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Rhino horn use by consumers of traditional Chinese medicine in China

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Abstract

The medicinal use of rhino horn in Asia is a major driver of poaching and illegal trade. Research into the different actors involved in this trade is needed to inform policymaking and improve conservation outcomes. While researchers have investigated rhino horn consumers in Vietnam, studies have yet to focus on China. Here, we conducted a large-scale online survey to investigate medicinal rhino horn consumption in China's Guangdong province. One in seven respondents reported having used rhino horn in the past year. These individuals tended to be older, male, wealthier and better educated; several healthcare usage variables were also associated with rhino horn consumption. These findings can help guide the development of tailored demand reduction interventions. Our results question the effectiveness of the global community's current approach to rhino conservation. We conclude by highlighting the need for conservationists to work more closely with key stakeholders to find lasting and sustainable solutions.

KEYWORDS

Chinese consumers, conservation policy, demand, medicinal use, poaching, rhino conservation, TCM, wildlife consumption, wildlife trade

1 | INTRODUCTION

The consumptive use of wildlife occurs globally and is driven by diverse motivations. Trade in many taxa is legal, regulated, and sustainable. However, not all trade is legal, and demand for certain wildlife products has led to unsustainable levels of exploitation that threaten thousands of species (Tittensor, Harfoot, McLardy, et al.,

2020). The global scale and severity of the illegal wildlife trade (IWT) have made it a prominent conservation issue ('t Sas-Rolfes, Challender, Hinsley, Veríssimo, & Milner-Gulland, 2019). IWT networks involve actors who play diverse roles to move wildlife products from the point of harvest to the end-user: wildlife harvesters (suppliers) introduce goods into the trade chain, intermediaries (middlemen) facilitate trade, and end-users ultimately consume the products (Phelps, Biggs, & Webb, 2016).

IWT has gravely impacted the five extant species of rhinoceros, fueled by demand for rhino horn in cultural, social and medicinal applications (Emslie et al., 2016). Records of the use of rhino horn as a medicinal ingredient in China date back millennia (Liu, Wang, Duan, Guo, & Tang, 2010). Such use has continued into the modern era (But, Lung, & Tam, 1990), in which traditional Chinese medicine (TCM) has experienced a revival through its integration into the healthcare system of the People's Republic of China for reasons that are both functional and politically motivated (Cheung et al., 2020; Croizier, 1965; Gross, 2018). Rhino horn is known in TCM as an ingredient that imparts potent "cool" or "cold" properties (But et al., 1990), and practitioners in China see it as a valuable treatment option for certain severe or critical conditions. Its primary functions are purported to be dispelling heat, detoxifying and cooling the blood, and treating *wenbing* (温病; externally contracted warm-heat infectious diseases) (Cheung, Mazerolle, Possingham, & Biggs, 2018).

The international trade in rhino horn has been banned by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) since 1977. The Chinese government banned the domestic trade and medicinal use of rhino horn in 1993, and removed rhino horn from the official TCM pharmacopeia (People's Republic of China, 1993). However, persistent and growing demand (particularly from China and Vietnam) has driven poaching and black market trade to dangerous levels over the past decade (Di Minin, Laitila, Montesino-Pouzols, et al., 2015; Lunstrum & Givá, 2020).

Reducing IWT in threatened species requires a combination of supply-side, transactional and demand-side measures ('t Sas-Rolfes et al., 2019) aimed at the various stakeholders involved (Phelps et al., 2016). Conservation policies and actions are more likely to succeed if they are accurately targeted, culturally nuanced and contextually appropriate (Greenfield & Veríssimo, 2019; Waylen, Fischer, McGowan, Thirgood, & Milner-Gulland, 2010). This requires an understanding and thorough consideration of the relevant social dimensions. Consumers ultimately determine demand, making insight into consumer characteristics and market dynamics necessary for effective conservation.

To better understand the demand side of the rhino horn trade, several peer-reviewed studies in recent years have focused on rhino horn use by traditional medicine consumers in Vietnam (*n.b.* as with many forms of traditional medicine in Asia, traditional Vietnamese medicine shares common origins with TCM, see Cheung et al., 2020), where end-users tend to be older, educated, wealthy men (Dang & Nielsen, 2018; Hanley, Sheremet, Bozzola, & MacMillan, 2018; Truong, Dang, & Hall, 2016). However, similar research on Chinese consumers has yet to be conducted, and whether similar patterns hold true in China remains unknown. This is despite China and Vietnam being implicated in the same amount of rhino horn seized between 2010 and 2015 (Emslie et al., 2016). The reasons behind the medicinal use of rhino horn by Chinese consumers are also unknown, making it impossible to assess whether consumption in the general public is consistent with what TCM practitioners in China describe as the appropriate application of rhino horn. Such research into Chinese consumers is needed for evidence-based policymaking. Here, we conducted a large-scale online survey of TCM consumers in China's Guangdong province. We investigated the:

1. Prevalence of rhino horn use by TCM consumers in the past year;
2. Demographic characteristics of TCM consumers who use rhino horn;
3. Reasons behind the medicinal use of rhino horn (medical conditions and context); and
4. Healthcare usage patterns associated with rhino horn consumption.

We stress that the medicinal use of rhino horn is not supported by biomedical evidence, and that our paper does not endorse such consumption. Rather, this study addresses a critical gap in the scientific understanding of rhino horn demand in an effort to improve conservation policy and outcomes.

2 | METHODS

2.1 | Research ethics

This research complied with the Australian National Health and Medical Research Council's National Statement on Ethical Conduct in Human Research. Human research ethics approval was granted by The University of Queensland (#2019000961).

2.2 | Study area

Located in southeastern China, Guangdong is the largest province by population and one of the wealthiest areas of

the country. Rates of wildlife consumption for medicine and for food have been reported to be higher in Guangzhou, Guangdong's provincial capital, than other major Chinese cities: 31.2% of people consume TCM or health products containing wildlife ingredients, compared with 1.5% in Beijing, 2.8% in Shanghai, 12.5% in Kunming and 23.6% in Nanning (Zhang & Yin, 2014). The Natural Resources Defense Council reported that 34.3% of people in Guangzhou who are aware of rhino horn's medicinal qualities would consume it, compared with 36.3%, 15.3%, and 10% in Harbin, Beijing, and Shanghai respectively (Kennaugh, 2016).

TCM practitioners cite dispelling heat, detoxifying the blood and treating *wenbing* as the most common clinical functions of rhino horn (Cheung et al., 2018). Geography is a key determinant of the illnesses that commonly manifest, and southern China is where the acute infections and epidemics associated with *wenbing* are most common (Hanson, 2011). Taken together, these factors suggest that data collected from Guangdong province would likely be on the upper end of the spectrum for medicinal rhino horn use.

2.3　│　Online survey

We contracted Acorn Asia, a professional market research firm, to administer the survey to participants recruited online through Acorn Asia's volunteer panel network. Conducting research online has some advantages over other survey delivery mechanisms, including the relatively lower cost of gathering data from larger samples. Social desirability bias tends to be lower online than in paper- or telephone-based surveys; online surveys tend to elicit greater honesty in terms of self-reported illegal or sensitive behaviors (Kreuter, Presser, & Tourangeau, 2008). Guangdong's high Internet penetration rate (74.0% in 2016) alleviated noncoverage concerns related to Internet access (China Internet Network Information Center, 2017). However, recruitment through volunteer panel networks has some methodological shortcomings, most notably the representativeness of sampling from a pool of individuals registered to partake in online surveys (Lee, 2006). Given practical constraints, we tried to mitigate this by recruiting participants using proportionate quota sampling (Im & Chee, 2011) to approximate the age and sex characteristics of Guangdong's population.

We recruited adult TCM consumers who had: (a) resided in Guangdong for the past year, and (b) either sought TCM services from a TCM practitioner or consumed TCM products for medicinal purposes (including prescribed decoctions, patent medicines, health tonics) in the past year. Respondents were asked about their consumption of rhino horn in the past (see Online Supporting Information for questionnaire). For those who have consumed rhino horn medicinally, we asked about any such use in the past year and inquired as to the specific medical conditions for which they had last consumed rhino horn. We also gathered information on respondents' demographic characteristics, healthcare usage and medical preferences.

2.4　│　Data analysis

To address the first two research questions, we used descriptive statistics to determine the prevalence of medicinal rhino horn use in our sample of TCM consumers and analyze the reasons behind such consumption (medical conditions and context). We conducted a binary logistic regression ("enter" method) in R (version 3.6.1) to identify predictors of rhino horn consumption in the past year and answer the third and fourth research questions. Independent variables included in the model consisted of demographic variables, basic healthcare preferences, and frequency of accessing TCM services and consuming TCM products. Summed scores were used for likelihood of consulting a TCM practitioner and of consuming TCM products for improving general health, treating mild illnesses and treating severe illnesses; these scores are considered continuous and can be used in logistic regression (Tabachnick & Fidell, 2013).

3　│　RESULTS

A total of 2,188 respondents completed our online survey in October 2019. This excludes an additional 70 completed surveys which were removed in data cleaning (straight-lined, sped-through, nonsensical or contradictory responses). Table 1 summarizes our sample's demographic characteristics.

Around half of our respondents (52.3% $n = 1,144$) were aware of the use of rhino horn as a medicinal ingredient in TCM. 17.6% of survey respondents ($n = 385$) reported having consumed rhino horn for medicinal purposes at any time in the past; 14.4% of respondents ($n = 316$) had consumed rhino horn within the past year. More consumers reported having used rhino horn (at any time in the past) to improve overall body conditioning ($n = 251$) and for treating a mild illness ($n = 234$) than for treating a serious condition ($n = 127$) (Figure 1). Consumers most commonly cited dispelling heat ($n = 289$) and detoxification ($n = 238$) as reasons for having used rhino horn in the past. Few have used rhino horn to treat cancer ($n = 20$), to remove alcohol from the body ($n = 37$) or as an aphrodisiac ($n = 49$).

TABLE 1 Demographic characteristics for our sample TCM consumers who completed our online survey (excludes an additional 70 removed during data cleaning)

Online survey respondent demographics					
Variable		**Result**	**Variable**		**Result**
Sex (n)	Male	1,042	Age (years)	Mean	32.8
	Female	1,146		Median	30
Administrative division in Guangdong province (n)	Guangzhou	947		Maximum	70
	Shenzhen	403		Minimum	18
	Dongguan	205	Hukou household registration (n)	Urban	1,686
	Foshan	201		Rural	502
	Zhuhai	66	Highest level of education (n)	Junior secondary or less	26
	Shantou	65		Senior/vocational secondary	208
	Zhongshan	52		Technical/vocational college	455
	Jiangmen	41		Undergraduate degree	1,323
	Zhanjiang	32		Master's degree	157
	Huizhou	28		Doctorate or above	19
	Zhaoqing	25	Personal income (n)	Under RMB 30 k	135
	Shaoguan	23		RMB 30–50 k	231
	Jieyang	21		RMB 50–100 k	657
	Chaozhou	16		RMB 100–200 k	834
	Qingyuan	15		RMB 200–500 k	275
	Maoming	13		Over RMB 500 k	56
	Meizhou	8	Household income (n)	Under RMB 50 k	62
	Shanwei	8		RMB 50–100 k	203
	Heyuan	7		RMB 100–200 k	766
	Yangjiang	6		RMB 200–500 k	904
	Yunfu	6		Over RMB 500 k	253

Our logistic regression showed several demographic factors to be significant predictors of rhino horn use (Table 2). Rhino horn consumption is more likely among people who:

- Are older (Odds Ratio OR = 1.034, $p < .001$);
- Earn more in personal income (OR = 1.276, $p = .020$); and
- Earn more in household income (OR = 1.367 $p = .013$).

Rhino horn consumers also tended to be male (OR = 0.804, $p = .107$) and better educated (OR = 1.150 $p = .143$).

Several variables related to healthcare usage patterns and preferences were also found to be significant predictors of rhino horn use (Table 2). We found that

consumers who consult TCM practitioners for both mild (OR = 1.279, $p = .024$) and severe illnesses (OR = 1.353, $p = .007$) are more likely to have consumed rhino horn in the past year. We also found rhino horn use to be associated with the number of times an individual sought a consultation with a TCM practitioner in public hospitals (OR = 1.1068, $p = .052$) and sourced TCM products from private hospitals (OR = 1.121, $p = .039$).

4 | DISCUSSION

Our results reveal that the existing medicinal use of rhino horn among TCM consumers in China may be substantial, despite the implementation of domestic trade controls for over a quarter century. One in seven TCM consumers we surveyed in Guangdong province reported
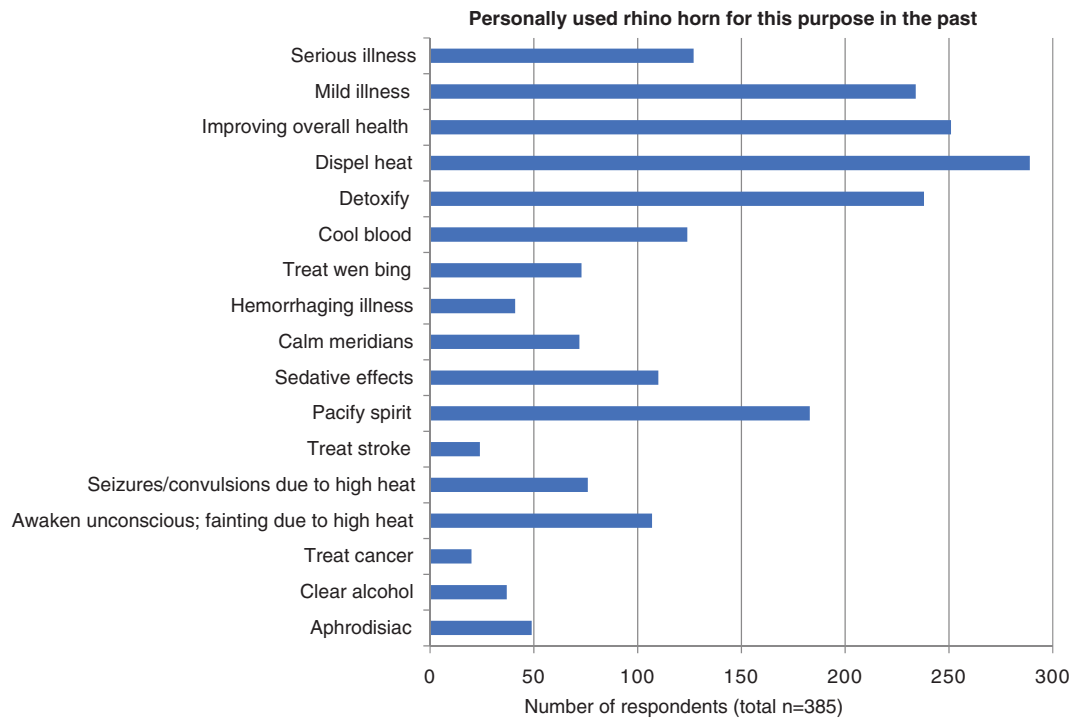
Personally used rhino horn for this purpose in the past

FIGURE 1   Summary of the conditions for which our survey respondents have personally consumed rhino horn in the past

having used rhino horn in the past year. Although we could not verify the authenticity of the products consumed, our results indicate that a considerable percentage of consumers believe that they have consumed rhino horn in the recent past. While it is widely recognized that China is a considerable source of global demand for rhino horn, ours is the first peer-reviewed study to investigate the prevalence of consumption in China. The considerable rate of rhino horn consumption we report here further calls into question the effectiveness of existing trade controls, behavior change and demand reduction interventions, and enforcement of domestic wildlife regulations (Di Minin et al., 2015; Li, 2007; Wong, 2019).

Having a better understanding of rhino horn use in China can improve the enforcement of existing domestic regulations and the effectiveness of demand reduction interventions. Our data shows that medicinal consumers of rhino horn tend to be older, male, educated and wealthier (Table 2). These demographic characteristics appear to largely mirror those of rhino horn end-users in Vietnam (Truong et al., 2016). We also found that respondents who have consumed rhino horn in the past year are likely to seek TCM services for both mild and serious illnesses, consult TCM practitioners in public hospitals with greater frequency and source TCM products from private hospitals with greater frequency (Table 2).

In general, TCM users tend to seek TCM services for treating milder illnesses and for improving overall health,

but prefer biomedicine (Western medicine) for serious illnesses. The view that biomedicine is more powerful and fast-acting, whereas TCM is seen to work more slowly and steadily, is commonly held (Chung et al., 2014). Our results indicate that individuals who do not conform to these general trends and would seek TCM treatment for serious conditions (which are typically beyond the capabilities of smaller clinics) are more likely to use rhino horn. More focused research on rhino horn consumers specifically will provide more insight into these trends.

The conditions for which our respondents consumed rhino horn (Figure 1) are largely consistent with what TCM practitioners in China see as its medicinal functions (Cheung et al., 2018). However, TCM consumers appear to use rhino horn more liberally than practitioners. While TCM practitioners mostly limit rhino horn's clinical applications to treating serious or critical illnesses, TCM consumers tend to use rhino horn more for improving general health and treating mild illnesses (Figure 1). This is of particular concern for conservation because it may be inflating demand for rhino horn beyond what TCM professionals deem to be medically necessary. Furthermore, the misuse of TCM ingredients in the past has led to health consequences that are severe or even fatal (Ng, Cheng, & Xu, 2009), and so the inappropriate use of rhino horn should also be of concern to the TCM community (and the wider medical community in China) on the grounds of public health.

Variable	*B*	*SE*	Wald	*p*	*Exp(B)*
Constant	−8.231	0.829	−9.931	**<.001**	<0.001
Demographics					
Age	0.033	0.006	5.212	**<.001**	1.034
Gender (M/F)	−0.219	0.136	−1.612	.107	0.804
Hukou urban/rural	0.202	0.189	1.071	.284	1.224
Education level	0.140	0.096	1.466	.143	1.150
Personal income	0.244	0.104	2.335	**.020**	1.276
Household income	0.313	0.126	2.481	**.013**	1.367
Healthcare accessed and preferences					
Medicinal use of TCM product (freq. past year)					
- With prescription	0.005	0.017	0.308	.758	1.005
- Without prescription	−0.017	0.023	−0.742	.458	0.983
TCM practitioner consultation (freq. past year)					
- Public hospital	0.066	0.034	1.943	**.052**	1.068
- Other government facility	0.053	0.042	1.271	.204	1.055
- Private hospital	−0.007	0.055	−0.134	.893	0.993
- Private practice	0.043	0.040	1.085	.278	1.044
Source of TCM product (freq. past year)					
- Public hospital	−0.036	0.036	−0.991	.322	0.965
- Other government facility	0.093	0.077	1.204	.229	1.097
- Private hospital	0.114	0.055	2.065	**.039**	1.121
- Private practice	0.041	0.050	0.825	.409	1.042
- Private herbal medicine shop	0.056	0.043	1.294	.196	1.057
- Private pharmacy	0.005	0.038	0.128	.898	1.005
Would consult TCM practitioner for:					
- Improving overall health	0.073	0.125	0.586	.558	1.076
- Mild illness	0.246	0.109	2.258	**.024**	1.279
- Severe illness	0.302	0.111	2.715	**.007**	1.353
Would consume TCM product for					
- Improving overall health	−0.091	0.127	−0.716	.474	0.913
- Mild illness	0.104	0.107	0.967	.334	1.109
- Severe illness	0.045	0.109	0.414	.679	1.046

TABLE 2 Predictors of rhino horn consumption in the past year by TCM consumers in Guangdong province

Note: Bold = significant at 95% confidence interval; R^2 = 0.146 (Hosmer-Lemeshow), 0.114 (Cox-Snell), 0.202 (Nagelkerke); model X^2 = 264.215, $p < .001$.

4.1 | Limitations, policy implications and recommendations

Although this is the first major study to report on the medicinal demand for rhino horn in China, we acknowledge the limitations of our findings. We stress that our results are cross-sectional and should not be interpreted as nationally representative, as our deliberate focus on Guangdong province was theoretically intended to investigate the upper end of the demand spectrum. Research on other parts of the country that

are less wealthy or have different disease patterns when compared to Guangdong province may yield different outcomes. Our results were collected online from a non-random sample of people who were registered to partake in surveys, which may have introduced sampling bias to our results. Although studies on sensitive or illegal behavior conducted via the Internet are more likely to elicit truthful responses, we stress that responses may have been impacted by social desirability bias given rhino horn's illegality. These factors must be considered together in any attempt to interpret the

results presented here. Noting these shortcomings, important implications for rhino conservation can be drawn from our findings.

Our study highlights the importance of having a nuanced understanding of wildlife consumption trends and ensuring that these distinctions are reflected in conservation solutions. The use of rhino horn for mild illnesses and to improve general health is not unique to consumers in China, and has also been reported among users of traditional medicine in Vietnam (MacMillan, Bozzola, Hanley, Kasterine, & Sheremet, 2017). However, while Vietnamese consumers commonly use rhino horn as a hangover cure (Dang & Nielsen, 2018; Truong et al., 2016), we did not find such consumption to be substantial among Chinese consumers (Figure 1). Our data suggests that there are differences in how rhino horn is used medicinally between China and Vietnam. Recognizing these distinctions is important not only to accurately assess the dynamics of rhino horn demand, but also to ensure that efforts to tackle IWT are culturally nuanced (Margulies, Wong, & Duffy, 2019).

Our results can be used to improve the effectiveness of demand reduction campaigns in China, where TCM remains a deeply entrenched part of people's culture and identity. The integration of TCM into the Chinese healthcare system and the active promotion of TCM by the Chinese government both domestically and abroad (Cheung et al., 2020) may affect the effectiveness of demand reduction campaigns that are centered on the message that rhino horn has no pharmacological efficacy or that TCM treatments are unscientific (Smith, 2018). Even though such messaging contributed to the reduction of rhino horn demand in Taiwan during the last few decades (Herbig & Griffiths, 2016), the design and implementation of behavior change interventions in China must consider the deep cultural roots of TCM and the complex political factors associated with its use and promotion in China (Cheung et al., 2020; Croizier, 1965; Manfredo et al., 2017).

Conservationists have increasingly recognized the need to engage with people in ways that are socially relevant and culturally appropriate (Margulies et al., 2019), and have been exploring ways to better tailor behavior change interventions to specific target groups (Greenfield & Veríssimo, 2019; Olmedo, Sharif, & Milner-Gulland, 2018). Tailored messaging has been shown to be more effective at changing behavior than more generic communication in public health campaigns (Noar, Benac, & Harris, 2007), and has been a central feature of anti-smoking and HIV risk reduction initiatives (Latimer et al., 2012; Rikard, Thompson, Head, McNeil, & White, 2011). In China, a culturally-adapted anti-smoking campaign which focused on the common social practice of gifting tobacco products

was able to discourage this behavior (Huang et al., 2015). These points to the potential for similarly tailored conservation interventions to influence the behavior of wildlife product consumers in China. Indeed, tailored messaging has been used in behavior change initiatives to reduce demand for rhino horn in Vietnam—TRAFFIC and Save the Rhino International's Chi campaign incorporated local values and beliefs in its messaging (Offord-Woolley, 2017).

The results reported here improves the evidence base available on rhino horn consumers, which can be used to guide the development of more robust demand reduction interventions in China (Greenfield & Veríssimo, 2019; Olmedo et al., 2018; Veríssimo & Wan, 2019). For instance, the TCM community perceives rhino horn to be a very potent medicinal ingredient characterized by its "cold" properties (But et al., 1990). Despite the view among practitioners that rhino horn is most appropriate for the treatment of certain severe or critical conditions (Cheung et al., 2018), we found that consumers use it more for mild illnesses or simply to improve overall health (Figure 1). As is the case with pharmaceuticals in biomedicine (Western medicine), consuming TCM products improperly or inappropriately can have serious ramifications (Ng et al., 2009). In the case of rhino horn, these dangers are amplified because the existence of fake rhino horn (the composition of which cannot be guaranteed) (Jha, Kshetry, Pokharel, Panday, & Aryal, 2015) and rhino horn that has been infused with chemical dyes and poisons (intended to deter poachers in source countries) (Ferreira, Markus, Pienaar, & Cooper, 2014) presents additional risks to the health and wellbeing of the consumer. That the misuse of rhino horn can harm and endanger the health of the user is a potentially powerful and personally relatable message for future demand reduction interventions. Social marketing campaigns centered on communicating the personal harms associated with certain risky behaviors have been successful at changing behaviors and improving public health (e.g., HIV/AIDS prevention, anti-smoking, heart disease, drunk driving) (LaCroix, Snyder, Huedo-Medina, & Johnson, 2014), and further research is needed to explore the potential effectiveness of such health risk messaging in reducing rhino horn demand.

Empirical insight into rhino horn demand in China is particularly urgent with the Chinese government having made clear its intentions to legalize domestic trade (People's Republic of China, 2018). Our results contribute to the available evidence base with which to evaluate the arguments for and against trade legalization, an issue on which the global conservation community has been unable to agree. In spite of existing measures that ban the international trade, domestic trade, and medicinal use of rhino horn in China, our study found that its consumption among TCM consumers remains substantial. It

is imperative for conservationists to work more closely with key stakeholders in the TCM community to reduce demand for, promote the substitution of and restrict access to medicinal products derived from endangered species like rhino horn more effectively. This will be particularly critical should the Chinese government commit to the unilateral pursuit of trade legalization.

CONFLICT OF INTEREST
The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS
All authors made a significant contribution to the design and execution of this research. Hubert Cheung conceived the study, analyzed the data, and led the writing of the manuscript. Lorraine Mazerolle guided survey design and data analysis. Lorraine Mazerolle, Hugh P. Possingham, and Duan Biggs contributed critical input to the writing of the manuscript. All authors approved the final manuscript.

ETHICS STATEMENT
This research complied with the Australian National Health and Medical Research Council's National Statement on Ethical Conduct in Human Research. Institutional human research ethics approval was granted by The University of Queensland (#2019000961).

DATA AVAILABILITY STATEMENT
Due to the possible sensitivity of human subjects' data and in compliance with human research ethics approval granted by University of Queensland, survey data are only accessible to the authors. However, anonymized data may be accessible by request on an individual basis.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.