		Shortage of enforcement officers
		Potential lack of reporting
		Fear of infection from animals
		Closure of bars leading to more alcohol consumption at home
		Aggravation of conduct disorders due to confinement
		Attachment to pets – unable to finding refuge that accepts pets
		Abandoned animals causing nuisance
		Safety concerns from hungry stray animals becoming threatening or aggressive
Section 2	Increased acquisition / rehoming of pets	Need for companionship
		Need for a means to access outdoor spaces
	Pet Abandonment / overload of rescue centres	Unable to cope with caring responsibilities
		Fear of infection from animals
		Reduction in animal rescues income (i.e. less donations)
	Human treatment delay	Shortage of personnel due to self-isolation, hospitalisation or death
	Risk of future development of separation anxiety	Unable to find accommodation for pets
	Improvements to separation anxiety symptoms	Confinement causing increased companionship
	Lack of general care and/or treatment	Restricted access to veterinary and/or animal care services (i.e. dog groomers)
		Shortage of personnel due to self-isolation, hospitalisation or death
Lack of exercise	Unable to cope with caring responsibilities	
	Unable to leave the house	
	Unable to walk in parks, travel to exercise in open spaces or undertake long walks	
Lack of socialisation	Unable to meet with other dogs/families	
	Vet practices unable to host 'puppy parties'	
Public safety issues from hungry stray animals	Lack of (enough) people on the streets feeding the animals	
Section 3	Animal handling changes	Risk of infection leading to a need for protective equipment and new disinfection protocols
		Shortage of personnel due to self-isolation, hospitalisation or death
	Food and feed shortages	Disruption of food supply chains
		Impact on desert locus controls due to decrease access to pastoral areas and/or shortage of personnel
	Reduced slaughter capacity, leading to: - Increased stocking densities, heat production and environmental factors reduction - Longer transport distances - Emotional distress due to farm losses (i.e. depopulation) and increased care responsibilities - Impacts on welfare of animals handled and stunned by overworked staff	High infection incidence on slaughterhouse workers
		Food chain disruptions, including animal transport
		Shortage of personnel due to self-isolation, hospitalisation or death
	Depopulation of farms, leading to welfare issues: - Use of inhumane culling methods - Causing abortions	Animal infection (i.e. mink)
		Unable to slaughter or sell livestock, leading to: - no longer profitable to keep livestock - no space available due to increased numbers animals kept on farm
	Difficulties providing routine animal care tasks (i.e. sheep shearing)	Confinement and lockdown
Shortage of personnel due to self-isolation, hospitalisation or death		
Section 4	Development of severe psychological conditions leading to calls for the use of animals in therapy	Confinement and lockdown
		Shortage of personnel due to self-isolation, hospitalisation or death
	Emotional needs of owners could negatively affect pets	Fear or infection
		Shortage of personnel due to self-isolation, hospitalisation or death
	Abandonment Animals handed over to rescue centres	Elderly unable to move with pets
		Shortage of personnel due to self-isolation, hospitalisation or death
Laboratory animal care shortages leading to: - Need to reduce number of kept animals - Emotional impact on laboratory staff	Fear or infection	
	Shortage of personnel due to self-isolation, hospitalisation or death	
Section 5	New guidance to work with wildlife developed Wildlife poaching increase	Risk of infection
		Loss of main economic income (i.e. tourism)
	Increase in wildlife sightings	Impacts on anti-poaching brigades due to confinement and lockdown or staff/supplies shortages.
No people on the streets / natural spaces		
Increase of invasive species		No people on the streets / natural spaces
		Staff shortages affecting invasive species controls
Collapse of conservation programmes		Reduction of income funding due to no tourism, sponsor organisations economic losses)
	Shortage of personnel due to self-isolation, hospitalisation or death	
Reduction in general care and resources within zoos leading	Reduced income as a result of closures or reduced visitor numbers	
	Cleaner beaches / rivers	Confinement and lockdown leading to closure of various industrial activities
		No tourist visiting beaches/rivers

Zambrano-Monserrate et al., 2020). Wildlife has reclaimed their territory and many media sources and publications have reported sightings of wild animals, including endangered species, not commonly seen in certain areas for a long time in temporarily less-disturbed habitats (Manenti et al., 2020; Sencilla, 2020; Silva-Rodríguez et al., 2020). Whilst the decrease in tourism has positively affected wildlife, a reduction on enforcement and controls has also opened the doors to increased wildlife crime threats (Kumar et al., 2020). A negative aspect of this increase is however a reported rise of some invasive species (Manenti et al., 2020). Publications have started reporting a rise of wildlife poaching in Africa, aggravated by the pandemic, as a replacement to the loss of main economic incomes, such as tourism (Xinhua, 2020). Impacts on anti-poaching brigades such as movement restrictions, working supplies and exhaustion or reduced staff moral have also been mentioned (Lindsey et al., 2020).

Further studies on the pandemic impacts where animal welfare, human wellbeing and the environment affect biodiversity should take place, particularly to help target the continuation and/or re-assessment of conservation programs during and after the pandemic recovery phase.

4. Conclusion

This paper has found multiple examples of areas where the welfare of animals, humans and the environment interconnect and have or are being affected by the COVID-19 pandemic. The paper is not fully comprehensive and areas such as the One Welfare impacts of pollution, as an example, require further research and review in order to understand the impacts in a holistic way. Table 3 provides an extract summary of some of the One Welfare impacts and causes highlighted in this paper. Given that this pandemic is ongoing, further evidence continues to arise and it is possible that some of the situations described may change or that additional examples emerge. (Table 3)

Some have already raised how “the experience of Covid-19 seems to speak to the broader limitations of the One Health movement, or at least, reinforce a demarcation and segregation between its various components” (Enticott and Maye, 2020). The author agrees and strongly supports an approach that includes not only human and animal health but also welfare components for all, to ensure that a fully comprehensive and holistic approach takes place.

Based on evidence summarised in this paper the author recommends that those responsible for managing the impacts and looking at the recovery phase of the pandemic should consider a holistic approach, including both health and welfare, by adopting One Health, One Welfare policies. For this, the role of Governments, civil society and academia is pivotal to educate, implement and disseminate One Health and One Welfare approaches.

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