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Measuring Asian Social Media Sentiments Toward Bat Exploitation

Amir A. Batrice, Tigga Kingston , and Abigail L. Rutrough 

Department of Biological Sciences, Texas Tech University, Lubbock, TX, USA

ABSTRACT

As human activities continue to negatively affect bat populations, bat conservation efforts continue to rely on questionnaires to understand human actions toward bats; however, the use of questionnaires constrains understanding by limiting the sample size to those who choose to participate, being subject to selection bias, and overall may not be the most efficient way of understanding sentiments and behaviors toward bats. We used social media to analyze sentiment toward bat exploitation behaviors in Asia and evaluated the influence that these posts have on users in the region. We gathered and analyzed a total of 458 social media posts and 2,427 comments throughout Asia utilizing keywords and hashtags in 16 languages. We found that nearly 90% of initial posts discussing bat exploitations were discussed in an acceptive, pro-bat exploitation way. Initial posts from Southeast and South Asia showed acceptance of bat exploitation. Comments on posts from Southeast Asia, particularly the Philippines and Indonesia, were acceptive of bat exploitation for food and medicine, whereas comments on posts from South Asia were rejective of bat exploitation, in contrast, with the initial South Asian posts, which were more acceptive of persecution of bats. We recommend using social media platforms to promote messages that reject bat exploitation and encourage bat conservation efforts as our results indicate that positive messages receive mostly positive comments, reinforcing the importance of protecting bats. Moreover, we suggest future work be conducted using social media to further understand region-specific narratives for and against bat exploitation.

KEYWORDS

Attitudes; bats;
human–animal interaction;
sentiment analysis; social
media

It has long been understood that humans and their activities lead to the overexploitation of wild mammal populations and diversity, which have declined dramatically in the last 29 years (Brodie et al., 2021; Gallego-Zamorano et al., 2020; Maxwell et al., 2016). Unique in mammalian evolution for their powered flight, bats are sentient, social, and diverse animals (Kunz, 2013) that hold great intrinsic value. Composing about one-quarter of the world's mammal species (Hutson et al., 2001), they are also an essential environmental component and provide many ecological and economic services, including but not

CONTACT Abigail L. Rutrough  abby.rutrough@ttu.edu  Department of Biological Sciences, Texas Tech University, 2901 Main Street, Lubbock, TX 79409-43131, USA

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limited to pollination, seed dispersal, and pest suppression (Fujita & Tuttle, 1991; Kunz et al., 2011). However, many bat species are susceptible to population losses associated with various human behaviors, such as hunting, consumption of meat and medicine, and persecution (Mildenstein et al., 2016; Tackett et al., 2022). Such behavior is a significant concern, which is evidenced by the IUCN Red List's identification of 130 bat species threatened by hunting and 53 bat species threatened by persecution. These population threats are compounded by the fact that bats are long-lived and reproduce slowly due to low numbers of offspring as a result of long gestational periods and slow fetal growth (Badwaik & Rasweiler, 2000; Rija et al., 2020).

Many social factors play a role in influencing human–bat interactions, especially sentiments (Musila et al., 2018). Sentiments are dispositions to “react emotionally, cognitively, and conatively toward a certain object (or situation)” (Cattell, 1940). Shared sentiments in a population, especially in the information age, can influence environmental behaviors (Bicchieri et al., 2023; DeSombre, 2018). There exists a need to document and study sentiments toward bats and various human–bat interactions as understanding these sentiments is crucial to developing and strengthening sustainable conservation campaigns (Kingston, 2016).

Recent publications on bat conservation focus largely on discussing how information collected from in-person questionnaires can contribute to help conservationists understand motivations for bat exploitation behaviors; few studies have deviated from questionnaires to gather such information (Boso et al., 2021; Musila et al., 2018; Straka et al., 2021). However, studies utilizing questionnaires tend to be limited by focus group size and resources (Suwannarong et al., 2020; Toivonen et al., 2019). Social media is a unique source for studying human activities and a catalyst for social change (Song et al., 2020; Väisänen et al., 2021; Yeung, 2018). It can be a valuable tool for studying conservation-relevant sentiments as it allows for the collection of large amounts of data from a diverse range of individuals over any period of time (Hausmann et al., 2020).

Asia presents an excellent opportunity to investigate social media sentiments toward bat exploitation as it is home to 10 biodiversity hotspots, broad ranges of cultures and ethnicities, and experiences widespread bat exploitation and persecution (Myers et al., 2000; Tackett et al., 2022). Southeast Asia is a known bat-hunting hotspot: Indonesia and the Philippines are among the top bat meat-consuming countries worldwide (Tackett et al., 2022), though bats are also persecuted as fruit-crop pests. In South Asia bats are more commonly hunted for medicinal use or persecuted as vermin, while bat consumption in East Asia appears to be limited to China and persecution in both China and Japan (Aziz et al., 2016; Mildenstein et al., 2016; Tackett et al., 2022).

Additionally, Asia is home to 60% of the world's population as well as the most explosive growth of internet usage in the last decade, making up around 52.2% of the world's total internet users as of 2020 (Statistia Research Department, 2022; Willnat & Aw, 2014). Such growth of internet usage may allow for more data to be collected from social media (Dixon, 2022).

Our study aimed to analyze Asian social media users' sentiment toward bat exploitation and persecution, as well as explore how sentiment manifests on social media by analyzing engagement variations in different Asian regions. We anticipated that sentiments toward bat exploitation would exhibit a complex relationship, with hunting potentially viewed more positively and persecution being perceived more negatively. Hunting,

especially in countries like the Philippines and Indonesia, is often deeply rooted in cultural practices and traditional medicine and might be viewed with a certain degree of acceptance. On the contrary, persecution could evoke more negative sentiments among locals because bats hold cultural significance in many areas, being associated with various positive beliefs, folklore, and traditions (Low et al., 2021). Further, our research was conducted at the height of the COVID-19 pandemic, a time when bats were vilified by authorities, media, and some researchers in a region that was repeatedly mocked and disparaged for its bat consumption, all of which could have shifted public sentiment toward accepting bat exploitation and persecution behaviors.

A crucial aspect of the study was also to assess the impact of local, relatively small-scale social media influencers on social media sentiment and behaviors regarding bat exploitation and persecution. We analyzed the attitudes of these influencers, whose reach was confined to a relatively modest audience, and assessed their impact on the sentiments of their audience. Our findings will highlight the benefits and challenges of using social media to gather data and could be used to design modern strategies to promote bat conservation, considering the role of social media influencers.

Methods

Overview

We searched for posts on social media that discussed bat exploitation and persecution and extracted those with unique instances of such behaviors. We analyzed both the extracted posts and their respective comments for their sentiment toward bat exploitation behaviors and categorized them into the following sentiments: acceptive, rejective, and neutral.

After consultation with the Research Compliance Manager, Human Research Protection Program at Texas Tech University, we determined our research did not qualify as human-subjects research and therefore did not require Institutional Review Board review and approval; however, all personal identifying information was removed from the dataset before publication.

Search Terms and Sites

We searched 11 social media sites (Facebook, Flickr, Instagram, LinkedIn, Naver, Reddit, TikTok, Tumblr, Twitter, Weibo, YouTube) in 16 languages (Arabic, Bengali, Bisaya, Chinese, English, French, Hindi, Ilocano, Ilonggo, Indonesian, Japanese, Korean, Malay, Nepali, Tagalog, Thai). Posts were translated by undergraduate students fluent in select languages or by using Google Translate. We only relied on Google Translate for Indonesian, Japanese, Malay, and Thai posts. Though imperfect, Google Translate allowed us to work in languages for which we did not have a fluent or proficient speaker and still allowed us to understand whether the author of the post or comment held pro- or anti-bat exploitation sentiments, both through the context of the post and the universal understanding of emojis (Guntuku et al., 2019).

We define bat exploitation as a broad term that can be broken down into the following behaviors: hunting, selling, consumption, and persecution. Hunting is when bats are killed

or captured. Selling is the sale of whole bats (alive or dead), bat meat, or bat parts, usually at a market or restaurant. Consumption is the act of eating or using bats, bat meat, or bat parts. Persecution is the deliberate and intentional actions of humans that cause harm or disturbance to bats. We draw a distinction between persecution and hunting, where persecution does not include hunting, but is focused on harm, abuse, or disturbance to bats due to a real or perceived threat and/or a nuisance to humans. Hunting is focused on the capture or killing of bats for consumption or sport.

We searched for posts manually using broad search terms that may be relevant to bat exploitation, combining “bat” with words like “hunting,” “eating,” “soup,” “persecution,” “murder,” and “meat” one at a time in each language, which laid the groundwork to search for more specific terms concerning special dishes and other unique terms to each language like “chamgadar market” and “adobong paniki.” In total, we searched using 366 search terms in all 16 languages (see online supplemental Table A1), which includes search terms that returned usable (extractable) and non-usable (non-extractable) posts. Because not all social media sites reported the number of results for any given search term, we were unable to quantify the total number of posts each search term produced on all social media sites.

Extractable Post Requirements

We determined three requirements for a post to be considered “extractable.” First, the post must have included bats, either in a photograph or in the text of the post. Second, the post must have included or inferred some instance of hunting, selling, consumption, or persecution of said bats. Third, the post must have indicated a country location of where bat exploitation occurred. We ensured that posts were reporting unique instances of bat exploitation and that the country of the poster could be determined.

Regions in Asia

Within Asia, we excluded West Asian results owing to the lack of hunting in West Asia (Ripple et al., 2016) and the lack of distribution of large-bodied fruit bats in the region (Mickleburgh et al., 1992). Large-bodied fruit bats (family Pteropodidae) are of greater concern as they tend to be disproportionately targeted by hunters compared with small bats, but it is worth noting that hunting also threatens species from at least six additional bat families (Aziz et al., 2021). We used the World Commission on Protected Areas (WCPA) classification of regions to identify which countries belong to South Asia (Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, Sri Lanka), Southeast Asia (Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand, Vietnam), and East Asia regions (China, Japan, Korea Republic, Mongolia) (IUCN, 2024).

Categorizing Sentiments for Posts and Comments

The sentiments of posts and comments were manually analyzed by two reviewers, initially independently. Both reviewers had to agree with the sentiment of the post or respective

comment. If there was any disagreement between the reviewers, the post was labeled as undeterminable. In addition, both reviewers could send doubts or questions to each other and co-authors and receive immediate feedback.

While sentiment can be extracted from social media statements using many automated methods (Thelwall et al., 2010), we analyzed the sentiment of every post and comment extracted from multiple languages manually. We complemented interpretation of the written text with assessment of facial expression and emoji use, as these have been shown to be the most accurate method of measuring sentiment in content analysis (Van Atteveldt et al., 2021). The use of sentiment analysis on social media in this study evaluates the sentiment of both the poster (influencer) and those who engage with the post (commentors), specifically regarding bat exploitation.

We categorized extracted posts by the poster's perceived sentiment toward bat exploitation as acceptive, rejective, or neutral. Acceptive sentiment is described as an advocacy for, affirmation of, or reinforcing of bat exploitation behaviors, which can be shown via happy facial expression or discussed in the text of the extracted posts via emoji use or affirming terms and phrases (Benitez-Quiroz et al., 2016). Rejective sentiment is described as denial of, dissension of, or advocating against bat exploitation behaviors shown via anger, disgust, and contemptuous facial expression or discussed in the text of extracted posts via emoji use or derogatory/unapproving terms and phrases. Neutral sentiment is described as neither advocating nor opposing bat exploitation behaviors and/or rationalizing bat exploitation behaviors from the point of view of the exploiters. All sentiments and their associated common elements, emoji uses, and facial expressions are described in Table 1.

For each post, we analyzed comments for their perceived sentiment toward the reported bat exploitation behavior. These sentiments were categorized by the commentor's perceived sentiment toward the published bat exploitation. The categories mimic the categories used for posts, with two additional categories labeled "undeterminable" and "irrelevant." Undeterminable comments were marked when they were not fully understood or agreed to by both reviewers. Irrelevant was used to describe comments that did not add to the discussion on the post's thread and was not relevant to the discussion of bat exploitation, such as bot and random comments.

We reviewed each comment to remove duplicate comments as well as to ensure that it was a unique commentor. If there were multiple comments from one commentor, the first randomly selected comment responding to the original post was chosen and all others from the same commentor were discarded. To analyze the overall sentiment of all comment sections, we sampled 50 random comments from posts that contained more than 50 comments. Posts that contained fewer than 50 comments had all comments analyzed. We numbered each comment in every post's respective comment section and used a random number generator to select 50 random comments. If the comment that was chosen was undeterminable or irrelevant, we would remove it from the list and randomly select another comment until we reached 50. Any repeated comments would be discarded, and any time a comment was chosen, we would remove it from the comment list.

Table 1. Overview of social media post sentiment classes (acceptive, rejective, and neutral), as well as associated common elements, emojis used, and facial expressions used to classify posts/comments.

Sentiment	Common elements	Emojis used (Unicode, 2023)	Facial expression and descriptions (Mizgajski, 2018)
Acceptive	Cultural significance Culinary enjoyment Medicinal beliefs	Face-smiling emojis	Happiness: Features include raised cheeks, upward-curved lips, and a relaxed jawline. The eyes may appear brighter, and the eyebrows may lift slightly, while the teeth may or may not be visible, conveying joy and contentment.
		Face-affection emojis Face-tongue emojis Face-hand emojis (Limited to smiling face with open hands, face with hand over mouth, face with hand over mouth)	Surprise: Features widened eyes with raised eyebrows, slightly parted lips, and potentially an open mouth. The facial muscles may appear relaxed and energized, conveying excitement and wonder.
Rejective	Ethical objections Health risks Fear and disgust	Face-hand emojis (Limited to face with open eyes and hand over mouth, face with peaking eye, shushing face) Face-unwell emojis	Anger: Features narrowed or squinted eyes, furrowed eyebrows, and a tense jaw. The lips may be pressed together firmly or curled downwards, conveying frustration, irritation, or displeasure.
		Face-concerned emojis Face-negatives	Disgust: Features wrinkled or raised nose, a curled upper lip, and narrowed eyes. The eyebrows may be lowered, and the mouth may be slightly open, conveying a strong aversion or revulsion. Fear: Features widened eyes with dilated pupils, eyebrows raised and drawn together, and a tense or open mouth. The facial muscles may appear tense, and overall conveys a sense of alarm, anxiety, or terror. Sadness: Features downturned corners of the mouth and possibly trembling lips. The eyebrows may be furrowed, and the eyes often appear watery or downcast, conveying a sense of grief, sorrow, or dejection.
Neutral	Observational, news updates Community perspectives	Face-neutral-skeptical emojis	Blank: Features facial muscles at rest, with the lips in a natural, unremarkable position, the eyes looking forward without any specific emotion, and the eyebrows neither raised nor furrowed.

Results

Overall Social Media Sentiment to Bat Exploitation in Asia

From June 2020 to May 2021, 471 posts related to bat exploitation from South Asia, Southeast Asia, and East Asia countries were extracted and analyzed. Posts from ten countries were found (Table 2), which were published on social media between the dates of January 2009 and April 2021. Breakdown by region saw no great deviation in proportionality between Southeast Asia and South Asia (Figure 1). East Asia had the lowest number of posts extracted, making up only 13 total posts. Both posts and comments

Table 2. Countries ($n = 10$) where bat exploitation and persecution were reported on social media, and counts of data points found during data collection between June 2020 and May 2021 (East Asia points were excluded from the analysis).

Region	Country	Social media posts
Southeast Asia	Cambodia	1
	Indonesia	257
	Laos	2
	Philippines	143
South Asia	Bangladesh	22
	India	31
	Maldives	2
	China	1
East Asia	Korea	10
	Taiwan	2

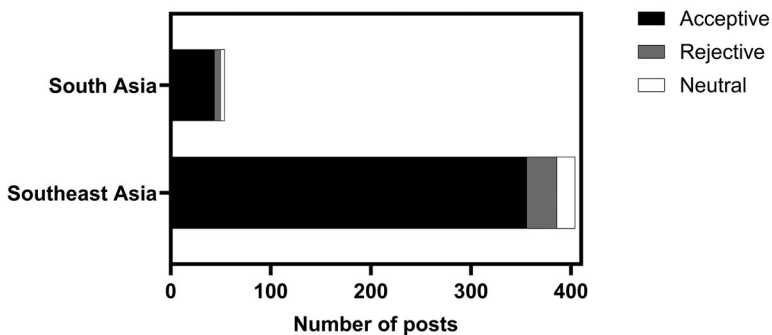


Figure 1. Comparison of number of acceptable (pro-bat exploitation), rejective (anti-bat exploitation), and neutral social media posts between Southeast Asia ($n = 404$) and South Asia ($n = 54$) posted from January 2009 to April 2021.

from East Asia were excluded from the regional analysis. Our analysis classified these posts on their sentiment toward bat exploitation as acceptable ($n = 400$, 87.4%), rejective ($n = 23$, 5%), and neutral ($n = 35$, 7.6%). Overall, the posts reflect acceptable sentiment toward bat exploitation in Asia.

Out of the 458 posts from South and Southeast Asia, a majority depicted consumption of bats ($n = 196$, 42.8%) and hunting ($n = 120$, 26.3%), followed by persecution ($n = 44$, 9.7%) and selling ($n = 30$, 6.6%). Some posts ($n = 68$, 14.6%) were grouped under selling and consumption because the posts contained both selling and consuming actions and could not be considered solely either selling or consumption.

Overall, posts that exhibited bat exploitation behaviors, apart from selling behaviors, were acceptable (Figure 2). Acceptive posts (accepting or approving of bat exploitation) from Southeast Asia typically depicted consumption ($n = 184$) or hunting ($n = 100$) of bats, while rejective (rejecting or opposing bat exploitation) posts typically depicted selling ($n = 10$) of bats (Figure 2(A)). Acceptive posts from South Asia typically depicted persecution ($n = 28$) or hunting ($n = 13$) (Figure 2(B)).

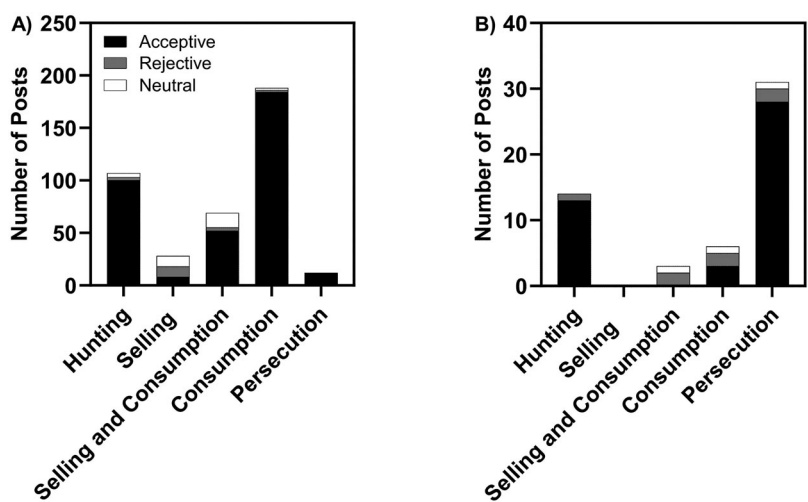


Figure 2. Sentiment toward hunting, selling, selling and consumption, consumption, and persecution reports posted from January 2009 to April 2021 in: (A) Southeast Asia ($n = 404$) and (B) South Asia ($n = 54$). Posts were classed as acceptive (pro-bat exploitation), rejective (anti-bat exploitation), and neutral.

Engagement of Posts

Overall, we analyzed 2,427 comments from the 458 extracted posts. Posts that featured a rejective view toward bat exploitation, on average, saw the highest number of comments ($n = 51$, Range = 0–713); posts with acceptive views had an average of 23 comments (Range = 0–704); and neutral posts trailed with an average of 12 comments (Range = 0–163). The number of comments published ranged from 0 to 704 (Figure 3). There were

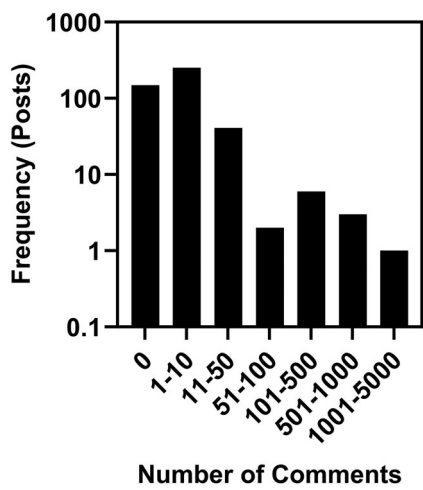


Figure 3. Distribution of the number of comments received by posts between January 2009 to April 2021.

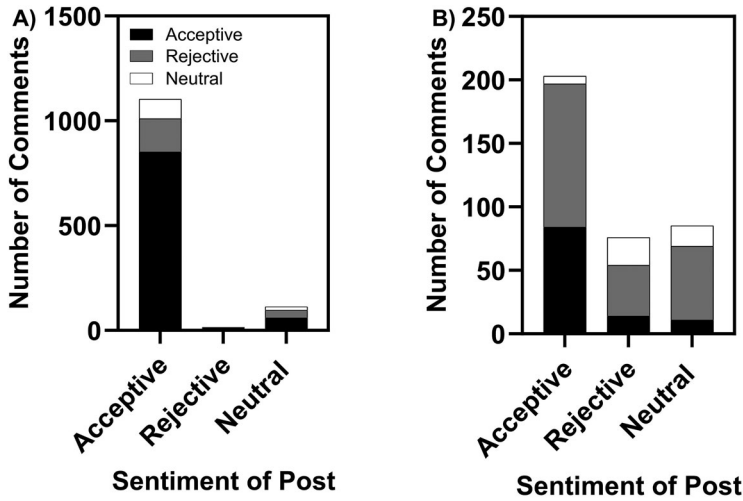


Figure 4. Comparison between the number/sentiment of comments and the sentiment of initial posts in (A) Southeast Asia ($n = 404$) and (B) South Asia ($n = 54$). Note that rejective posts in (A) are not fully displayed because their small volumes would affect the scale of the other sentiments. Posts from January 2009 to April 2021.

1,437 comments recorded under all rejective posts, 8,967 under all acceptive posts, and 433 under all neutral posts. Around one-third of posts received no comments, and only 3% of posts had more than 50 comments.

We found for a majority of posts that expressed acceptive sentiment toward bat exploitation that there were often more acceptive comments than any other type of comment, whereas posts that expressed rejective and neutral sentiment toward bat exploitation often saw mostly rejective comments (Figure 4). Broadly, initial posts attract comments like sentiments on bat exploitation. A deeper analysis within the three regions showed unique variation. In Southeast Asia, acceptive posts elicited mostly acceptive comments, rejective posts had sparse interactions, and an even split of acceptive and rejective comments for neutral posts. In South Asia, acceptive posts elicited a near split between

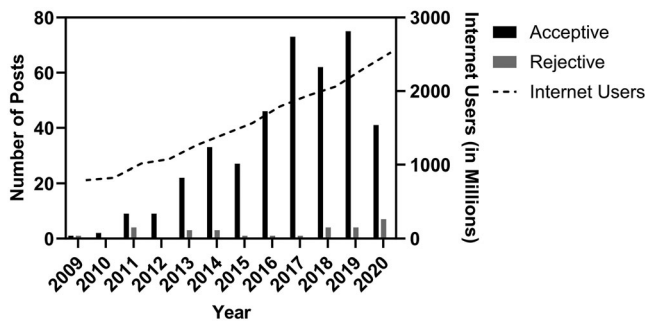


Figure 5. Growth in posts acceptive and rejective of bat exploitation, as well as growth of Asian internet users between 2009 and 2020 (Petrosyan, 2023).

acceptive and rejective comments, whereas rejective and neutral posts elicited mostly rejective comments.

The earliest post we found that discusses bat exploitation was posted in 2009. Since 2009, the number of posts discussing bat exploitation increased year after year. We found a total of 79 posts in 2019, comprising 75 acceptive posts and four rejective posts. In contrast, the year 2020 witnessed 48 posts, with 41 being acceptive and seven being rejective. These data illustrate a noteworthy shift, indicating a decrease of 40% in the total number of posts from 2019 to 2020 (Figure 5).

Discussion

In Southeast and South Asia, the sentiment toward bat exploitation behaviors is overwhelmingly acceptive (Figure 1). While initial posts from South Asia were predominantly acceptive of bat exploitation, most comments were actually rejective of bat exploitation. East Asia had very few posts extracted, even though it has been reported that many species of bat are locally traded and found in menus in the Chinese provinces of Guangdong and Guangxi (Mickleburgh et al., 2009). Such low extraction value could be attributed to the censoring of bat exploitation-related posts in China due to the COVID-19 outbreak (Ruan et al., 2020). This censorship may apply to posts made both before and after the COVID-19 outbreak (Bamman et al., 2012). As such, East Asian results may not reflect reality; they may reflect what was allowed to stay on social media from East Asia.

Acceptive social media posts usually matched bat exploitation behaviors that had been reported as norms in Southeast and South Asia. In Southeast Asia, primarily in the Philippines and Indonesia, there has been a long history of hunting bats at high levels. Local norms promote the consumption of bats, which we found is reflected on social media, with most acceptive posts from the Philippines and Indonesia depicting the consumption and hunting of bats (Boso et al., 2021). Similarly, in parts of South Asia, bats are legally classed as vermin and are persecuted (Low et al., 2021). Hence, they are consumed infrequently, which is reflected on social media posts as well, with most acceptive posts discussing persecution and a majority of rejective posts discussing selling and consumption. Although it is also reported that bats are killed often for medicinal purposes in South Asia (Mickleburgh et al., 2009), out of the 54 posts extracted from there, none mentioned using bats in a medicinal manner. One explanation could be the lack of internet connection for those living in rural areas, where greater use of bats in a medicinal manner might be expected (Tackett et al., 2022).

In Southeast Asia, rejective posts had very little engagement and had the least rejective comments compared with the other regions, which suggests that there are fewer people speaking out against bat exploitation in that region. Of the posts we analyzed, users who commented negatively were not harassed or shamed. There was nothing to suggest that speaking out on social media against bat exploitation in Southeast Asia would extract public harassment from those who support it. Although posts in South Asia were mostly acceptive, comments toward these posts tended to be rejective on average. This was unexpected, as posts seemed to paint a picture of widespread approval of hunting and persecution, though it is important to note that many of the rejective

comments from South Asia expressed concerns about the potential spread of zoonotic diseases when discussing bats.

Many posts originating from Southeast Asia seemed to be posted and viewed among close-knit individuals, such as family and friends, as comments on these posts refer to the poster as “cousin,” “bro,” or other phrases that indicate a close, although not necessarily familial, relationship. This differs greatly from posts originating from South Asia, which we found do not have those kinds of close interactions.

Although we did not explicitly explore individuals’ sentiments toward bats, we observed that most acceptive posts and comments did not indicate posters’ attitudes toward bats. In contrast, many rejective (anti-bat exploitation) posts and comments did show negative attitudes toward bats, often linking bats to diseases such as COVID-19 and describing them as “diseased” and “nasty.” Notably, a minority of commenters against bat exploitation behaviors described bats as innocent animals, undeserving of whatever action occurred. Various factors such as concerns about diseases, economic interests, and other influences may ultimately result in a mismatch between how people view bat exploitation and how people view bats. This finding aligns with the broader psychological theory that attitude/belief is only one aspect of many that determine human behavior (Ajzen, 1991).

This research was conducted amid the COVID-19 pandemic, which has been widely attributed to bats. A common element among some rejective posts and comments made in 2020 was the COVID-19 pandemic and its potential origin from bats, and this may have been responsible for the sharp decrease in acceptive posts and doubling of rejective posts in 2020 vs. 2019 (Figure 5). Specifically, the association of bats with COVID-19 may have pushed more people toward self-censorship, both from posting about their pro-exploitation stance or their anti-exploitation stance, leading to an overall decrease in exploitation posts, especially pro-bat exploitation posts. At the same time, this comparison between bats and COVID-19 may have also empowered more people to speak out against bat exploitation. It should be stressed, though, that some of the reasons presented for these rejective sentiments were not ones of animal welfare or morality; rather, they were about disgust for bats because of their link to COVID-19. Though bats are the likely ancestral host of Sars-CoV-2, this attitude of disgust ignores intermediate hosts, the significant role of the wildlife trade, and live markets in the initial outbreak (Worobey et al., 2022).

In contrast with Africa, Asia, and Latin America, Western media stories in the early months of the COVID-19 pandemic more predominantly attributed blame to human activities rather than bats (Nanni et al., 2022). It is crucial to acknowledge that this research only included one Asian language, Chinese, and news reports from just three South or Southeast Asian countries (India, Pakistan, and the Philippines). Thus, the extent to which this apparent narrative aligned with media in South and Southeast Asia remains uncertain, but there appears to be a disconnect between Western news media and Asian social media users. However, there is growing concern that the increased contact at the human–wildlife interface caused by habitat loss, land-use change, increasing human population, and climate change, combined with the elevated stress on wildlife populations that these factors pose, will lead to novel or more frequent zoonotic spillover events (Allen et al., 2017; Carlson et al., 2022). While this is an ongoing global concern, the

focus of government, researchers, and the public should be on reducing risks and not the vilification of specific taxa, which is unlikely to effectively prevent future outbreaks as it does not address any of the underlying drivers behind zoonotic spillover events (Rocha et al., 2020).

Limitations and Strengths

While we believe social media has much to contribute to bat conservation, several challenges and limitations need to be addressed. Although we had fluent undergraduate speakers in 10 of the languages used, we did not translate many mainland Southeast Asian languages, as well as languages like Mongolian, Russian, and Japanese. We also concentrated our search on bat hunting and consumption-oriented keywords, though we recorded bat persecution when it was found. Specifically searching for persecution activities could have yielded more results as it has been reported that bat persecution is commonplace when there is a perceived threat of disease or crop destruction (Aziz et al., 2016; Nanni et al., 2022; Schneeberger & Voigt, 2016). Finally, manually gathering information from social media is very time-consuming and suffers from data saturation. A potential remedy would be to automate portions of this process with AI or programming to locate and save valuable objective information, such as location, time, and language.

Similar to questionnaires, using social media to gather data on bat exploitation does not omit biases or data limitations. Not everyone uses social media, or does everything that happens get reported. For example, in Southeast and South Asian countries, it is known that isolated groups consume bats both as food and medicine; so studying social media posts might not be reflective of certain communities that may be exerting the greatest pressure on bat populations (Suwannarong et al., 2020). Additionally, the use of social media presents other challenges such as language barriers, which can limit the amount of data collected from non-English speaking communities. Furthermore, biases can also be present in the data. For example, people may be more likely to post positive comments or experiences rather than negative ones, potentially skewing data. However, social media provides unique and unfettered access into the narratives used by many different ethnic groups to promote bat exploitation behaviors. With the increasingly widespread use of social media, it becomes much easier to identify trends and patterns in bat exploitation. This real-time data collection capability can also be beneficial for conservationists as it allows them to respond quickly to harmful trends, as well as to correct any misinformation or misconceptions about bats that might be prevalent. In addition, using social media to gather data on bat exploitation can be a more cost-effective and time-efficient method compared with traditional survey methods.

Conclusion

The acceptive (pro-bat exploitation) sentiment expressed in the majority of posts we found on social media is concerning, as it suggests a lack of awareness and understanding of the negative impacts of bat exploitation. Given their intrinsic value as one of the most species-rich and ecologically diverse group of mammals, and the role that they play in maintaining ecosystems and contributing to human health, it is essential that efforts are made to raise

awareness and educate people about the importance of bats and the dangers of exploiting them. To achieve this, there are several recommendations that should be considered. Firstly, increasing public awareness and education campaigns about the negative impacts of bat exploitation and the importance of bats to ecosystems and human health should be a priority. Such campaigns should also be designed carefully; although rejective posts indicated a stance against bat exploitation, they did not always depict bats in a positive light. Many comments and some posts, made both before and during the pandemic, discussed bats only in their potential for zoonoses. As illustrated by MacFarlane and Rocha (2020), we suggest using social media to debunk misinformation; counteracting negative associations of bats may be an effective way of altering social norms, but stress that careful collaboration from public health officials and conservationists take place to limit the potential for overblown or poorly contextualized information to be spread on social media.

Another recommendation is to utilize social media platforms to promote messages that reject bat exploitation and encourage the conservation of bats; this could include promoting messages about the importance of bats and using social media influencers to encourage people to support conservation efforts. Such support can range from direct actions, such as building shelters for bats away from human habitations and avoiding damaging bat habitats/roosts, to indirect actions, such as disseminating information about the dangers of bat exploitation, both for the person and the bat, as well as shifting away from cultural practices that can be harmful to bats.

Finally, promoting a deviation from cultural diets using social media can be highly persuasive (e.g., Friedman et al., 2022; Kane et al., 2012), and could be effective in decreasing the number of bats killed for meat in regions like the Philippines and Indonesia, where bats are considered delicacies in some local cultures. The results of the study further support this recommendation as we found that the sentiment of the post often directly influenced the sentiment of the comments, highlighting the impact of social media in shaping public perception and opinion.

Overall, a coordinated effort is needed to shift sentiment toward rejecting bat exploitation and promoting bat conservation. By raising awareness and educating the public, alongside utilizing social media to promote conservation messages, we can ensure that bats and the important role that they play in maintaining ecosystems and contributing to human health are valued and protected.

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Data Availability Statement

Data at country and social media site level are available at <https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/V91XXK>. Owing to the sensitive nature of these data, the full dataset is only available by request.

Use of Artificial Intelligence (AI)

During the preparation of this work the authors used Chat GPT in order to outline the conclusion. After using this tool/service, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

ORCID

Tigga Kingston  <http://orcid.org/0000-0003-3552-5352>

Abigail L. Rutrough  <http://orcid.org/0000-0002-6319-7221>

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