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## Low pangolin consumption in Hong Kong pre- and post- the COVID-19 outbreak: Conservation and health concerns both contribute to people's attitudes

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### ABSTRACT

Pangolins have recently received significant media attention globally as the trade for their scales and meat is driving many species closer to extinction. As a result of this, there have been increased legal regulations placed on pangolin trade in recent years. The suggestion that pangolins may have been involved in the transmission of COVID-19 further brought the issues of pangolin consumption to the fore in 2020. However, we have little understanding of the attitudes of the general public towards pangolin consumption pre- or post the outbreak of COVID-19. We conducted surveys in Hong Kong, a critical transit hub in the trafficking routes for pangolins, in 2015 (n = 1037) and 2020 (n = 1028) to determine general attitudes towards pangolin consumption in the city, and whether these attitudes changed since the onset of COVID-19. We found low reported rates of pangolin consumption (< 1% of respondents) in both surveys, and most of the respondents who professed to eating pangolins were aged above 50. Perceptions of how trends in pangolin consumption are changing were consistent between 2015 and 2020, with 55% of the public in 2015 and 57% in 2020 believing that consumption has declined over time. In 2020, respondents cited conservation (endangered status of pangolins) and health concerns (risk of disease transmission) as the two primary reasons (> 50%) for declining attitudes toward consumption. Overall, COVID-19 does not, specifically, appear to be associated with changed perceptions of pangolin consumption in Hong Kong: > 75% of respondents stated that there is no relationship between pangolins and COVID-19, or were unsure about any such connection. Only 1% mentioned an awareness of the illegality of pangolin consumption as a reason for not consuming them. As such, our results challenge simple narratives regarding the impact of COVID-19 on pangolin consumption. We suggest that future demand reduction efforts could emphasize the conservation impact and health risks of consuming pangolins, and specifically focus on the older generations. As pangolins continue to be trafficked and threatened with extinction, further research into the perceptions and attitudes of consumers of these products is needed to inform targeted and effective interventions.

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## 1. Introduction

Wildlife trade and consumption pose significant threats to global biodiversity and public health due to the overexploitation of wild populations of species and increasing risks of zoonoses (Chomel et al., 2007), especially in the age of accelerated globalization and rapid economic development which facilitates the international trafficking of wildlife (Karesh et al., 2005; Nijman, 2010). The effective management of wildlife trade and consumption calls for demand reduction strategies, which require a comprehensive understanding of the demand (Olmedo et al., 2021; Thomas-Walters et al., 2020; Veríssimo et al., 2020). Many previous studies have focused on understanding the demand for wildlife and their products such as ivory, rhino horn (Greenfield and Veríssimo, 2019; Milner-Gulland, 1993), bear bile (Davis et al., 2019), and tiger bone (Davis et al., 2020), on which scholars based their advice on corresponding management strategies and demand reduction campaign designs for these and other species.

Among all the species that are traded in the global market, pangolins are the most heavily trafficked wild mammals in the world (Heinrich et al., 2016) and are consumed for various purposes (Soewu et al., 2020; Xing et al., 2020). For example, their body parts are used in traditional medicines — the indigenous medical practices developed in different societies prior to the era of modern medicine — or as a food source in some regions of Asia and Africa (Mohapatra et al., 2015; Soewu and Ayodele, 2009; Xing et al., 2020). Pangolin leather was also historically used in the manufacture of cowboy boots in the United States of America (Challender et al., 2020; Heinrich et al., 2019; Wu et al., 2004). One of the greatest demand regions for pangolins is China, where pangolin meat is a luxurious dish with tonic values, and pangolin scales are used in Traditional Chinese Medicines for multiple purposes, such as stimulating lactation, treating infertility, and as a cure for liver disease and tumors (Burgess et al., 2020; Heinrich et al., 2016; Nijman et al., 2016; Wang et al., 2020). In the 1960s, around 160,000 pangolins were removed from the wild every year in China (Nijman, 2010; Wu et al., 2004). The population size of Chinese pangolins (*Manis pentadactyla*) declined dramatically in the 1990s across its range due to increasing domestic demand and exports, which also corresponded with an increase in trafficking of other Asian pangolin species from different parts of their range to China (Challender et al., 2020; Wu et al., 2004). At the beginning of the 21st century, Asian pangolin species failed to meet the demand of the market and consequently African pangolin species (mostly scales) began being shipped by the tonnes, both legally and illegally, from Africa to Asia (Challender et al., 2020; Heinrich et al., 2017).

As an international port, Hong Kong Special Administration Region (hereafter “Hong Kong”) is a crucial transit hub for the trafficking of pangolins (Challender et al., 2020; Cheng et al., 2017). According to seizures reported by Hong Kong Customs, more than seven tonnes of pangolin scales were trafficked to Hong Kong between 2010 and 2015 (Heinrich et al., 2017), with the majority of these shipments coming from Africa (Cheng et al., 2017). The increasing magnitude and frequency of seizures since 2015 reflects a worsening situation. In a single seizure in 2019, Customs officers found eight tonnes of pangolin scales disguised as frozen beef in a shipping container from Nigeria (Asia Debt Management Hong Kong Limited “ADM Capital” Foundation, 2021; Chow et al., 2019).

The intensification of pangolin poaching and trafficking has received recent legislative and public attention. In 2017, all eight pangolin species were upgraded from Appendix II to Appendix I of the Convention on International Trade in Endangered Species of wild fauna and flora (CITES) (UNEP-WCMC, 2014). The upgrade came into effect in Hong Kong under The Protection of Endangered Species of Animals and Plants Ordinance, Cap. 586 (2018) (Zhang, 2019a). The Ordinance stipulates that commercial trade in pangolins is prohibited, and the possession of pangolins, their parts and derivatives, except for those with a license obtained in advance, is illegal in Hong Kong with a maximum penalty of HK\$10 million (approximately US\$1.3 million), and ten years imprisonment for any contraventions (Hong Kong SAR Government, 2021b).

Meanwhile, pangolins have frequently been highlighted in the public sphere for reasons of conservation and public health. Non-government Organizations such as Humane Society International (2015) initiated awareness-raising actions for pangolin conservation in Hong Kong. News agencies such as the South China Morning Post (Lo, 2020; Zhang, 2019b) and HK01 (Cheung, 2018) have covered stories of pangolin poaching, trafficking, consumption, and conservation. The news reporting mirrored increasing global attention towards pangolin consumption. Additionally, the outbreak of the COVID-19 health emergency further brought pangolins into the media spotlight. Based on the discovery of coronaviruses related to SARS-COV-2 (the causative agent for the COVID-19 outbreak) in pangolins, some studies proposed that pangolins may have been an intermediate host and linked to the origin of COVID-19 (Lam et al., 2020; Zhang et al., 2020). While there is little evidence at this point that pangolins were involved in the origin of COVID-19 (Frutos et al., 2020), this media attention has likely linked pangolins and coronaviruses in the public sphere.

We investigated whether and how Hong Kong residents’ awareness, attitudes, and behaviors concerning pangolins and pangolin consumption have changed pre- (2015) and immediately post the COVID-19 outbreak (2020). As mentioned, between 2015 and 2020 there has been increased coverage of pangolins in the media, potential links drawn between pangolins and infectious disease, and legislative changes to pangolin consumption – all of which may have impacted public attitudes toward pangolin consumption and trade in Hong Kong. We therefore repeated the 2015 survey in 2020 to determine whether there has been a change in demand for pangolin products over those five years. We conducted telephonic surveys among Hong Kong residents in 2015 and 2020 to determine 1) the reported levels of pangolin consumption, 2) perceptions of demand for pangolin products and trends in demand, and 3) reasons for attitudes or changing attitudes towards pangolin consumption. Comparing the results of these two surveys provides important information regarding attitudes towards pangolin consumption in a key location within the global pangolin trade network, as well as data on the impact of different factors (conservation awareness, health risks, illegality, social stigma, COVID-19) on people’s consumption preference and attitudes, which can advise the focus of future conservation work in pangolin demand reduction (Burgess et al., 2020).

## 2. Methods

### 2.1. Survey

The survey was conducted telephonically using a questionnaire format and conducted on residents of Hong Kong from June 29 to July 2 in 2015, and from October 16 to November 4 in 2020. The questionnaire contained 12 questions designed to gauge people's knowledge, behavior, attitudes, and perceptions concerning pangolins and the consumption of pangolins, as well as a standard set of five questions to capture the respondent's demographic data, including: gender, age, occupation, level of education, and income bracket. We used the same questionnaire in 2015 and 2020 for comparison, and added two additional questions in the 2020 questionnaire that are specifically designed to understand changes in attitude towards pangolin consumption: 1) compared to five years ago, has your opinion towards pangolin meat or scales consumption changed? If yes, have you become more in favor of or more opposed to such consumption? 2) as far as you know, is there any relationship between COVID-19 and pangolins?

The questions were ordered according to the level of sensitivity: less-sensitive questions concerning people's knowledge, previous behaviors, attitudes, and perceptions were listed earlier in the questionnaire, while questions inquiring people's legal awareness and COVID-19 relations were listed in the latter part of the questionnaire. The length of the survey was limited to < 10 min for each respondent. The questions of the 2015 and 2020 surveys in both English and Cantonese are listed in [Appendix A](#).

### 2.2. Sampling

A random telephone sampling method was used to obtain a representative sample of Cantonese-speaking Hong Kong residents aged 18 and above. The Hong Kong Public Opinion Research Institute (HKPORI) were commissioned to conduct the telephone survey. Telephone numbers were randomly generated using known prefixes assigned to telecommunication services providers under the Numbering Plan provided by the Office of the Communications Authority. Invalid numbers were eliminated according to an algorithm and manual dialing records to produce the final sample. When telephone contact was successfully established with a target household, one person who met the study's requirements was selected from all those present using the "next birthday" rule (i.e., select the member whose birthday is nearest to the interview date). Initial call-ins took place between 6:30 pm and 10:30 pm on weekdays. We targeted 1000 respondents in each year (2015 and 2020) to represent the 7,474,200 residents in Hong Kong (Hong Kong SAR Government, 2021a). It is to be noted that we did not intentionally re-interview the same people as those in the 2015 survey in 2020.

The questionnaire was administered in Cantonese, and the responses were translated to English and answers to open-ended questions were categorized by HKPORI. According to [Newing \(2010\)](#), conducting surveys in local languages minimizes social desirability bias. In Hong Kong, Cantonese is the most common language, and around 90% of the population is able to communicate effectively in Cantonese ([Census and Statistics Department, Hong Kong Special Administrative Region, 2020](#)). All data were collected using a Computer Assisted Telephone Interview system, which allows real-time data capture and consolidation. All survey calls were conducted anonymously and without disclosure of funding in order to minimize pressure on participants in discussing a sensitive topic. To ensure data quality, voice recording, screen capturing, camera surveillance and on-site supervision was used to monitor interviewer performance. The research design was approved by the University of Hong Kong Human Research Ethics Committee (Reference number: EA200041).

### 2.3. Statistical analyses

Descriptive statistics were calculated based on the number of responses received for each question. Multinomial logistic regression was used to investigate the relationship between demographics and people's attitudes and perceptions for the 2020 survey. All analyses and visualization of data were conducted in R ([R Core Team, 2021](#)).

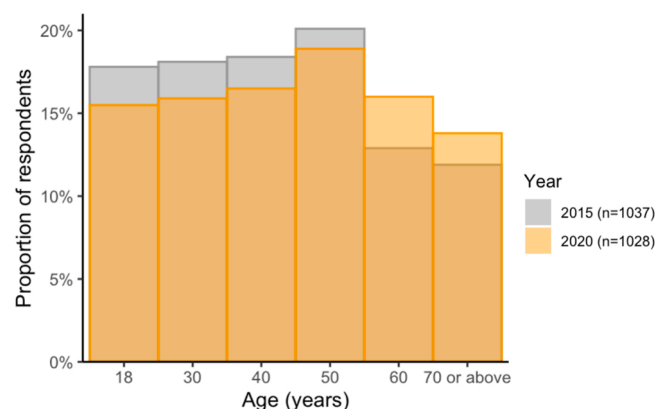


Fig. 1. Age distribution of respondents in the 2015 and 2020 surveys, respectively.

### 3. Results

#### 3.1. Demographics

In 2015, we sampled 1037 effective respondents over four days, consisting of 469 males and 568 females (self-reported gender identity) with a response rate of 67.6%. Five years later, in 2020, we sampled 1028 effective respondents over 19 days, consisting of 483 males and 545 females, with a response rate of 73.5%. The respondents were relatively evenly distributed across different age groups (Fig. 1), and the self-professed gender was also nearly equal during both surveys. The sampling errors for both surveys were controlled  $< \pm 3.1\%$  at a 95% confidence level (see Appendix B for the calculation method).

#### 3.2. Behavior of pangolin consumption

Most of the consumption of pangolin meat and scales in Hong Kong was reported to have occurred before 2010 by 7.8% of the survey participants (Fig. 2). Less than 1% of the respondents reported having consumed pangolin products within five years of both surveys (i.e., 2010 – 2015 for the 2015 survey, 2015 – 2020 for the 2020 survey, referred to as current consumers in Fig. 2). Only two respondents reported having consumed pangolin meat from 2018 to 2020.

More than 95% of the reported consumers of pangolin meat and scales in 2015 were aged above 30: 52% of the consumers were aged between 30 and 59, 44% were aged above 60. The consumers in the 2020 survey were all aged above 50, except for one scale consumer aged under 30. In other words, younger people (below 30) were less likely to consume pangolins compared to people aged above 30.

Respondents consumed pangolin meat for diverse reasons, most commonly for its health benefits and good taste. Pangolin scales were reportedly used for a myriad of medicinal purposes, including curing sores, itchiness, cancer, rheumatism, and promoting hemostasis and circulation.

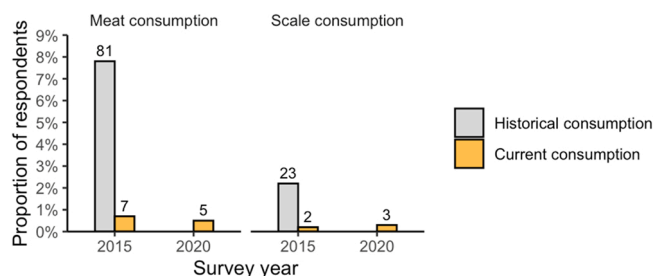
#### 3.3. Perception of social trend

In both 2015 and 2020, more than half of the respondents believed that the number of people consuming pangolin meat and scales in Hong Kong was decreasing (Fig. 3). Meanwhile, 10.2% of the respondents in 2015 and 8.4% in 2020 believed that the number was increasing in both years.

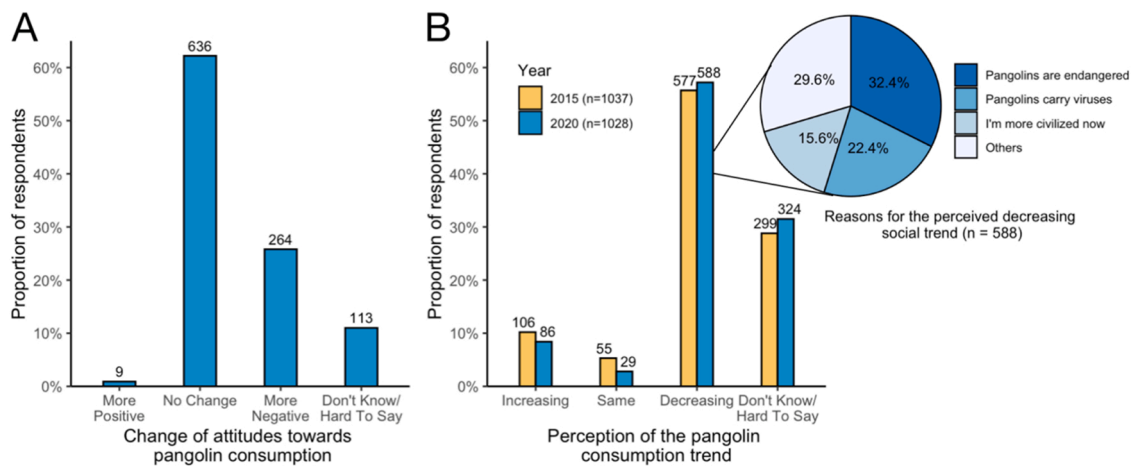
Only the 2020 survey asked respondents about the reasons for their perception towards consuming pangolin meat and scales, in the form of an open-ended question where options were not read out. Conservation awareness was the most important factor driving respondents' perception of the decline in the number of pangolin consumers (Fig. 3). One-third of the respondents who believed that the pangolin-consumer population was shrinking ( $n = 191$ ) attributed the decline to people's awareness of pangolins' endangered status (Fig. 3). Secondly, approximately one quarter of the 588 respondents ( $n = 130$ ) also referred to the belief that pangolins carry viruses as the main reason for this presumed decline (Fig. 3). Of these 130 individuals, 44 believed that pangolins were associated with COVID-19. The result of an independent Chi-square test showed that the people believing that pangolins carry viruses were also more likely to believe that pangolins were associated with COVID-19 ( $X^2 = 7.87$ ,  $df = 2$ ,  $p = 0.02$ ).

The third most frequently mentioned reason for the perceived decline in the consumption of pangolin meat and scales was that people believed, in their own words, that they were more "civilized" now, which in a Chinese context means that they are better mannered and educated, in contrast to backward and rude. This suggests that there is a social stigma attached to consuming pangolins in Hong Kong society, and this social stigma led to 15% of the 588 respondents perceiving the social trend in pangolin consumption to be decreasing. Notably, the illegality of pangolin consumption as the reason for the negative perception was only mentioned by 10% ( $n = 60$ ) of respondents who perceived the consumption trend to be decreasing.

For the respondents who believed that pangolin consumption was increasing in popularity ( $n = 86$ ), the health benefit derived from pangolin products was perceived to be the main reason.



**Fig. 2.** The proportion of pangolin consumers among participants reported in each survey. Historical consumption refers to consumers who reported having consumed pangolins before 2010 in the 2015 survey results, and current consumption refers to consumers who had consumed pangolins within five years of the survey (i.e., 2010 – 2015 for the 2015 survey, 2015 – 2020 for the 2020 survey). The numbers above the columns indicate the sample size for each category.



**Fig. 3.** (A) Respondents' change of attitudes towards pangolin consumption in 2020 ( $n = 1028$ ), and (B) their perception of the social trend in pangolin consumption in 2015 ( $n = 1037$ ) and 2020 ( $n = 1028$ ), and the reasons behind the perceived decreasing trend. The numbers above the columns indicate the sample size for each category.

### 3.4. Attitudes towards the consumption of pangolins

Contrary to expectations, there was little reported change in attitudes towards the consumption of pangolins between 2015 and 2020 (Fig. 3). For the quarter of respondents who were more opposed to pangolin consumption ( $n = 286$ ), the main reasons were similar to those causing people's perception of a decreasing consumption trend: conservation awareness, links with viruses, and people becoming more civilized. Only 5% of those people who are now more opposed to pangolin consumption ( $n = 14$ ), which is around 1% of the total sample, mentioned the awareness of the illegality of pangolin consumption as reasons for not consuming them.

### 3.5. Legal awareness

Despite a ban on pangolin trade coming into effect between the two survey periods, respondents' awareness of the illegality of pangolin consumption remained almost the same in 2015 and 2020. Overall, respondents were more aware of the illegality of consuming pangolin meat, specifically, than scales: 72.9% of the respondents in 2015 and 75% in 2020 knew that consuming pangolin meat was illegal, and only slightly more than half of the respondents (51.1% in 2015 and 56.5% in 2020) acknowledged that consuming pangolin scales was illegal.

### 3.6. Relationship with COVID-19

Most respondents did not make a direct connection between the COVID-19 outbreak and pangolins. Forty-four percent of the respondents ( $n = 451$ ) stated that no relationship existed between pangolins and COVID-19, and more than one-third of the respondents ( $n = 374$ ) were not clear whether there was any connection between the two. Still, the remaining 20% of the respondents ( $n = 223$ ) specifically pointed out how pangolins could be the possible cause of the COVID-19 pandemic (e.g., pangolins might be the carrier or source of COVID-19). Interestingly, three individuals believed that, instead of being the cause, pangolin products were the cure for COVID-19.

### 3.7. Multinomial logistic regression

The multinomial logistic regression indicated that few clear relationships could be discerned between people's perceptions and their demographic characteristics in the 2020 survey (Appendix C). Only the models of people's legal awareness and perceptions of the relationship between COVID-19 and pangolins was significantly correlated. On the one hand, people with higher education levels tend to believe that consuming pangolin meat is legal (see Appendix C3). On the other hand, females and students are more likely to believe that COVID-19 is associated with pangolins, while housewives are more uncertain about this potential relationship. Executives and professionals think that there is no relationship between COVID-19 and pangolins (Appendix C5).

## 4. Discussion

The suggestion that pangolins may have been involved in the transmission of COVID-19 stirred up wide discussion about pangolin consumption in 2020 (Frutos et al., 2020; Zhang et al., 2020). However, no studies have yet compared people's behaviors, perceptions, and attitudes towards pangolin consumption pre- and post- the outbreak of COVID-19. Here, we took advantage of a 2015 survey



conducted in Hong Kong and repeated it in 2020 to determine whether the pandemic shifted attitudes or perceptions with regards to the consumption of pangolins. First, we found that reported historical levels of consumption in Hong Kong (~8%) were similar to estimates of current (from 2000s to before the pandemic) consumption in China (7–10%; Burgess et al., 2020). Current levels of reported consumption in Hong Kong were low in both 2015 and 2020 (< 1% of people surveyed). Second, we observed that pangolin consumption was perceived to be decreasing in Hong Kong, and many people have become more opposed to pangolin consumption. However, these perceptions of pangolin consumption trends over time differed little in our 2015 and 2020 surveys. Finally, conservation and health risks were the two most frequently reported reasons for reported negative attitudes towards pangolin consumption.

Our survey results from 2020 indicated that only 0.2% of the respondents consumed pangolin meat and 0.1% consumed scales in the past three years. By comparison, the results of a 2018 survey involving 1800 participants in mainland China found that 0.7% of the participants had consumed pangolin meat and 4.3% consumed scales in the past year (USAID Wildlife Asia, 2018). These results suggest that the current reported rates of consumption of both pangolin meat and scales in Hong Kong are lower than in mainland China (Burgess et al., 2020; USAID Wildlife Asia, 2018), even though Hong Kong is one of the largest transit cities of pangolin products, and residents did historically consume pangolins (Challender et al., 2020; Cheng et al., 2017; Xing et al., 2020). It should be noted that there is a legal market for pangolin scales in mainland China, where certified hospitals can sell pangolin scales from a legal stockpile (Wang et al., 2020; Xing et al., 2020), which might partly contribute to higher scale consumption rates in mainland China. Still, the 2020 survey shows that the total meat consumption rate in Hong Kong from 2018 to 2020 (0.2%) is lower than that of mainland China in the single year of 2018 (0.7%; USAID Wildlife Asia, 2018). This suggests that the consumption rate in Hong Kong is indeed minimal (Burgess et al., 2020).

The younger generation appears not to have acquired the behavior of consuming pangolins, with most of the people that consume pangolins being aged above 50 (2015 = 44%, 2020 = 88%). This trend of declining use of wildlife products in younger generations has also been reported in Laos (Davis and Glikman, 2020), where these authors inferred that the decline might be attributed to the decrease in supply or decrease in young people's desire for wildlife products. Our results did not show any relationship between the respondents' age and perception and attitudes towards pangolin consumption, so the reasons behind the decline of pangolin consumption in younger people remains to be investigated. Still, the pattern of limited consumption in younger generations at least suggests that the overall decline in pangolin consumption is likely to be sustained in the future.

Similar to the consumption behavior results, we did not observe clear changes in most people's perceptions and attitudes between the pre- and post-COVID-19 surveys. More than half of the respondents perceived the number of pangolin consumers to be decreasing in both years, and the perceived negative connotations towards pangolin consumption persisted from 2015 to 2020. At the same time, most respondents in 2020 (62%) reported that they did not change their attitudes in those five years. A simple explanation can be that these respondents did not experience any opinion-changing events, or they did not change their minds despite external changes such as the pangolin trade ban, increased public campaigns and COVID-19. The latter situation could be partly because of people's negative attitudes towards pangolin consumption persisting from 2015 since the reported consumption rate is low. It could also be attributable to possible ineffectiveness of awareness-raising campaigns and media coverage in those five years (Olmedo et al., 2020).

For the 26.7% of participants in 2020 who did change their attitudes towards pangolin consumption from five years ago, conservation concerns for pangolins were considered the most prominent factor for their more negative attitudes toward consumption. When it comes to wildlife consumption, raising conservation awareness remains one of the most recommended solutions to demand reduction (Lee et al., 2009; Liu et al., 2020; Zhang et al., 2008, 2014). On the contrary, Moorhouse et al. (2017) found that in the case of exotic pets, conservation impacts did not influence consumer choices, while legality and zoonotic risk did. Our survey results support the notion that conservation awareness is a prominent determinant in changing people's attitudes and perceptions towards the consumption of pangolins. Consequently, future conservation efforts on pangolin demand reduction should consider focusing on raising awareness of the conservation status of pangolins and other threatened species.

Interestingly, legal awareness did not play an important role in turning people's attitudes towards pangolin consumption more negative. First, the increase in the awareness of the illegality of pangolin consumption was minimal (from 72.9% to 75% for pangolin meat consumption and from 51.1% to 56.5% for pangolin scale consumption) despite the legislative changes since 2015. Similarly, in Vietnam, laws banning pangolin trade were found not to have had much impact on consumption in a survey conducted in 2018 (Sexton et al., 2021). Future legal awareness campaigns may be more effective if messages are tailored to the target audience, for example breaking down the legislative texts into easily understood messages such as "consuming pangolins is illegal in Hong Kong" (Olmedo et al., 2020). However, only a small portion of the respondents regarded the legal issue as the main reason for a more negative attitude towards pangolin consumption. According to Wang et al. (2020), legal awareness is supposed to be the most important factor influencing people's attitudes towards pangolin consumption. This could be explained by Ajzen's theory of planned behavior Ajzen (1991), where Ajzen argued that the conduct of behavior is jointly dependent on intention and behavior control. In our case, when people lack the intention to consume pangolins due to conservation concerns, hygienic concerns, and social pressure, the illegality as a behavioral control might be regarded as lower on the resistance priority list.

At the same time, the discussion concerning the possible link between COVID-19 and pangolin consumption seemed to have little impact on the demand for pangolins in Hong Kong. For the portion of respondents who believed that pangolins carry viruses ( $n = 130$ , 12.6%), COVID-19 appears to have limited influence on their perception (if any), since of these 130 individuals, 44 believed that pangolins were associated with COVID-19. That is to say, many respondents believe that pangolins present health risks to humans but not necessarily because of COVID-19. More generally, most of the respondents did not think that there was a direct connection between COVID-19 and pangolins. In other words, COVID-19 did not constitute the main reason preventing people from consuming pangolins in 2020.

However, caution should be exercised when interpreting these results as the prevalence of consuming pangolins in Hong Kong

might be underestimated due to the sensitivity and legality of the issue. According to Krumpal (2013), respondents tend to underreport socially undesirable behaviors due to concerns about their self-image. This social desirability bias is very likely to be present in our survey results since pangolin consumption was perceived by some respondents as illegal and “uncivilized”. A recent study investigating pangolin consumption behavior in Vietnam found that three times more pangolin meat consumers were detected when using the unmatched count technique that minimized social desirability bias than when using the direct questioning technique (Olmedo et al., 2021). In future, the unmatched count technique could be used to avoid this bias that likely impacted our survey results. As such, the prevalence of pangolin consumption reported here is likely an underestimate, and respondents might be more willing to give “desirable” answers such as high conservation awareness, even when anonymous. Nevertheless, compared to other studies in mainland China which also likely have underestimated levels of consumption (e.g., USAID Wildlife Asia, 2018), the rates reported here are still low.

Our results challenge simple narratives regarding the impact of COVID-19 on pangolin consumption. In Hong Kong, we found that most pangolin consumers were people aged above 50 and the current consumption level was very low. At the same time, attitudes toward pangolin consumption remain largely unchanged pre- and post- the COVID-19 outbreak. The lack of change across time in our study could be attributed to the already low reported rates of pangolin consumption in Hong Kong. For the people whose attitudes towards pangolin consumption became more negative, conservation remained the primary reason, followed by health risks and social stigma. Our study suggests that future demand reduction efforts should focus on people above 50 years old and emphasize the conservation impact and health risks of pangolin consumption. Further research on public opinion, attitudes and behaviors of consumers of pangolin products in mainland China is necessary for the effective design of targeted interventions for demand reduction (Burgess et al., 2020).

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## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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## Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at [doi:10.1016/j.gecco.2022.e02107](https://doi.org/10.1016/j.gecco.2022.e02107).

## References

- Ajzen, I., 1991. The theory of planned behavior. *Organ. Behav. Hum. Decis. Process.* 50 (2), 179–211. [https://doi.org/10.1016/0749-5978\(91\)90020-T](https://doi.org/10.1016/0749-5978(91)90020-T).
- Asia Debt Management Hong Kong Limited (“ADM Capital”) Foundation. (2021, March). Still Trading in Extinction: The Dark Side of Hong Kong’s Wildlife Trade. Retrieved from ([https://www.admcf.org/wp-content/uploads/2021/03/STIE\\_Full-report-.pdf](https://www.admcf.org/wp-content/uploads/2021/03/STIE_Full-report-.pdf)).
- Burgess, G., Olmedo, A., Verissimo, D., Waterman, C., 2020. Changing consumer behavior for pangolin products. In: Challender, D.W.S., Nash, H.C., Waterman, C. (Eds.), *Pangolins: Science, Society, and Conservation*. Academic Press, pp. 349–366.
- Census and Statistics Department, Hong Kong Special Administrative Region. (2020). Use of Language in Hong Kong. *Hong Kong Monthly Digest of Statistics*. Retrieved from (<https://www.statistics.gov.hk/pub/B72001FB2020XXXXB0100.pdf>).
- Challender, D.W., Heinrich, S., Shepherd, C.R., Katsis, L.K., 2020. International trade and trafficking in pangolins, 1900–2019. In: Challender, D.W.S., Nash, H.C., Waterman, C. (Eds.), *Pangolins: Science, Society, and Conservation*. Academic Press, pp. 259–276.
- Cheng, W., Xing, S., Bonebrake, T.C., 2017. Recent pangolin seizures in China reveal priority areas for intervention. *Conserv. Lett.* 10 (6), 757–764. <https://doi.org/10.1111/conl.12339>.
- Cheung, Men. (2018, February 5). 【穿山甲之死】上環藥房出售鱗片 港淪穿山甲走私中轉站. HK01. Retrieved from (<https://www.hk01.com/>)社會新聞/156342/穿山甲之死-上環藥房出售鱗片-港淪穿山甲走私中轉站.
- Chomel, B.B., Belotto, A., Meslin, F.X., 2007. Wildlife, exotic pets, and emerging zoonoses. *Emerg. Infect. Dis.* 13 (1), 6–11. <https://doi.org/10.3201/eid1301.060480>.
- Chow, V., Pearson, J., & Master, F. (2019, February 1). Hong Kong customs seize record haul of pangolin scales bound for Vietnam. *Reuters*. Retrieved from (<https://www.reuters.com/article/us-hongkong-seizures-idUSKCN1PQ3LU>).
- Davis, E.O., Glikman, J.A., 2020. An assessment of wildlife use by Northern Laos nationals. *Animals* 10 (4), 685. <https://doi.org/10.3390/ani10040685>.
- Davis, E.O., Glikman, J.A., Crudge, B., Dang, V., Willemsen, M., Nguyen, T., Bendixsen, T., 2019. Consumer demand and traditional medicine prescription of bear products in Vietnam. *Biol. Conserv.* 235, 119–127. [doi:10.1016/j.biocon.2019.04.003](https://doi.org/10.1016/j.biocon.2019.04.003).



- Davis, E.O., Willemsen, M., Dang, V., O'Connor, D., Glikman, J.A., 2020. An updated analysis of the consumption of tiger products in urban Vietnam. *Glob. Ecol. Conserv.* 22, e00960 <https://doi.org/10.1016/j.gecco.2020.e00960>.
- Frutos, R., Serra-Cobo, J., Chen, T., Devaux, C.A., 2020. COVID-19: Time to exonerate the pangolin from the transmission of SARS-CoV-2 to humans. *Infect., Genet. Evol.* 84, 104493 <https://doi.org/10.1016/j.meegid.2020.104493>.
- Greenfield, S., Veríssimo, D., 2019. To what extent is social marketing used in demand reduction campaigns for illegal wildlife products? Insights from elephant ivory and rhino horn. *Soc. Mark. Q.* 25 (1), 40–54. <https://doi.org/10.1177/1524500418813543>.
- Heinrich, S., Wittmann, T.A., Prowse, T.A., Ross, J.V., Delean, S., Shepherd, C.R., Cassey, P., 2016. Where did all the pangolins go? International CITES trade in pangolin species. *Glob. Ecol. Conserv.* 8, 241–253. <https://doi.org/10.1016/j.gecco.2016.09.007>.
- Heinrich, S., Wittmann, T.A., Ross, J.V., Shepherd, C., Challender, D.W.S., Cassey, P., 2017. *The Global Trafficking Of Pangolins: A Comprehensive Summary of Seizures and Trafficking Routes from 2010 –2015*. TRAFFIC, Southeast Asia Regional Office, Petaling Jaya, Selangor, Malaysia.
- Heinrich, S., Ross, J.V., Cassey, P., 2019. Of cowboys, fish, and pangolins: US trade in exotic leather. *Conserv. Sci. Pract.* 1 (8), e75 <https://doi.org/10.1111/csp2.75>.
- Karesh, W.B., Cook, R.A., Bennett, E.L., Newcomb, J., 2005. Wildlife trade and global disease emergence. *Emerg. Infect. Dis.* 11 (7), 1000. <https://doi.org/10.3201/eid1107.050194>.
- Krumpal, I., 2013. Determinants of social desirability bias in sensitive surveys: a literature review. *Qual. Quant.* 47 (4), 2025–2047. <https://doi.org/10.1007/s11135-011-9640-9>.
- Lam, T.T.Y., Jia, N., Zhang, Y.W., Shum, M.H.H., Jiang, J.F., Zhu, H.C., Cao, W.C., 2020. Identifying SARS-CoV-2-related coronaviruses in Malayan pangolins. *Nature* 583 (7815), 282–285. <https://doi.org/10.1038/s41586-020-2169-0>.
- Lee, T.M., Sodhi, N.S., Prawiradilaga, D.M., 2009. Determinants of local people's attitude toward conservation and the consequential effects on illegal resource harvesting in the protected areas of Sulawesi (Indonesia). *Environ. Conserv.* 36 (2), 157–170. <https://doi.org/10.1017/S0376892909990178>.
- Liu, S., Ma, Z.F., Zhang, Y., Zhang, Y., 2020. Attitudes towards wildlife consumption inside and outside Hubei Province, China, in relation to the SARS and COVID-19 outbreaks. *Hum. Ecol.* 48 (6), 749–756. <https://doi.org/10.1007/s10745-020-00199-5>.
- Lo, C. (2020, September 24). Hong Kong customs seizes a tonne of pangolin scales in biggest haul of year so far. *South China Morning Post*. Retrieved from (<https://www.scmp.com/news/hong-kong/law-and-crime/article/3102858/hong-kong-customs-seizes-tonne-pangolin-scales-biggest>).
- Milner-Gulland, E.J., 1993. An econometric analysis of consumer demand for ivory and rhino horn. *Environ. Resour. Econ.* 3 (1), 73–95. <https://doi.org/10.1007/BF00338321>.
- Mohapatra, R.K., Panda, S., Acharjyo, L.N., Nair, M.V., Challender, D.W., 2015. A note on the illegal trade and use of pangolin body parts in India. *Traffic Bull.* 27 (1), 33–40.
- Moorhouse, T.P., Balaskas, M., D'Cruze, N.C., Macdonald, D.W., 2017. Information could reduce consumer demand for exotic pets. *Conserv. Lett.* 10 (3), 337–345.
- Newing, H., 2010. *Conducting Research In Conservation: Social Science Methods And Practice*. Routledge.
- Nijman, V., 2010. An overview of international wildlife trade from Southeast Asia. *Biodivers. Conserv.* 19 (4), 1101–1114. <https://doi.org/10.1007/s10531-009-9758-4>.
- Nijman, V., Zhang, M.X., Shepherd, C.R., 2016. Pangolin trade in the Mong La wildlife market and the role of Myanmar in the smuggling of pangolins into China. *Glob. Ecol. Conserv.* 5, 118–126. <https://doi.org/10.1016/j.gecco.2015.12.003>.
- Olmedo, A., Milner-Gulland, E.J., Challender, D.W., Cugnière, L., Dao, H.T.T., Nguyen, L.B., Veríssimo, D., 2020. A scoping review of celebrity endorsement in environmental campaigns and evidence for its effectiveness. *Conserv. Sci. Pract.* 2 (10), e261 <https://doi.org/10.1111/csp2.261>.
- Olmedo, A., Veríssimo, D., Milner-Gulland, E.J., Hinsley, A., Dao, H.T.T., Challender, D.W., 2021. Uncovering prevalence of pangolin consumption using a technique for investigating sensitive behaviour. *Oryx* 1–9. <https://doi.org/10.1017/S0030605320001040>.
- R Core Team (2021). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing, Vienna, Austria. Retrieved from (<https://www.R-project.org/>).
- Sexton, R., Nguyen, T., Roberts, D.L., 2021. The use and prescription of pangolin in traditional Vietnamese medicine, 1940082920985755 *Trop. Conserv. Sci.* 14. <https://doi.org/10.1177/1940082920985755>.
- Soewu, D.A., Ayodele, I.A., 2009. Utilisation of pangolin (*Manis* spp) in traditional Yorubic medicine in Ijebu province, Ogun State, Nigeria. *J. Ethnobiol. Ethnomed.* 5 (1), 1–11. <https://doi.org/10.1186/1746-4269-5-39>.
- Soewu, D.A., Ingram, D.J., Jansen, R., Sodeinde, O., Pietersen, D.W., 2020. Bushmeat and beyond: historic and contemporary use in Africa. In: Challender, D.W.S., Nash, H.C., Waterman, C. (Eds.), *Pangolins: Science, Society, and Conservation*. Academic Press, pp. 241–258.
- The Protection of Endangered Species of Animals and Plants Ordinance, Cap. 586 (2018).
- Thomas-Walters, L., Veríssimo, D., Gadsby, E., Roberts, D., Smith, R.J., 2020. Taking a more nuanced look at behavior change for demand reduction in the illegal wildlife trade. *Conserv. Sci. Pract.* 2 (9), e248.
- UNEP-WCMC. (2014). Checklist of CITES species. Retrieved from (<http://checklist.cites.org/>).
- USAID Wildlife Asia (2018). Research study on consumer demand for elephant, pangolin, rhino and tiger parts and products in China. Washington, DC: USAID Wildlife Asia.
- Veríssimo, D., Vieira, S., Monteiro, D., Hancock, J., Nuno, A., 2020. Audience research as a cornerstone of demand management interventions for illegal wildlife products: Demarketing sea turtle meat and eggs. *Conserv. Sci. Pract.* 2 (3), e164 <https://doi.org/10.1111/csp2.164>.
- Wang, Y., Turvey, S.T., Leader-Williams, N., 2020. Knowledge and attitudes about the use of pangolin scale products in Traditional Chinese Medicine (TCM) within China. *People Nat.* 2 (4), 903–912. <https://doi.org/10.1002/pan3.10150>.
- Wu, S.B., Liu, N.F., Zhang, Y.M., Ma, G.Z., 2004. Assessment of threatened status of Chinese Pangolin (*Manis pentadactyla*). *Chin. J. Appl. Environ. Biol.* 10, 456–461.
- Xing, S., Bonebrake, T.C., Cheng, W., Zhang, M., Ades, G., Shaw, D., Zhou, Y., 2020. Meat and medicine: historic and contemporary use in Asia. In: Challender, D.W.S., Nash, H.C., Waterman, C. (Eds.), *Pangolins: Science, Society, and Conservation*. Academic Press, pp. 227–239.
- Zhang, K. (2019a, May 2). The pangolin trade explained: Situation in Hong Kong. *The Pangolin Reports*. Retrieved from (<https://www.pangolinreports.com/hong-kong/>).
- Zhang, K. (2019b, September 25). Illegal trade in pangolin thrives despite 2017 global ban, according to investigative report that blames demand in China and huge profits on the black market. *South China Morning Post*. Retrieved from (<https://www.scmp.com/news/hong-kong/health-environment/article/3030162/illegal-trade-pangolin-thrives-despite-2017>).
- Zhang, L., Yin, F., 2014. Wildlife consumption and conservation awareness in China: a long way to go. *Biodivers. Conserv.* 23 (9), 2371–2381. <https://doi.org/10.1007/s10531-014-0708-4>.
- Zhang, L., Hua, N., Sun, S., 2008. Wildlife trade, consumption and conservation awareness in southwest China. *Biodivers. Conserv.* 17 (6), 1493–1516. <https://doi.org/10.1007/s10531-008-9358-8>.
- Zhang, T., Wu, Q., Zhang, Z., 2020. Probable pangolin origin of SARS-CoV-2 associated with the COVID-19 outbreak. *Curr. Biol.* 30 (7), 1346–1351. <https://doi.org/10.1016/j.cub.2020.03.022>.

## Further reading

- Hong Kong Special Administrative Region Government. (2021a, February 18). Year-end population for 2020 [Press Release]. Retrieved from (<https://www.info.gov.hk/gia/general/202102/18/P2021021800322.htm>).
- Hong Kong Special Administrative Region Government. (2021b, May). Protection of endangered species. Retrieved from ([www.gov.hk/en/residents/environment/conservation/protectendangerspecies.htm](http://www.gov.hk/en/residents/environment/conservation/protectendangerspecies.htm)).