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Keep your distance: Using Instagram posts to evaluate the risk of anthroponotic disease transmission in gorilla ecotourism

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Abstract

1. Mountain gorilla *Gorilla beringei beringei* trekking is a substantial source of revenue for the conservation of this threatened primate and its habitat. Trekking, however, may pose a threat of human-to-gorilla disease transmission that could have disastrous effects on wild gorillas.
2. We used 858 photographs posted on Instagram in 2013–2019 to analyse the proximity of tourists visiting mountain gorillas in the wild. We classified photographs of the encounters according to the distance between the closest gorilla and human, the age class of the gorilla, the trekking location and presence of a surgical face mask on the tourist. We ran a generalised linear mixed model to test whether these variables influenced the distance between the human and the wild gorillas in the photographs, and to test whether these distances have changed over time.
3. Most sampled photographs (86%) showed tourists within a critical 4 m of the gorillas, with 25 incidents of physical contact between a tourist and a gorilla, and only 3% at the recommended distance of 7 m or more. We only were able to record face mask use in the Democratic Republic of Congo, where these were present in 65% of uploaded photos.
4. Tourists and immature gorillas tended to get closer to each other than tourists and adult gorillas, and this is more pronounced in female tourists than male tourists. The mean distance between human and wild gorillas decreased by ~1 m between 2013 and 2019.
5. The results indicate that existing rules are not enforced and raise attention to this unsustainable aspect of mountain gorilla trekking as it is practiced today. These ever-growing tourist attractions in the range countries pose risks of disease transmission in both directions between tourists and wildlife. The popularity of photograph-based social media may stimulate closer contacts and influence people into risky behaviours.
6. We advocate the establishment and reinforcement of regulations relating to the distance between animals and tourists in any in situ wildlife ecotourism context,

as well as campaigns to raise awareness regarding the risks of anthroponosis, and fines applied in case of non-compliance.

KEYWORDS
conservation, Covid-19, disease transmission, ecotourism, *Gorilla beringei beringei*, Instagram

1 | INTRODUCTION

Wildlife tourism is an ever-growing field and an important contributor to the national income in many countries (Muehlenbein & Ancrenaz, 2009), and in 2018 it generated US$120.1 billion to the global GDP (World Travel & Tourism Council, 2019). Tourism is especially growing in areas with rare and threatened wildlife species and this trend is predicted to continue (Cong et al., 2014; Muehlenbein & Ancrenaz, 2009). This growth in wildlife tourism presents the problematic issue of anthroponotic (reverse zoonotic) disease transmissions due to the increase in human–wildlife interactions (Devaux et al., 2019; Muehlenbein, 2016; Rondeau et al., 2020; Sleeman et al., 2000; Woodford et al., 2002). Threatening both wildlife conservation and public health (Taylor et al., 2001), anthroponotic and zoonotic disease transmission between human tourists and the animals visited is therefore a crucial aspect to consider regarding the sustainability of these practices (Muehlenbein et al., 2010). In this context, gorillas (*Gorilla* spp.) are especially at risk due to their close genetic similarity with humans (e.g. a codon region analysis identified an amino acid sequence divergence between humans and gorilla proteins of a mere 1.58%; Hacia, 2001), and their susceptibility to emerging infectious diseases that affect humans globally (e.g. Lam et al., 2020). In the last decade, trekking to see mountain gorillas, a subspecies of the eastern gorilla *G. beringei*, has become a major tourist attraction in the range countries Rwanda, Uganda and Democratic Republic of Congo (DRC). The number of tourists visiting mountain gorillas has reached approximately 50,000 tourists every year (Robbins, 2018). As a result, Spelman et al. (2013) estimated 60% of wild mountain gorillas have been habituated to humans for tourism and research, with each group of habituated gorillas being exposed to thousands of visitor-hours per year (Homsy, 1999; Weber et al., 2020). In 2018 alone, gorilla permits were sold by the Rwanda Development Board for a total of US$19.2 million (Rwanda Development Board, 2019). Because of the substantial revenue it generates, 'gorilla ecotourism' is considered a key component for regional economic development and gorilla conservation (Moorhouse et al., 2015).

Nonetheless, the value of ecotourism as a conservation tool and its sustainability are debated due to its potential negative impacts on gorilla populations (Dunay et al., 2018; Goldsmith, 2014; Muehlenbein & Wallis, 2014). These doubts include behavioural disturbances (Klailova et al., 2010), increased stress levels (Shutt et al., 2014; Woodford et al., 2002) and the risks of anthroponosis. The risk is particularly important considering great apes (i.e. chimpanzees, bonobos, the two species of gorillas and the three species of orangutans) due to the close phylogenetic relationship that these primates share with humans, making them susceptible to a wide range of infectious human diseases and a potential source of human infections (Devaux et al., 2019; Hacia, 2001; Narat et al., 2017; Sleeman et al., 2000; Woodford et al., 2002).

Diseases potentially transmittable to apes include, but are not restricted to, respiratory illnesses such as human paramoxyvirus (Köndgen et al., 2008); human respiratory syncytial virus (Szentiks et al., 2009); human metapneumovirus (Palacio et al., 2011); influenza A and B (Buitendijk et al., 2014) as well as the human coronavirus OC43 (Patrono et al., 2018); gastrointestinal bacteria such as *Escherichia coli* (Rwego et al., 2008); and parasites like *Sarcoptes scabiei* (Kalema-Zikusoka et al., 2002) or *Giardia duodenalis* (Graczyk et al., 2001). In addition, the novel coronavirus SARS-CoV-2, which can cause Covid-19 in humans and is responsible for the 2019–2021 pandemic, is known to also to infect great apes (Gillespie & Leendertz, 2020; Melin et al., 2020; Gibbons, 2021). Diseases originating from humans have repeatedly caused the death of habituated apes (Grützmacher et al., 2018; Köndgen et al., 2008; Negrey et al., 2019; Palacios et al., 2011; Spelman et al., 2013) and are suspected to be responsible in numerous further cases (Grützmacher et al., 2018; Hill et al., 2001; Wallis & Lee, 1999). Researchers suggest that respiratory illnesses represent the main threat posed by tourists to great apes (Cranfield, 2008; Wallis & Lee, 1999), and that such risks rise with increasing proximity between the two (Sandbrook & Semple, 2006; Williamson & Macfie, 2014). In the case of gorilla trekking, tourists seem to be getting closer to the animals than in the past, thus increasing the risks (Hanes, 2012; Hanes et al., 2018; Sandbrook & Semple, 2006).

Photography plays a central role in wildlife tourism (Lemelin, 2006; Pearce & Moscardo, 2015) and in the recurrence of close encounters. Taking selfies has become a means to organise memories and share them, including on social media (Schleser, 2014). The like currency generated from such photos also forms the basis of the trend for tourism selfies and can be an incentive to visit attractions with animals. Wildlife selfies—that is, when people take photos of themselves with wild animals—have become highly popular on the Internet, regardless of the negative impacts and risks often associated with them (Carder et al., 2018; D'Cruze et al., 2017; Ellenberg, 2017; Hasanah Abd Mutalib, 2018; Kitson & Nekaris, 2020; Pagel et al., 2020; Pearce & Moscardo, 2015). While this issue is not entirely new (Sontag (1977) already highlighted how intrusive tourists' photography can be for the visited environment and its inhabitants), the latest technological advances have multiplied these effects. Today, with the democratisation of both Social Networking Sites (SNS) and smartphones, an increasingly large

portion of the global population is able not only to produce but also distribute and consume photographs. The ensuing massive numbers of images depicting close interactions with wild animals that are published on SNS such as Facebook, Instagram and Twitter have a great influence on their audience, tourists' actions and decisions (Spradlin et al., 2001). It can push people into risky behaviours to reproduce what they have seen, with the images that drew them to the location in the first place sometimes creating unrealistic expectations (Pagel et al., 2020). These selfies require a certain proximity between tourists and wildlife and are therefore inextricably linked to issues of anthroponotic disease transmission.

One of the strategies used to mitigate the risk of disease transmission is an international rule recommending tourists to maintain a minimum distance of 7 m to gorillas while visiting them (Macfie & Williamson, 2010). This 7 m rule was established based on research demonstrating that disease-carrying droplets can travel up to 6 m (Xie et al., 2007). Evidence suggests that this rule is often neither followed by the tourists nor enforced by their accompanying staff (Hanes et al., 2018; Sandbrook & Semple, 2006; Weber et al., 2020). In 2004, Sandbrook and Semple (2006) conducted 361 tourist interviews to determine distances of encounters initiated while trekking gorillas in Uganda's Bwindi Impenetrable Forest National Park (NP). Their results showed a mean distance of 2.76 m at the moment of closest proximity, closer than proscribed. Hanes et al. (2018) supported these results with a mean nearest distance of just over 2 m for the same park. Furthermore, five of their 25 interviewees reported physical contact with gorillas during the trek. Weber et al. (2020), also focussing on Bwindi Impenetrable Forest NP, found that the 7 m rule was violated in 98% of the studied trekking tours. Other guidelines established by the International Union for Conservation of Nature in their *Best Practice Guidelines for Great Ape Tourism* (Macfie & Williamson, 2010) recommend wearing a surgical facemask when visiting gorillas for research or tourism because it represents one of the most effective means of prevention of aerial disease transmission. They suggested restricting the number of tourists to eight per habituated gorilla group each day, and the visitation time to 1 hr maximum in order to minimise adverse effects on gorillas.

Although the reasons behind these regulations are widely understood, their implementation is still sometimes lacking (Otsuka & Yamakoshi, 2020). Unfortunately, the above-mentioned studies focusing on distance are limited geographically to one national park in Uganda, one of three mountain gorilla range countries, and limited in time by the length of the respective data collection periods in the field. Here we use data available online on the social networking site Instagram, a platform based on photograph publication, to investigate the implementation of the 7 m rule between tourists and gorillas. While we expect the rule to be broken, our research was further directed by the following set of questions: How does the rule adherence varies geographically and temporally? What are the different factors affecting the proximity of tourists to the photographed gorillas? And what are the risks associated with the encounters depicted in online publications? To answer these questions, we first explore and describe the prevalence of proximity in gorilla trekking photographs. Then, we analyse the situations depicted in relation to their context. Finally, we highlight the related risks and propose a course of actions to mitigate them. We present a new angle on the problematic issue of proximity in gorilla trekking practices and the potential for anthroponotic disease transmission that is ultimately threatening their welfare.

2 | METHODS

2.1 | Data collection

To gather photographs from Instagram, we systematically used the search terms #gorillatrekking and #gorillatracking, which together resulted in over 18,000 photographs published between 2 December 2012 and 14 October 2019. These hashtags were selected after an initial search on Instagram, showing these to be the most frequently used and providing most relevant photographs (i.e. excluding gorillas in zoos and gorillas art). From this initial photographic database, ordered chronologically based on publication date, we selected all the photographs where at least one gorilla and one tourist were visible. It is common to post the so-called throwback photographs, whereby the hashtag #tbt is used, but none were recorded in our study. When several photographs were published by the same person, we selected the first photograph that was uploaded, and we consider this to be representative of that person's experience. In the cases where multiple persons were present in the frame, we chose the person closest to any gorilla. We focused on the distance between mountain gorillas and tourists. Accordingly, photographs showing researchers and gorillas, or western lowland gorillas *G. g. gorilla* and eastern lowland gorillas *G. b. graueri* and people, were discarded.

We recorded the country where the gorillas were visited—using the Instagram geo-tag or the post's description. We distinguished immature (sexually immature individuals) and adults (including adult females, blackbacks and silverbacks; Robbins, 2007). Infants were normally photographed with their mothers and were not independent, thus we estimated the distance of the tourist to the mother rather than the infant. Additionally, we noted the sex of tourists and the presence or absence of them wearing facial masks.

Parallel with their rising popularity among users, social networking sites are becoming more common in tourism and conservation research (Barry, 2014; Barve, 2014; Liang et al., 2020; Tenkanen et al., 2017). When conducting research using open data on social media pages, the privacy of users can be a concern (Highfield & Leaver, 2015). Indeed, although people acknowledge operating in public, they hold ambiguous perceptions of privacy and how their information can be used (Markham & Buchanan, 2012). For ethical reasons, we only analysed photographs shared publicly. Instagram provides a clear opportunity to choose between public and private accounts (Zimmer & Proferes, 2014). Moreover, we anonymised the data and retained no personal information (Lomborg & Bechmann, 2014; Zook et al., 2017).

2.2 | Estimating distance

In each photograph, we recorded the distance between the closest human and mountain gorilla (estimated in meters). Following recommendations from Narat et al. (2017) who demonstrated terminology inconsistencies across the zoonoses literature, we use the term 'contact' in this article when referring to those instances where clear physical contacts between human and gorillas were occurring. Particular attention was given to photographs with a shallow depth of field to examine carefully the areas out of focus. We calculated a strong inter-observer reliability by comparing the estimates of two authors on a subset of the photographs ($N = 336$) (Pearson's $R = 0.869$, $p < 0.00001$). The remaining photographs were then assessed by one of the authors. The reliability was high considering 89% of the estimates were identical or within 1 m, only 2% showed a difference over 2 m. The photographs whose estimations were not agreed on in the first round (i.e. those where the estimates differed 2 m or more) were reviewed with an additional author until consensus was achieved. While this approach remains susceptible to estimation error, we consider it fits the general objective of this study.

2.3 | Data analysis

We performed a generalised linear mixed model (GLMM) to test whether the distance between the tourist and the wild gorillas on the photographs was influenced by the gorilla age class (immature/adult), the sex of the tourist (woman/man), the use of masks (yes/no), the country where the encounter took place and the year of the record based on the posting date. To account for the difference in sample size (number of pictures posted) over the year, we included month as a mixed factor.

We tested models with all possible combinations among the recorded variables, a null model (no effect of predictor variables) and the interaction between the variables 'age of the closest gorilla' and 'the sex of the closest tourist'. For testing the family of distribution that would better fit our response variable, we considered families appropriate for discrete values that included zero, for situations when the visitor was touching the closest gorilla (e.g. normal, zero-adjusted inverse Gaussian, zero-adjusted Gamma, zero-adjusted Poisson, generalised t and the negative binomial distribution). Finally, we selected the family of distribution and the best model based on the Akaike information criteria (AIC) for generalised models. We considered models with good support all models with ΔAIC values smaller than 2 in relation to the model with the smallest AIC (best-ranked model) (Burnham & Anderson, 2004). Zero-adjusted Gamma was the best-fitted family of distribution. We tested for multicollinearity among the variables using the variance inflation factor (VIF). All variables presented VIF equal or lower than 2.5, which indicates absence of collinearity and allows its inclusion in the same generalised model (Belsley et al., 1980). We ran statistical analyses using R 3.6.3 (http://www.R-project.org/). We used the R-packages car for testing multicollinearity, gamlss for running the GLMM and ggplot2 for plotting the graphs. We considered statistically significant effects in the models when $p < 0.05$.

3 | RESULTS

Based on the hashtags #gorillatrekking and #gorillatracking, we obtained 858 photographs of humans in shot with mountain gorillas, excluding those with gorillas or humans only as we aimed to investigate the adherence by tourists to the 7 m rule. 52% were taken in Uganda (i.e. Bwindi Impenetrable Forest NP, Mgahinga NP), 41% in Rwanda (Volcanoes NP) and 5% in DRC (Virunga NP; Table 1). Most photographs illustrated situations where the 7 m rule was not respected: 86% portrayed tourist within 4 m distance from the gorillas. Only an approximate 3% of the photographs showed tourists at the recommended distance of 7 m or more. On 25 occasions, a human–gorilla contact was depicted in the sampled photograph (Table 1). The overall average distance was 2.94 m (±1.7), ranging from physical contact to 12 m. The majority of photographs taken in DRC (65%) showed people wearing face masks, contrasting with Uganda and Rwanda where we observed no face masks in the photographs. Women were closer to gorillas in 68% of the photographs than men.

The distance between the human and the nearest gorilla was significantly influenced by the age of the gorilla, the sex of the tourist and the country where the visit took place (Figure 1, Table 2). People got significantly closer to immature gorillas than to adult gorillas (means of 2.9 ± 1.3 m and 3.2 ± 1.4 m, respectively); the minimum distance between humans and immature gorillas was larger than that between humans and adult gorillas (Figure 1a). Women were photographed on average 1 m closer to immature gorillas than men (Figure 1a, Table 2). No such difference was found between men and

TABLE 1 Categorisation of the Instagram posts depicting an encounter with wild mountain gorillas based on the distance between the tourists and the closest gorilla (into four classes), on the location (Uganda, Rwanda, DRC), and on the age group of the closest gorilla (immature or adult)

Gorilla-tourist distance	Physical contact	1–4 m	5–6 m	≥7 m	Total
Location					
Uganda	13	373	46	16	448
Rwanda	11	286	41	10	348
DRC	1	34	3	2	40
Unknown	0	19	3	0	22
Gorilla age group					
Adult	13	541	86	21	664
Immature	12	164	7	4	187
Ambiguous	0	7	0	0	7
Total	25	712	93	25	858

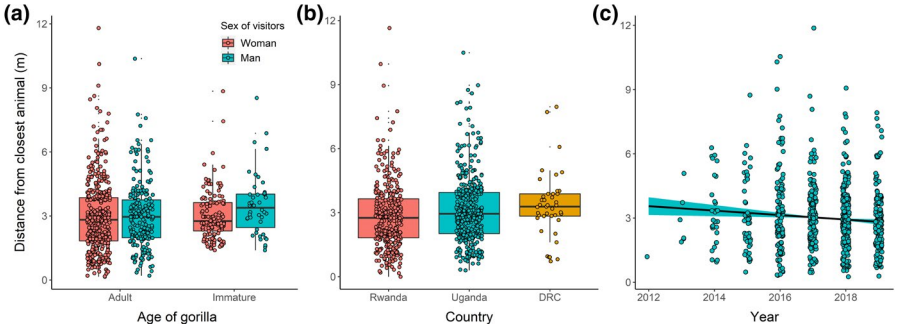

FIGURE 1 Average distance between tourists and wild mountain gorillas according to the age of the gorilla, sex of the tourist, and country and year of the visit. The shaded area in figures (a) and (b) represents the 25%–75% interquartile and the solid black line the median while the shaded area in figure (c) represents the 95% confidence interval

TABLE 2 Details of the best-fit generalised linear mixed model for the distance between humans and the closest gorilla *Gorilla b. beringei* in Instagram photographs according to the age of gorillas, year of the record, country and sex of the tourist

Best-fit model[a]						
Response variable	**Predictor variables[b]**	**Estimate**	***SE***	***t* value**	***p* value**	**ΔAIC (ΔAIC_{null})[c]**
Distance from the closest animal	(Intercept)	214.7	79.21	2.7	0.006	2.62 (52.6)
	Age of gorilla: Immature	−0.81	0.13	−6.2	1×10^{-9}*	
	Year	−0.15	0.04	−2.7	0.008*	
	Country: Rwanda	−0.68	0.28	−2.4	0.01*	
	Country: Uganda	−0.40	0.28	−1.4	0.15	
	Age of gorilla × Sex of tourist	0.52	0.26	2.0	0.046*	
	Sex of tourist: Male	−0.20	0.13	−1.5	0.12	

[a]The family of distribution used was Zero-adjusted Gamma and the link function was identity.
[b]Reference classes: adult for age of gorilla, DRC for country and female for sex of tourists.
[c]ΔAIC is the difference between the AIC of the best model and the second-best ranked model and ΔAIC_{null} is the difference between the AIC of the selected model and the AIC of the null model.
*$p < 0.05$.

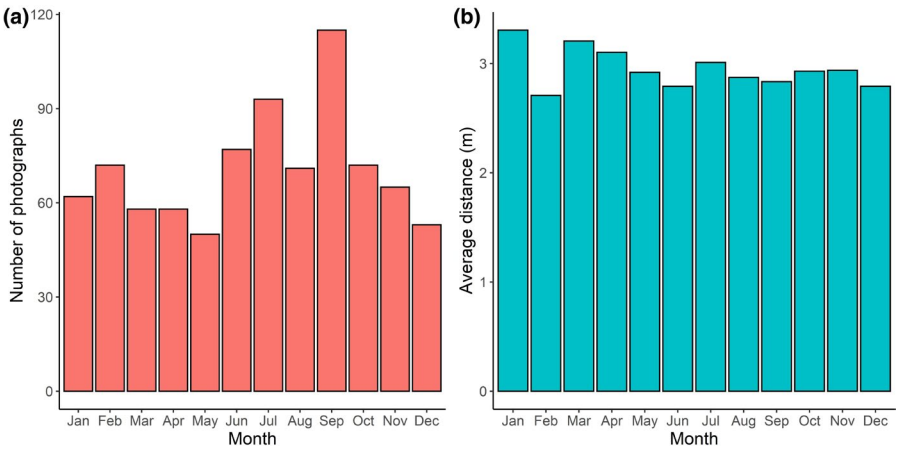

FIGURE 2 Number of photographs posted on Instagram depicting tourists and gorillas (a) and the average distance between tourists and gorillas (b) per month ($n = 846$)

women for adult gorillas. Tourists posting photographs from visiting Rwanda tended to get on average 0.6 m closer to gorillas than tourists visiting DRC (2.8 ± 1.6, 3.1 ± 1.5 and 3.4 ± 1.6 m for Rwanda, Uganda and DRC, respectively) (Figure 1b, Table 2). The distance between the human tourists and the gorillas has diminished by 0.8 m over the last 7 years (Figure 1c, Table 2). In 2012, the average distance was estimated as 3.6 m while the average distance estimated in 2019 was 2.8 m.

The number of photographs varied among months, with the majority being posted in September ($n = 115$), followed by July (93), June (77), February (72), October (72) and August (71) (Figure 2a). The distance between tourists and gorillas did not change substantially

between months, but lower average distance between tourists and wild gorillas was found in February (2.7 m) followed by December and June (2.8) (Figure 2b).

4 | DISCUSSION

Gorilla trekking is becoming increasingly popular (Bizimungu, 2019; Butera, 2020). While this may show a growing desire in the human population to reconnect with nature and wild animals, the parallel increase in proximity over time between tourists and gorillas presents great risks for the species' survival. Not only do our results support previous research conducted in Bwindi Impenetrable Forest NP (Hanes, 2012; Hanes et al., 2018; Sandbrook & Semple, 2006; Weber et al., 2020), but they also bring new insights regarding other sites where gorilla trekking is offered and an examination of how interactions between humans and gorillas has evolved in the last 7 years. We have characterised the interactions of wild mountain gorillas and the tourists visiting them as depicted in Instagram photographs, with a particular attention to proximity, and analysed the factors affecting this proximity. The results reveal that (a) the large majority of photographs analysed presented humans and gorillas within 4 m of each other, (b) tourists and immature gorillas tend to get closer to each other than tourists and adult gorillas, and this is more pronounced in female tourists than male tourists and (c) the overall distance has decreased over the last 7 years.

The relation between gorilla age class and distance may confirm the idea of immature gorillas being more curious, and more likely to approach and initiate contact with people (Sandbrook & Semple, 2006). Yet, it could also be a sign that most tourists, idealising the cuteness of immature gorillas, are less afraid to approach them as opposed to their dangerous-looking, adult counterparts. This aspect of the results is not reassuring when we consider that the risk of disease transmission is inversely correlated with the gorillas' immune maturity (Homsy, 1999).

The number of Instagram photographs related to gorilla trekking in DRC is lower compared to Rwanda and Uganda, indicating the prominent role Uganda and Rwanda play in the gorilla trekking industry. This difference can be partly explained by the long-lasting social and political unrest in the region, and more recently the security incident (i.e. the death of a ranger and abduction of two British tourists in the national park) that forced the Virunga NP's authorities to close its access to tourists from May 2018 to February 2019. Nonetheless, DRC is the country where the distance with gorillas is the most respected, and the percentage of their gorilla trekking tourists wearing face masks implies that their 2009 regulation on compulsory masks is enforced, making them a model to follow in this matter (Weber et al., 2020).

Surgical face masks are known to decrease the risk of aerial disease transmission (Feng et al., 2020; Gilardi et al., 2015). They should be made compulsory for every person visiting mountain gorillas and other great apes. With the more widespread acceptance of face mask wearing due to the Covid-19 pandemic, we are confident that this measure in isolation will not negatively affect tourist numbers or the tourist experience. Reflecting the current situation in DRC, where tourists visiting mountain gorillas are accepting face masks without problems, researchers also found that the majority of their respondents would be willing to wear face masks to prevent disease transmission to gorillas (Hanes et al., 2018; Weber et al., 2020). The one potential downside of compulsory face masks is that this may lead to an even lower adherence to the 7 m rule. However, the Covid-19 pandemic has made wearing masks and social distancing more widespread and more acceptable and during the pandemic wearing face masks when visiting mountain gorillas has been made mandatory also in Rwanda and Uganda (Richardson, 2021). It would be a missed opportunity to not use this momentum to continue to promote the use of facemasks and appropriate distancing when visiting mountain gorillas and indeed other great apes. Furthermore, we believe these undesirable effects could be avoided by working simultaneously on the implementation of compulsory face masks and the 7 m rule, in parallel with awareness raising efforts concerning anthroponotic disease transmission.

The various forms of anthroponosis made possible by the close proximity in our sample highlight the extent of risks created by the situations depicted on Instagram. Airborne infections may be transmitted through natural breathing, speaking, coughing and sneezing (Yan et al., 2018). While some of the responsible particles can travel long distances (Tellier et al., 2019) or remain suspended in the air for several hours (Centers for Disease Control & Prevention, 2014). Studies have demonstrated that large droplets—for example, the ones carrying disease causing agents—can travel over 6 m when expelled through a sneeze, 2 m from a cough and up to 1 m when breathing (Bourouiba, 2020; Xie et al., 2007). These results were obtained from tests in an indoor environment and are thus subject to variation, with outside wind. Hypothetically, this means that at least 96% of the depicted encounters in our study presented serious risk of disease transmission, would sneezing occur.

The above potential for anthroponotic disease transmission is dependent on tourists' behaviour. This behaviour, in turn, cannot be explored with the use of Instagram photographs alone. Glasser (2019), in a neighbouring chimpanzee *Pan troglodytes* tourism site in Uganda's Kibale NP, revealed that, far from being rare, human sneezing occurred in 65% of the observed encounters with wild chimpanzees. In addition, the 25 tourists in our sample that are photographed in direct contact with a wild gorilla could transmit disease by the sole act of breathing. That is still without considering the risk of numerous other infectious agents that can be transmitted through deposit on fomites. Some of which can remain infective for up to 6 hr after leaving their source (Nardell, 2015). Tourists may still go visit wild mountain gorillas if they feel sick, Hanes et al. (2018) reported 51% of their respondents said they would. Measures should thus be taken around the factors we can have an effect on, including proximity during visits.

The low number of photographs showing both people and gorillas with a large enough distance (>7 m) between them is not surprising given that it certainly is less spectacular and thus less likely to be posted on Instagram. At the same time, it is not always possible to

take a photograph on the spot, and thus the Instagram posts consequently may not always show the closest proximity of an encounter. In this study, we focus on the two most commonly used Instagram hashtags in relation to gorilla trekking tourism. Our data represent a subset of all Instagram posts relating to gorilla trekking and our results are not intended to be generalised to all gorilla trekking practices, but rather demonstrate that unsustainable practices do happen frequently. While gorillas may sometimes be the initiators of close proximity, maintaining a 7 m distance will give more time to react and thus avoid potentially harmful situations. Keeping an appropriate distance will also help to reduce over-habituation (Macfie & Williamson, 2010; Strier, 2010), which can potentially lead to conflicts in an environment encroached by people (Goldsmith, 2014).

When using social media data for research, interpretation of the results should be made cautiously considering the bias resulting from the self-selective users, meaning the sample will not be representative of the whole population but rather of the user-community (Longley et al., 2015; Tufekci, 2014). When compared to official data and other platforms, Instagram has been confirmed as a reliable source for monitoring tourists' activities in protected areas (Di Minin et al., 2015; Tenkanen et al., 2017). Furthermore, the use of social media data is particularly suitable for this study considering that (a) we are interested in the occurrence of close proximities during gorilla trekking rather than in the characteristics of the people engaged in the activity and (b) we aimed at cross-validating previous studies on the subject.

Unveiling what may therefore be common practices in wildlife ecotourism and highlighting the plethora of risks associated with those, our results show the paradoxical nature of endangering the very animals we wish to see thrive. There is a real gap between the raising public concerns for the species' survival, and the proximity depicted in the photographs. Only a substantial lack of information can explain this gap without questioning the veracity of people's concerns for conservation. It has been demonstrated that tourists are not the best assessors of the animal welfare and conservation impacts of their activities (Moorhouse et al., 2015). Examples of unsustainable practices and their impact are numerous in the industry: over 90% of the wildlife attractions in the Amazon allow problematic direct contact with animals (D'Cruze et al., 2017) and Meissner et al. (2015) demonstrated that viewing boats in New Zealand are affecting the feeding patterns of common dolphins; tourists visiting penguins can disrupt a whole colony's activity, and negatively impact the juveniles' survival (Ellenberg, 2017; McClung et al., 2004). A paradigm shift replacing the animals' interests before profit maximisation in wildlife ecotourism is crucial for both the industry and the wildlife species in question.

This situation also forces us to question our use of and the impacts of social media, particularly in relation to wildlife, where it can be seen as a double-edge sword (Kitson & Nekaris, 2020; Liang et al., 2020; Osterberg & Nekaris, 2015). Although this use promotes conservation awareness, it also pushes us to get closer to wildlife to get the perfect shot, normalising abnormally close distances to wild animals (Lenzi et al., 2020; Pagel et al., 2020). Social media could be used to raise public awareness; not only regarding the potential effects of unsustainable ecotourism but also concerning the effects of our choices when uploading content on social networking sites. Used in this way, it could actually help put a brake on what Otsuka and Yamakoshi (2020) call 'the negative spiral', referring to the way social media content portraying close interactions with gorillas influences other people into expecting and willing to attain such proximity, which they will, in turn, advertise on social media after their visit. Social media platforms are, by essence, spaces of moral reflexivity where people form and adapt what they perceive as ethical.

The findings of our study have broad implications that are relevant for the management of wildlife ecotourism attractions and the related policymaking. We draw attention to the urgent need for (a) stricter regulations relating to the distance between wildlife and tourists, (b) a continual enforcement of those rules, (c) an enhanced awareness campaign for tourists and social media users and (d) and a reinforced training for guides and rangers on strategies to deal with proximity between visitors and gorillas, mitigate the impacts of gorilla trekking and sensitise visitors to anthroponotic diseases risks. Although it is believed policy measures to ensure more sustainable practices can be adopted without affecting the experience of tourists (Muntifering et al., 2019), they need to be implemented carefully in view of the essential source of revenue gorilla trekking represents for both the local economy and the conservation efforts. While it plays an important part in wildlife viewing experiences (Curtin, 2010), physical proximity is not the only factor of tourists' satisfaction when viewing wildlife (Orams, 2000). Tourists visiting mountain gorillas are willing to adopt new safety protocols if the impact of such measures is explained to them (Hanes et al., 2018; Weber et al., 2020). Indeed, it has been demonstrated that tourists are more likely to comply with regulations if they are thoroughly informed on the risks they may pose to the animals' health and conservation (Hanes et al., 2018). Rethinking the information provided to tourists before viewing wild animals and the awareness campaign efforts is therefore vital to mitigate its negative impacts. If we fail to address this issue in the near future, this form of ecotourism might turn into one of the main threats to the remaining wildlife populations' survival and untimely ruin its potential for positive socioeconomic impacts.

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CONFLICTS OF INTEREST

No conflicts of interest to declare.

AUTHORS' CONTRIBUTIONS

G.V.H., M.S.S. and V.N. conceived the ideas and designed the methodology; G.V.H. and M.S.S. collected the data; G.V.H., T.Q.M. and V.N. analysed the data; G.V.H. and M.S.S. led the writing of the

manuscript. All authors contributed critically to the drafts and gave final approval for publication.

DATA AVAILABILITY STATEMENT

Data are archived on RADAR, the Oxford Brookes University open access data repository, via this link: https://doi.org/10.24384/t3zb-qz22 (Van Hamme et al., 2021).

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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