



Preferences for lion and tiger bone wines amongst the urban public in China and Vietnam

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ABSTRACT

A controversial, multifaceted debate surrounds the trade in commercially captive-bred (farmed) lion skeletons. A prominent topic relates to relative preferences for tiger and lion bone in Asian consumer countries. To contribute preliminary information on this subject we conducted the first quantitative study to assess the consumer preferences of the urban public in China and Vietnam for lion versus tiger and wild versus farmed bone wine products. Using an online questionnaire we ranked respondents' stated preference for wild tiger, farmed tiger, wild lion, and farmed lion bone, and tested for the effect of demographic and attitudinal variables on product preferences. Our findings indicate that in both China and Vietnam tiger bone wine is greatly preferred over lion bone wine, and that respondents showed high levels of fidelity to their choice of farmed or wild designation across species. We emphasise the real-world complexity of lion and tiger bone product interactions and highlight opportunities for further in-depth study.

1. Introduction

Big cats (*Panthera* spp.) are amongst the species for which exist the highest levels of conservation concern, both due to the threats facing them and their emblematic and charismatic status (Macdonald et al., 2015). Both tigers (*Panthera tigris*) and lions (*Panthera leo*) have seen large recent population reductions. There are only an estimated 2154–3159 mature tigers remaining in the wild (Goodrich et al., 2015). Lions have disappeared from 92 % of their historic range and have declined by 43 % during the two decades between 1993 and 2014, leaving an estimated 23,000–39,000 individuals living in the wild (Bauer, Packer, Funston, Henschel, & Nowell, 2016). Both tiger and lion populations continue to experience population declines; with tigers currently listed as 'Endangered' by the IUCN Red List, whereas lions are listed as 'Vulnerable' (Bauer et al., 2016; Goodrich et al., 2015).

The primary threat to wild tigers is poaching fuelled by the illegal trade in high-value products such as skins and bones (Goodrich et al., 2015). Desirability of tiger products appears to be primarily linked to medicinal uses (Nowell & Ling, 2007; Nowell, 2010), but diverse additional reasons have been recorded, including talisman/protection properties, and as a symbol of prestige and status - along with gift

giving (Davis, Willemsen, Dang, O'Connor, & Glikman, 2020). Tiger parts may also be subject to *option demand* whereby purchases are made in anticipation of future scarcity and/or price increases (Moyle, 2009).

Due to demand for tiger products, in addition to the black-market trade in wild tiger products (Moyle, 2009), numbers of captive-bred tigers have proliferated in commercial breeding facilities in Southeast Asia and China (EIA, 2013; EIA, 2017a; Nowell & Ling, 2007; Stoner, Krishnasamy, Wittmann, Delean, & Cassey, 2016). These increasing numbers are a cause of concern in relation to the illegal tiger trade, with captive-bred tiger products prominently featuring in seizures from the illegal trade (Stoner et al., 2016).

Owing to the threat posed to wild tigers by international trade, since 1987, the tiger has been listed under Appendix A of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) which effectively prohibits all international trade in tiger parts or derivatives. In 1993, under mounting international pressure, China, a major consumer of tiger products, banned domestic trade in tiger bone and tiger bone medicines. Subsequently, in 2007, CITES parties agreed to also stop domestic commercial trade in captive-bred tiger parts and derivatives. However, tiger products appear to continue to be manufactured, sold, and consumed in East and Southeast Asia including in

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China and Vietnam (Davis et al., 2020; EIA, 2012; EIA, 2014; EIA, 2017b; Gratwicke et al., 2008; Nowell, 2010). In 2018 the Chinese State Council introduced a new order allowing the use of farmed tiger bones in medical treatment and research. The implementation of the order was delayed following international criticism, but the policy was not rescinded, suggesting the trade of farmed tiger in China falls into a legal grey area. In Vietnam the domestic trade in tiger products is illegal, but as with China it remains a major consumer of tiger products (Davis et al., 2020) and its captive breeding facilities are of concern regarding illegal trade (CITES Secretariat, 2018).

In addition to an increase in farmed tiger numbers in Asia there has also been an increase in farmed lion numbers, often kept at Asian tiger facilities (Williams, Loveridge, Newton, & Macdonald, 2017). Separately, in South Africa, large numbers of captive-bred lions exist in private facilities (Williams, Newton, Loveridge, & Macdonald, 2015). These South African lions are primarily bred as part of the captive-bred hunting industry, but also contribute to the legal international lion bone trade, either as a by-product after captive-bred hunting or, increasingly, a primary use (Williams & t Sas-Rolfes, 2019). Since 2008 lion bones and skeletons have been legally exported from South Africa to Southeast Asia to supply demand for big-cat bones. Captive-bred lion skeletons are thought to be used in traditional medicinal and cultural preparations, especially medicinal and tonic wines, which would traditionally contain tiger bone (Williams, Newton, Loveridge, & Macdonald, 2015; Williams et al., 2017).

The major threats to lions in the wild are prey depletion, livestock encroachment, illegal killing due to conflict over livestock, and habitat conversion (Bauer et al., 2015). In addition, there are suggestions that illegal trade may increasingly become a threat for wild lions in Africa if markets for big-cat bones, both within Africa and intercontinentally, stimulate increased targeted poaching of wild lions for sale in these markets (Everatt, Kokes, & Pereira, 2019).

International commercial trade in lion skeletons is permitted under CITES Appendix II; with an export quota for South African captive-bred lions established at the 17th CITES Conference of the Parties (COP17) in 2016. The majority of South African exports are destined for Lao PDR and Vietnam (Williams et al., 2017) where felid bone products are both consumed domestically and distributed internationally (EIA, 2015). Exports from South Africa have grown from ± 314 skeletons per year in 2008–2011 to ± 1312 skeletons per year in 2013–2015, peaking at 1700 in 2016 before the introduction of the CITES quota limiting the number to 800 in 2017. In total over 6000 skeletons have been shipped from South Africa to South East Asia since 2008 (Williams et al., 2017). However, in August 2019, the South African High Court (Gauteng) determined that lion skeleton export quotas from South Africa in 2017 and 2018 were unlawful and unconstitutional due to inadequate consideration of the welfare of captive bred lions in the process of quota determination (Republic of South Africa, 2019).

The trade in farmed lion bones has become a contentious ethical and conservation issue with proponents and critics of the farmed lion bone trade suggesting respectively that lion bone trade could lessen, or increase the risk of over-exploitation of wild felids threatened by extinction, especially tigers and lions (Coals, Burnham, Loveridge et al., 2019). The 'supply-side approach' to wildlife trade interventions suggests that provision of legal, captive produced (farmed/ranch) wildlife products can depress prices, and thus lower incentives for illegal exploitation of wildlife (Bulte & Damania, 2005). Definitive evidence for the efficacy of the supply-side approach for lion skeleton trade is unlikely to be forthcoming in the foreseeable future (see Coals, Burnham, Johnson et al., 2019 for detail). Nevertheless, theoretically, if such an approach is to be successful it is generally agreed that a number of conditions regarding the nature of the market must be satisfied. Important amongst these is the potential substitutability of the farmed for the wild product (Challender et al., 2019; Dutton, Gratwicke, Hepburn, Herrera, & Macdonald, 2013; Phelps, Carrasco, & Webb, 2014; Tensen, 2016). Such consumer preference is an important

consideration and a general condition of farmed products being an adequate substitute for wild is that that there is no, or limited, preference for wild over farmed products. However, this is not the only requirement (see Phelps et al., 2014; Challender et al., 2019). Indeed, general acceptability of trade in farmed lion bones requires consideration of a great range of factors, both empirical and normative (Coals, Burnham, Loveridge et al., 2019; Coals, Burnham, Johnson et al., 2019).

Both tiger and lion skeletal parts (including bones, teeth, and claws) are traded in Southeast Asia and China (EIA, 2017b; Williams et al., 2015a). Skeletal products from tigers and lions may have markedly different uses depending on the specific part used (i.e. bone, teeth, claws etc.), and the geographical region under consideration. Principal uses, however, are as consumable medicinal products, talismans, ornamentation, or curios (though such a list may not be exhaustive) (Williams et al., 2015a, 2017). China and Vietnam have been identified as major consumer countries for tiger skeleton products (Davis et al., 2020; Goodrich et al., 2015; Nowell, 2010; Stoner et al., 2016) and lion skeletal products are also known to be consumed in both countries (EIA, 2017b; Outhwaite, 2018; Williams et al., 2015a). Little is known about lion products that consumers encounter but available information indicates that lion bones are closely aligned with the uses of tiger bone in China and Southeast Asia: lion bone is variously substituted for tiger bone (a substitution of which the customer may or may not be aware (Nowell, 2010)), or sold as a product in its own right (EIA, 2017b).

In China and Vietnam tiger products have been found to be mainly consumed for medicinal and health purposes (Davis et al., 2020; Drury, 2011; Gratwicke et al., 2008; Nowell, 2010). In China tiger and lion bone wine has been recorded to be produced in large quantities (through steeping of bones in wine (EIA, 2017b)) and is regarded as a long-established use of felid bone (Nowell, 2010). Wine occupies an important role in the practice of consumptive traditional Chinese medicine (TCM – as a formal term for regulated practice *sensu* Hsu (2018)) and wider cultural traditional medicinal uses (TM), both for its own effects and as a solvent for additional ingredients, of which tiger bone has been historically important (Xia, 2013). In addition to the medicinal significance of tiger bone wine in China it has been also suggested, along with other wildlife consumption, to constitute a display of prestige and wealth (Zhang & Yin, 2014). Much of the information concerning Chinese use of tiger bone wine is over a decade old and may be outdated (e.g. Gratwicke et al., 2008; Nowell, 2010). It is also possible that the use of felid bone 'glue' (see below) is greatly increasing in China (Lemieux & Bruschi, 2019).

In Vietnam it is more common for tiger bone to be consumed as *cao hồ cốt* (felid bone 'glue', 'paste' or 'cake'), although such 'glue' is also available in China (Nowell, 2010). A recent study found that *cao hồ cốt* was the tiger product most commonly consumed in two major cities in Vietnam (Davis et al., 2020). The bone 'glue' is made by cooking tiger bones into a paste (Davis et al., 2020; Nowell, 2010). Lion bone has also been recorded as being made into 'glue' (Outhwaite, 2018), as has leopard (EAGLE, 2018), and jaguar bone (Lemieux & Bruschi, 2019). A common method of consuming *cao hồ cốt* is by dissolving it in wine, and so it may be regarded as a *partial* precursor to bone wine consumption - whilst remembering that it is not the only method of consumption (EIA, 2019b), and that steeping of felid bones to make wine also continues (EIA, 2017b).

Felid bone consumption is often for medicinal related purposes and is commonly consumed in the form of bone wine and *cao hồ cốt*. Therefore, in this study we focus on bone wines and *cao hồ cốt* in China and Vietnam in the context of medicinal wildlife products (see Methods for specific description of products tailored to each country). Each country has specific traditional medicine contexts but both make use of traditional medicinal products (predominantly herbal) and techniques which are formally integrated into public health treatment (e.g. Wahlberg, 2006; Hsu, 2018). Such traditional medicines are acknowledged to have a formal, officially regulated sector and informal sector

that is without regulation and varies in quality and type of practice; under which designation much illegal wildlife consumption is likely to fall (Hsu et al., 2012). Use for medicinal purposes is well recorded as a significant threat to the conservation of a number of high-profile wildlife species in both China and Vietnam, e.g. bear bile (Crudge, Nguyen, & Cao, 2018; Davis, Glikman, et al., 2019), pangolins (Challender, Waterman, & Baillie, 2014; Nijman, Zhang, & Shepherd, 2016), and tiger (Davis et al., 2020; Nowell & Ling, 2007). However, medicinal purposes are, as previously mentioned, not the only reasons for consumer demand for such products, as exemplified by use of rhino horn both medicinally and for social status (e.g. Dang Vu & Nielsen, 2018).

This study presents the results of a stated preference survey conducted in China and Vietnam focussing on bone wine products; including bone wine and dissolved 'glue' wine (and its partial precursor *cao hồ cốt*). Our aim was to determine whether there were differences in preference for lion and tiger bone, preferences for farmed or wild origin of bone wine, and to identify differences in stated preferences of the urban public between the consumer countries China and Vietnam. Our core, conservation-led objective was to contribute information on relative preferences for tiger and lion bone, which forms a major aspect of the continuing debate surrounding the trade in farmed lion bone (Coals, Burnham, Loveridge et al., 2019; Coals, Burnham, Johnson et al., 2019).

Preferences for tiger and lion products in China and Vietnam are poorly understood, including the influence of captive-bred or wild sourced status - though such a designation has been argued to be overly simplistic (Hinsley & 't Sas-Rolfes, 2020). Nevertheless, a variety of studies has considered preference for wild sourced or farmed wildlife by Chinese and Southeast Asian respondents; where 'wild' products are generally stated to be preferred over farmed (e.g. Drury, 2009; Dutton, Hepburn, & Macdonald, 2011; Crudge et al., 2018). We might therefore expect wild bone wines to be preferred over farmed. However, preference in the wild-farmed product nexus is complex (Davis et al., 2016; Hinsley & 't Sas-Rolfes, 2020) and stated preference for wild products does not always reflect actual consumption (Davis, Glikman, et al., 2019). Likewise, the geographical origin of wildlife products is of importance to some traditional medicine practitioners and consumers, meaning that traditional products and products from within an organism's natural range may be valued more highly (Hinsley et al., 2019). Hence wild tiger and wild lion might be expected to be preferred to farmed tiger and farmed lion. However, significant heterogeneity in preference has been shown between products and species (Shairp, Verissimo, Fraser, Challender, & MacMillan, 2016). Therefore such predictions, in the absence of testing, are extremely uncertain.

A general gap in research into preferences for wildlife products is the consideration of preference between species (Hinsley & 't Sas-Rolfes, 2020). Accordingly, we consider preference for lion versus tiger bone wine. We expect tiger to be preferred over lion given the historical precedent for the use of tiger. However, consumer motivations are complex and variable. For example, Luong (2009) found that consumers of traditional medicinal wildlife products balance conservation consciousness against belief in the efficacy of wild products, and are more willing to accept substitutes for high-profile species such as tiger. Values and attitudes towards, and understanding of, conservation and animal welfare may differ between regions and cultures (e.g. Li & Ernst, 2015). Differing cultural values - which impact motivations, attitudes, and beliefs are acknowledged to be important factors in the interpretation of preferences for wildlife products (e.g. Challender, Wu, Nijman, & MacMillan, 2014; Davis et al., 2016; Moorhouse, D'Cruze, & Macdonald, 2017) and designing effective behavioural change interventions (Moorhouse, Dahlsjö, Baker, D'Cruze, & Macdonald, 2015; Moorhouse, Balaskas, D'Cruze, & Macdonald, 2017). In addition, demographic variables, such as age, have also been shown to impact purchase and consumption of traditional medicinal wildlife products in Southeast Asia (e.g. Doughty et al., 2019). To date, little information on

demographic influences on felid product usage is available from Vietnam, though Davis et al. (2020) found tiger product users in Vietnamese urban areas to be generally older but identified few other distinguishing characteristics. Therefore, in this study we examined the influence of cultural context and demographic variables along with attitudes towards conservation, animal welfare, regulation of traditional medicine, and substitute ingredients in traditional medicines on choices of tiger and lion bone wine products among respondents from China and Vietnam.

2. Methods

Data collection was carried out as part of a larger survey focused on social marketing interventions in traditional medicine (TM) usage and exotic pet ownership. Details and findings from the other survey aspects are reported elsewhere (Moorhouse, Coals, D'Cruze, & Macdonald, 2020). Here we focus specifically on survey participants' responses to questions concerning lion and tiger bone wine. The survey was designed in collaboration with, and conducted by, market-research professionals (Touchstone Partners Limited, <http://www.touchstonepartners.co.uk>) who coordinated respondent recruitment through market research panels. Our sample size of 2000 respondents, stratified by country (China and Vietnam), was achieved after removing those who took less than one third of the median response time (a market research industry standard action to exclude disengaged respondents). Panellists were familiar with online surveys but not contacted so frequently as to have become unrepresentative of the wider population. Ethical review and approval was provided by the University of Oxford (reference number: R57894/RE002).

2.1. Study sites

The survey targeted respondents in China and Vietnam: 1000 from each country with a 50 % split of male and female respondents. All respondents were computer-literate and came from urban areas across both countries.

Our survey response locations were major urban areas in China and Vietnam. Responses were spread across geographical regions and no single geographic region predominated in either country (Appendix A). In China the greatest numbers of respondents were located in the Shanghai Municipality (10.5 %), Beijing Municipality (9.9 %), and Guangdong Province (6.4 %). In Vietnam the greatest numbers of respondents were more geographically restricted; coming from the major cities of Ho Chi Minh (25.9 %) and Hanoi (17.9 %).

In China residents of cities in different regions have been shown to have differing attitudes toward wildlife consumption, for example Zhang and Yin (2014) reported greater recent public opinion shifts in favour of conservation in Beijing and Shanghai than in Guangzhou. In addition, wildlife consumption for traditional medicinal purposes also differs markedly between urban areas, with consumption rates in Beijing being under 2% and those in Guangzhou over 30 % (Zhang & Yin, 2014). General trends of decreasing usage of traditional medicine (though note that a very wide range of potential product types, from wildlife to herbal, may fall under that label) have also been observed in cities, particularly among more affluent households (Jin, 2010). The wide socioeconomic disparity between urban and rural areas in China, with higher levels of socioeconomic development generally found in cities (Liu, Valentine, Vanderbeck, Diprose, & McQuaid, 2019), mean that results of this study are only applicable to the urban, computer-literate public and not necessarily rural areas.

Vietnam also shows significant urban-rural inequality (Luong, 2009). However, by comparison to China, wildlife consumption in Vietnam appears to be more uniformly high between the major urban areas of Hanoi and Ho Chi Minh (Davis et al., 2020; Shairp et al., 2016) than the striking regional differences reported in China's cities (Zhang & Yin, 2014). Vietnam is also regarded as a hub for illegal wildlife

trade, of which a significant proportion is for traditional medicinal purposes (Ngoc & Wyatt, 2013). The use of traditional medicine is also reported to be widespread in the Vietnamese population (Van Nguyen & Nguyen, 2008).

In summary, our survey responses represent urban dwelling, computer literate, general public in China and Vietnam. As the survey did not focus predominantly on specific regions the results may only be thought of as a general urban-area response, with the caveat that there is nonetheless likely to be significant variation in wildlife usage and attitudes between regions even in an urban context.

2.2. Survey content

Surveys were professionally translated into Chinese and Vietnamese and verified by native speakers. The survey began by asking respondents for demographic information, including: age, income level, education level, and occupation type. They were then asked about their regularity of TM use and purchase (options: “I regularly buy traditional medicine”, “I occasionally buy traditional medicine” and “I don’t buy traditional medicine”). Following this introductory section respondents proceeded to ranking of choices of tiger and lion bone wine (Appendix B). As the focus of the wider survey was on traditional medicine ingredients (see Moorhouse et al., 2020 for detail) we were constrained to consider only the traditional medicinal aspects of tiger and lion bone wine products. Although medicinal use is not the only motivation for consumption of felid bone products, it has been found to be a major motivation, so such a focus is not without value (also see Limitations section for specific consideration of the vagueness of traditional medicine terminology).

2.3. Lion and tiger bone wine preferences

For tiger and lion bone wine products respondents were presented with a single screen with pictures of four bone wine products: wild lion, farmed lion, wild tiger, and farmed tiger, displayed in random order. They were asked to select which of the four products they preferred, and the process was then repeated twice with only the previously unchosen product options remaining, in order to generate a ranking of preference for lion and tiger bone wine products. Bone wine product pictures were designed to resemble generic felid bone wine products from the country in which the survey took place (see Fig. 1). Chinese bone wine is made by steeping bones in wine then bottling whereas in Vietnam bone wine is more often made by dissolving cao hồ cốt (felid bone ‘glue’ or ‘cake’) in wine (EIA, 2019b). Vietnamese cao hồ cốt is made by cooking bones into a paste which is then packaged into solid blocks. Cao hồ cốt may be purchased pre-dissolved in wine or added to wine later by the purchaser. The two methods of manufacture lead to different colours of wine with Vietnamese bone-glue wine darker than Chinese bone wine (Fig. 1). In the product descriptions wines were referred to as “bone strengthening wine” in China and “bone glue wine” in Vietnam.

Following the initial questions, which asked respondents to rank their preference for tiger and lion bone wines, respondents were subsequently asked to indicate whether they would buy big cat bone wine (Appendix A). Vietnamese respondents were also asked whether they would purchase cao hồ cốt. Those who stated that they would purchase any of those products were asked to indicate all intended recipients of the purchase (“Which of these would you buy?” - “For myself”, “For others in my family”, “As a gift”).

2.4. Attitudinal statements

At the end of the survey respondents were shown 14 attitudinal statements in random order, and asked to indicate how strongly they agreed or disagreed with each on a ten-point Likert scale (1 = disagree strongly, and 10 = agree strongly). Statements were formulated to



Fig. 1. Pictures of bone wine products presented to respondents in stated preference experiments.

- (a) Lion bone wine, China
- (b) Tiger bone wine, China
- (c) Lion bone wine, Vietnam
- (d) Tiger bone wine, Vietnam

gauge responses towards four focal subjects in the context of traditional medicines; conservation (three statements), animal welfare (three statements), substitute ingredients (four statements), and regulation (four statements) (Table 1).

Levels of agreement with attitudinal statements were analysed using Exploratory Factor Analysis (Thompson, 2004) to identify the underlying relational structure between statements and place them into focal groups accordingly. Analysis was carried out using psych package for Factor Analysis and data reduction in R (Revelle, 2019). Analysis indicated that the 14 statements could be reduced to 5 factors (RMSR root mean square of residuals = 0.01; RMSEA root mean square error of approximation = 0.033; Tucker-Lewis Index of factoring reliability = 0.984). The five factors related to: (1) *Duty towards conservation and welfare when purchasing traditional medicinal products*; (2) *The value of human health weighed against conservation and animal welfare*; (3) *Shops only being permitted to sell products that were not harmful for conservation or animal welfare*; (4) *Quality and genuineness of ingredients in traditional medicine products*; and (5) *The acceptability of substitutes in traditional medicines* (Table 1). Although separate understanding of conservation and welfare can be important for understanding farmed and wild wildlife usage (e.g. Davis, 2019), we found that respondents' attitudes towards conservation and welfare aligned in Exploratory Factor Analysis, therefore throughout the results and discussion we consider them together as an attitudinal factor.

2.5. Statistical analysis

Chi-squared and binomial tests were used to assess the significance

Table 1

Statements used to gauge respondents' attitudes and opinions towards focal subjects relating to TM trade and use and their groupings into factors following Exploratory Factor Analysis. Respondents were asked to indicate their agreement with statements on a 10 point Likert scale with increasing number representing increasing agreement.

Statement	Intended focal subject	Factor Analysis Grouping	Brief group description
1. Human health is more important than animal welfare	Animal welfare	2	Human health value
2. Human health is more important than species conservation	Conservation	2	Human health value
3. It is okay for traditional medicines to use rare or threatened animals	Conservation	2	Human health value
4. Medicines with substitute ingredients are better for animals than those with traditional ingredients	Substitutes	5	Substitute ingredients
5. I would be happy to buy medicine made with substitute ingredients if prescribed by a TCM practitioner	Substitutes	5	Substitute ingredients
6. If they worked just as well I would choose medicines with substitute ingredients	Substitutes	5	Substitute ingredients
7. Medicines with synthetic ingredients are as safe as the traditional formulations	Substitutes	5	Substitute ingredients
8. I have a duty to only buy medicines that do not harm animal welfare	Animal welfare	1	Duty towards animals
9. I have a duty to only buy medicines that do not harm species conservation	Conservation	1	Duty towards animals
10. If traditional medicines were bad for animal welfare shops wouldn't be allowed to sell them	Regulation	3	Trade regulation
11. If traditional medicines were bad for species conservation shops wouldn't be allowed to sell them	Regulation	3	Trade regulation
12. I carefully choose which medicines to buy to avoid harming animals	Animal welfare	1	Duty towards animals
13. The quality of traditional medicines is well regulated	Regulation	4	Quality regulation
14. Traditional medicines always contain the ingredients they claim to	Regulation	4	Quality regulation

Factor Analysis Groups: (1) Duty towards conservation and welfare when purchasing traditional medicinal products; (2) The value of human health weighed against conservation and animal welfare; (3) Shops only being permitted to sell products that were not harmful for conservation or animal welfare; (4) Quality and genuineness of ingredients in traditional medicine products; (5) The acceptability of substitutes in traditional medicines.

of differences between proportions of product preferences (conducted in R statistical programming language [R Core Team, 2019]). Effects of demographic variables, respondents' stated regularity of TM purchase and use, and attitudinal factors on respondent's product choices were tested for using general linear, binary, and ordinal regression models with the nnet package in R statistical programming language (Venables & Ripley, 2002).

2.6. Limitations

Due to constraints on the number of questions presented in the questionnaire we were unable to fully explore the type of traditional medicines purchased and used by respondents in their daily lives. The type of TM used is likely to have important ramifications for the conclusions that can be drawn from the use of TMs on wildlife usage. Specifically, it is likely that the majority of TM usage is plant-based and not endangered animal-based but we had no way to separate these different types of TM. Therefore, our consideration of the questions pertaining to TM purchase and use are limited. While medicinal purposes are not the only motivations for use of tiger or lion bone wine products, the context of the survey was in relation to traditional medicine (see Moorhouse et al., 2020). Therefore it is likely that respondents made their choices in the context of medicinal usage of products, but we have no way to be certain of this. Due to constraints of this format we were not able to explore alternative reasons for use.

Respondents were also obliged to answer questions about their preference for tiger or lion bone wine, regardless of whether they were actual purchasers of such products. Hence results represent a reflection of the general urban, computer literate public's forced preferences as opposed to detailed information on actual buyers and consumers. This study was also constrained to using only stated preferences, and price was not included in the choices presented to respondents as insufficient price information for lion bone wines was available and the experimental format used was not designed for inclusion of pricing. In real-world purchasing situations it is highly likely that price would constrain the consumer-base for big cat wine products (Gratwicke et al., 2008; Nowell, 2010). Later in the survey respondents were asked whether they would buy a tiger or lion bone wine or cao hổ cốt (in Vietnam), however bearing in mind the illegality of tiger products it is unlikely that these stated responses to direct questions were truthful representations of actual behaviour (e.g. Davis, Crudge, et al., 2019), rather than representing respondents' aspirations. Likewise direct income-related questioning may have also been subject to deceit (Vyas & Kumaranayake, 2006). Sensitive questioning techniques (e.g. Nuno &

St. John, 2015) may prove more effective in eliciting future information about real-life consumers of lion and tiger products.

Although we presented simple, clearly labelled choices between lion and tiger and wild and farmed origin bone wines it is likely that, at least in some real-world markets, the origins and ingredients of bone wines are more impenetrable. Indeed, records indicate that tiger may be sold as lion (to deceive law enforcement), lion as tiger (to deceive consumers), and lion as lion (honest sale), and the extent to which wild felids are laundered as farmed in Asia is largely unknown (EIA, 2017b). The farmed or wild origins of these products are also unlikely to be advertised due to illegality of wild tiger products in both China and Vietnam. This uncertainty complicates investigation of product preferences – especially amongst non-buyers who are unlikely to examine felid bone wine products in detail. Nevertheless, there are mechanisms by which buyers of wildlife products have been shown to ensure that products are genuine and provenance is known; primarily through trusted supplier networks (Nowell, 2010; van Uhm & Wong, 2019). Thus, although our results must be considered with these real-world potential complications in mind they are not entirely divorced from the well-informed choices made in our experimental set-up.

In addition, the binary choice of farmed or wild may be overly simplistic (Hinsley & 't Sas-Rolfes, 2020) given the multitude of additional factors, including legality and market availability, that could influence real-world choices under highly variable consumer circumstances. The source of products in consumer perception may also be more complex than simply wild or farmed. For example domestic or foreign production, or variation between specific geographic regions. We were, however, constrained by a lack of substantial existing knowledge of the variability of sources of lion and tiger bone wines. Whilst acknowledging that presenting choices as farmed or wild may be an oversimplification, in the case of known sources of lion and tiger bones to Asian markets and in the context of the South African farmed lion bone trade, farmed or wild was a logical choice under the constraints of the survey method used.

We were limited in the exploration of respondents' attitudes that could be carried out within the constraints of the survey. In particular, for two questions intended to explore respondents' attitudes towards animal welfare and conservation, we asked respondents to state their agreement with statements beginning "I have a duty to only buy medicines that do not harm..." (Table 1 Questions 8 & 9). It is unclear exactly what respondents understood by 'duty' as we provided no clarification. However, the implication is a deontological ethical interpretation whereby the morality of an action is judged by its adherence to a set of moral requirements which are necessarily normative

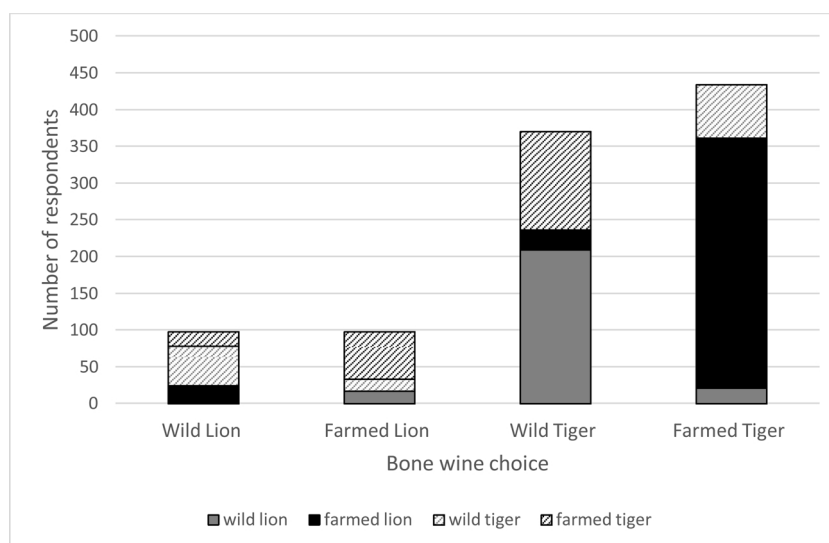


Fig. 2. Chinese respondents' first and second stated preferences for wild lion, farmed lion, wild tiger, and farmed tiger bone wine products. First choice product shown by full bar, second choices of product shown as proportions of the full bar.

(see Alexander & Moore, 2016). It has been argued that the conception of 'duty' may differ markedly with culture (Miller, 1997), and differing values towards nature have been noted between 'Western' (American) and East Asian (Chinese) subjects (Li & Ernst, 2015). Extensive discussion is outside the scope of this paper, however we note that 'Western' understandings of deontology have been suggested to be similar to Confucian ethics of East and Southeast Asia (Weiling, 2011). Detailed investigation of conceptions of morality and values towards nature would lend clarity to the simplistic dealings of 'duty' as presented in this survey.

3. Results

3.1. General public stated preferences for big cat bone wines

Tiger bone was overwhelmingly the first choice of respondents in both China and Vietnam. Approximately 82 % (n = 1635) of all respondents selected tiger bone wine as their first choice, with an even split for preference between wild (Total 41 % n = 824; China 37 % n = 370; Vietnam 45.4 % n = 454) and farmed (Total 41 % n = 811; China 43.3 % n = 434; Vietnam 37.7 % n = 377) sources (Figs. 2 & 3).

Overall, approximately 18 % (n = 365) of respondents stated lion bone as their first choice and, as with tiger, showed an even preference for wild (Total 9% n = 182; China 9.8 % n = 98; Vietnam 8.4 % n = 84) and farmed (Total 9% n = 183; China 9.8 % n = 98; Vietnam 8.5 % n = 85) sources (Figs. 2 & 3). However, the proportion of respondents choosing tiger vs lion differed significantly between countries (China 80 % tiger n = 804, 20 % lion n = 196; Vietnam 83 % tiger n = 831, 17 % lion n = 169; X-squared = 6.0062, df = 1, p = 0.014). As did the proportion of respondents choosing farmed vs wild (China 53 % farmed n = 532, 47 % wild n = 468; Vietnam 46 % farmed n = 462, 54 % wild n = 538; X-squared = 9.5223, df = 1, p = 0.00203).

Respondents' second choices showed greater fidelity to captive or wild designation rather than species. As a result (due to respondents preferentially selecting tiger products for their first choice) lion products accounted for the greatest proportion of second choices (China 63.8 % n = 638; Vietnam 61.2 % n = 612) (Figs. 2 & 3). Of those that chose a farmed first choice product, 76.1 % (n = 405) of Chinese (Fig. 2) and 75.3 % (n = 348) of Vietnamese respondents (Fig. 3) also chose a farmed second choice product. Of those that chose a wild first choice product fidelity was lower, with 56.2 % (n = 263) of Chinese (Fig. 2) and 66.5 % (n = 358) of Vietnamese respondents (Fig. 3).

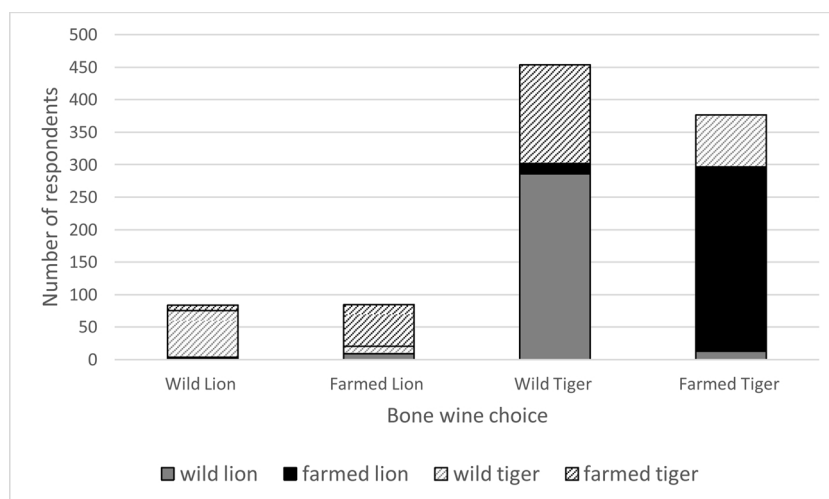


Fig. 3. Vietnamese respondents' first and second stated preferences for wild lion, farmed lion, wild tiger, and farmed tiger bone wine products. First choice product shown by full bar, second choices of product shown as proportions of the full bar.

Table 2

Binomial logistic regressions of demographic variables on choice of lion or tiger and farmed or wild origin bone wines.

Model	SE	z	p
sex on choice of lion or tiger, China	0.1636	3.269	0.01
sex on choice of wild or farmed, China	0.12795	-2.548	0.05
age on choice of lion or tiger, China	0.009066	5.803	< 0.001
age on choice of wild or farmed, China	0.006038	-2.98	0.01
income on choice of lion or tiger, China	0.352199	-1.289	> 0.1
income on choice of farmed or wild, China	0.236312	0.706	> 0.1
sex on choice of lion or tiger, Vietnam	0.1714	1.614	> 0.1
sex on choice of farmed or wild, Vietnam	0.12841	1.491	> 0.1
age on choice of lion or tiger, Vietnam	0.009351	3.129	> 0.1
age on choice of farmed or wild, Vietnam	0.006395	1.491	> 0.1
income on choice of lion or tiger, Vietnam	0.4058	-0.76	> 0.1
income on choice of farmed or wild, Vietnam	0.27519	-0.304	> 0.1

selecting a wild second choice product.

When asked if they would buy a big-cat bone wine product 49.1 % (n = 491) of Chinese respondents said they would buy tiger bone wine, and 44.7 % (n = 447) said they would buy lion bone wine. Of Vietnamese respondents 52.6 % (n = 526) said they would buy tiger bone wine, 43.2 % (n = 432) lion bone wine, and 51.3 % (n = 513) cao hổ cốt. Respondents were not constrained to a single product choice and also had the option to say they would not buy (Appendix B). Nevertheless, such statements are highly unlikely to represent real-life purchasing of big cat bone products (see Limitations).

3.2. Demographics

We investigated the effect of respondents' sex on their choices. Amongst Chinese respondents males were more likely to choose tiger bone wine (binomial logit, SE = 0.1636, z = 3.269, p = 0.01), and were also more likely to choose farmed than wild bone wine (binomial logit, SE = 0.12795, z = -2.548, p = 0.05) (Table 2).

Vietnamese respondents showed no significant effect of sex on choice of tiger or lion bone wine (binomial logit, SE = 0.1714, z = 1.614, p > 0.1), and no effect of sex on choice of farmed or wild origin of bone wine (binomial logit, SE = 0.12841, z = 1.491, p > 0.1) (Table 2).

Choice of tiger or lion bone wine amongst Chinese respondents was affected by their age, with tiger more likely to be chosen by older respondents and lion by younger (binomial logit, SE = 0.009066, z = 5.803, p < 0.001). Farmed origin bone wine was more likely to be chosen by older respondents whilst younger respondents were more likely to choose wild (binomial logit, SE = 0.006038, z = -2.980, p = 0.01) (Table 2). Stated income was higher amongst lower ages of Chinese respondents (ordered logit, logit coefficient -0.022, relative risk ratio 0.978, p < 0.01), and younger Chinese respondents stated that they were more likely to regularly buy TM (ordered logit, logit coefficient -0.019, relative risk ratio 0.981, p < 0.01) and use TM (ordered logit, logit coefficient -0.025, relative risk ratio 0.975, p < 0.01) (Table 3).

In Vietnam we found no significant effect of age on respondents' choice of tiger or lion bone wine (binomial logit, SE = 0.009351, z = 3.129, p > 0.1) or choice of farmed or wild origin (binomial logit, SE = 0.006395, z = 1.491, p > 0.1) (Table 2). There was no significant effect of age on stated income (ordered logit, logit coefficient 0.011, relative risk ratio 1.011, p > 0.1). Age showed no significant effect upon respondents' stated frequency of purchase of TM (ordered logit, logit coefficient -0.011, relative risk ratio 1.011, p = 0.1) but there was an increasing regularity of TM usage amongst older respondents (ordered logit, logit coefficient 0.017, relative risk ratio 1.018, p < 0.05) (Table 3).

For Chinese respondents there was no significant effect of income on

choice of lion over tiger bone wine (binomial logit, SE = 0.352199, z = -1.289, p > 0.1). Likelihood of choosing wild over farmed was also not significantly influenced by income (binomial logit, SE = 0.236312, z = 0.706, p > 0.1) (Table 2). In China TM was stated to be purchased at higher frequency with increasing income (ordered logit, logit coefficient 1.396, relative risk ratio 4.040, p < 0.01), and was more likely to be used more regularly by respondents with higher stated income (ordered logit, logit coefficient 1.392, relative risk ratio 4.022, p < 0.01) (Table 3).

Amongst Vietnamese respondents there was no significant influence of income on choice of tiger or lion bone wine (binomial logit, SE = 0.4058, z = -0.760, p > 0.1), or choice of farmed or wild origin (binomial logit, SE = 0.27519, z = -0.304, p > 0.1) (Table 2). Vietnamese respondents reported increasing regularity of TM purchase with increasing income (ordered logit, logit coefficient 1.396, relative risk ratio 4.040, p < 0.01) and increasing regularity of use of TM with increasing income (ordered logit, logit coefficient 1.392, relative risk ratio 4.022, p < 0.01) (Table 3).

3.3. Attitudinal statements

Respondents generally felt that they had a high level of duty towards conservation and animal welfare when purchasing traditional medicinal products. Vietnamese respondents showed greater overall levels of agreement with duty towards conservation and animal welfare than Chinese respondents (China mean = 16.66; Vietnam mean = 17.08, t-test, SE = 0.1535, t = 2.707, p = 0.01) (Table 4). Of Vietnamese respondents, those with higher stated levels of agreement with duty towards conservation and animal welfare were more likely to select farmed felid bone wine (binomial logit, SE = 0.02084, z = -2.604, p = 0.01) (Table 5). In China stated agreement with duty towards conservation and animal welfare significantly increased with increasing age of respondents (glm, SE = 0.01019, t = 2.011, p = 0.05).

There was a difference in levels of agreement that human health had a greater value than conservation and welfare between countries, with Vietnamese respondents less likely to agree that human health had a greater value (China mean = 11.90, Vietnam mean = 10.40, t-test, SE = 0.00842; t = -6.221, p < 0.001) (Table 4). In both China and Vietnam, respondents with higher levels of agreement that human health had a greater value than conservation and welfare were more likely to choose lion bone wine (China, binomial logit, SE = 0.01585, z = -4.24, p < 0.001; Vietnam, binomial logit, SE = 0.017, z = -1.724, p = 0.05) (Table 6), and were more likely to choose a wild origin felid bone wine (China, binomial logit, SE = 0.01287, z = 7.434, p < 0.001; Vietnam, binomial logit, SE = 0.01319, z = 4.957, p < 0.001) (Table 5). In Vietnam level of agreement that human health had a greater value than conservation and welfare increased with increasing age (glm, SE = 0.06505, t = 2.844, p = 0.01).

Vietnamese respondents showed higher levels of agreement that shops are only permitted to sell products that were not harmful for conservation or animal welfare (China mean = 11.1; Vietnam mean = 13.8, t-test, SE = 0.1549, t = 17.45, p < 0.001) (Table 4). In China respondents with higher levels of agreement were more likely to choose lion bone wine (binomial logit, SE = 0.0237, z = -4.093, p < 0.001) (Table 6), and were more likely to choose wild origin felid bone wine (binomial logit, SE = 0.0181, z = 5.098) (Table 5). Conversely, in Vietnam respondents with higher levels of agreement were more likely to choose a farmed origin felid bone wine (binomial logit, SE = 0.02229, z = -2.159, p = 0.05) (Table 5).

Vietnamese respondents were more likely than Chinese respondents to believe that the quality and genuineness of ingredients in traditional medicines are well regulated (China mean = 7.86, Vietnam mean = 8.13, t-test, SE = 0.08, SE = 0.11806; t = 2.224, p = 0.05) (Table 4). Amongst Chinese respondents, those with higher levels of agreement that the quality and genuineness of ingredients in traditional

Table 3

Ordered logistic regressions of demographic variables on income, and regularity of purchase and use of TMs.

Model	logit coefficient	relative risk ratio	p
sex on income, China	−0.554	0.575	< 0.01
age on income, China	−0.022	0.978	< 0.01
age on regularity of TM purchase, China	−0.019	0.981	< 0.01
age on regularity of TM purchase, China	−0.025	0.975	< 0.01
income on regularity of TM purchase, China	1.396	4.04	< 0.01
income on regularity of TM purchase, China	1.392	4.022	< 0.01
sex on income in Vietnam	−0.227	0.797	> 0.1
age on income, Vietnam	0.011	1.011	> 0.1
age on regularity of TM purchase, Vietnam	−0.011	1.011	0.1
age on regularity of TM use, Vietnam	0.017	1.018	< 0.05
income on regularity of TM purchase, Vietnam	1.396	4.04	< 0.01
income on regularity of TM use, Vietnam	1.392	4.022	< 0.01

medicines are well regulated were more likely to choose lion bone wine (binomial logit, SE = 0.03249, $z = -4.049$, $p < 0.001$) (Table 6), and were more likely to choose wild origin bone wine (binomial logit, SE = 0.02577, $t = 6.048$, $p < 0.001$) (Table 5). Agreement with this factor increased with age in China (glm, SE = 0.007733, $t = -2.514$, $p = 0.05$).

Responses concerning the acceptability of substitutes in traditional medicines did not differ significantly between China and Vietnam (China mean = 19.81, Vietnam mean = 20.01, t -test, SE = 0.1642, $t = 1.226$, $p > 0.05$) (Table 4). In Vietnam respondents who agreed more with the acceptability of substitutes in traditional medicine were more likely to choose bone wine made from tiger bone (binomial logit, SE = 0.02449, $z = 2.105$, $p = 0.05$) (Table 6).

4. Discussion

The interaction of wild sourced and captive-bred tiger and lion products in traditional Asian medicines has recently become a contentious issue, especially regarding the commercial captive-bred lion skeleton industry in South Africa, and increasing numbers of lions kept in SE/E Asia (EIA, 2017a; Nowell & Ling, 2007). Although there is much debate over the potential interaction of consumer preferences for lion and tiger products and their captive or wild designations (see Coals, Burnham, Loveridge et al., 2019; Coals, Burnham, Johnson et al., 2019) to our knowledge there have been no peer-reviewed studies that quantitatively consider relative preferences for tiger and lion bone products. Our results are a representation of the preferences of the general urban public, and we have no reliable indication of whether they would actually buy or consume lion or tiger bone products or not. Thus we discuss our findings as a preliminary indication of potential preferences that may guide more specific future investigation of the interactions of lion and tiger bone wine products.

In both China and Vietnam we found that tiger bone wine was greatly preferred by the majority of respondents over lion bone wine. This strong stated preference for tiger likely reflects the long history of the use of tiger bone, often (but not exclusively) for traditional medicine and health purposes, across East and Southeast Asia (Alves et al., 2013; Flaws, 1994). Lion was far less popular as a first choice when presented alongside bone wine options containing tiger bone.

Nevertheless, approximately 20 % of respondents representing the general urban public indicated lion as a first choice over tiger, although we had no way to determine whether these stated preferences would accurately represent actual purchase or use. The choice of lion may be influenced by the real-world availability of big cat products and barriers to the acquisition of tiger. For example, in China, trade of lion products is not illegal and they may be found openly available for sale (EIA, 2017b; Nowell & Ling, 2007) whereas it is generally understood by the public that the trade in tiger is illegal (Gratwicke et al., 2008; Nowell & Ling, 2007). Likewise in Vietnam import and sale of farmed lion skeletons is legal (Williams et al., 2017). The choice of lion is therefore more likely to be a legally acceptable choice with fewer barriers which, in real-world situations, could conceivably lead to a higher proportion of consumers opting for lion over tiger. Indeed, legality has been shown to be a key influencer of decisions to not buy wildlife products (Moorhouse, Balaskas et al., 2017). Such belief in regulatory mechanisms surrounding wildlife has been found to be particularly strong in China (Moorhouse, D'Cruze, & Macdonald, 2019). We also emphasise the complexities of the real-world marketing of lion and tiger bone products where it may not be clear whether a product contains tiger or lion (EIA, 2017b). The confusion arising from unclear marketing, and generally low levels of specific knowledge concerning wildlife consumption laws (e.g. Gratwicke et al., 2008; Zhang & Yin, 2014), is likely to make it difficult for the general public to discern origins of products and their legality - especially non-buyers as they are unlikely to be closely examining products (Nowell, 2010).

We did not explore effects of general understanding of wildlife laws and wildlife use campaigns in China and Vietnam on product choices. However we found that respondents who showed high levels of agreement that shops were only permitted to sell products that were not harmful for conservation or animal welfare differed in their product choices between China and Vietnam (China: lion bone, wild origin; Vietnam: no preference for lion or tiger bone, farmed origin). Future work could explicitly explore country-specific differences in lion and tiger product preferences with respect to the type of conservation, welfare, and legality messaging that the general public has been exposed to.

There was no overriding preference for wild or farmed sources as a first choice of felid bone wine amongst the general urban public we

Table 4

T-tests for differences in attitude factor values between China and Vietnam.

Attitude factor	SE	t	p	China mean	Vietnam mean
(1) Duty towards conservation and welfare when purchasing traditional medicinal products	0.1535	2.707	0.01	16.66	17.08
(2) The value of human health weighed against conservation and animal welfare	0.00842	−6.221	< 0.001	11.9	10.4
(3) Shops only being permitted to sell products that were not harmful for conservation or animal welfare	0.1549	17.43	< 0.001	11.1	13.8
(4) Quality and genuineness of ingredients in traditional medicine products	0.11806	2.224	0.05	7.86	8.12
(5) The acceptability of substitutes in traditional medicines	0.1642	1.226	> 0.05	19.81	20.01

Table 5
Binomial logistic regressions for effect of attitude factors on choice of farmed or wild origin bone wine.

Model	SE	z	p	farmed mean	wild mean
attitude factor 1 on farmed or wild, China	0.01858	−0.326	> 0.1	16.67	16.64
attitude factor 2 on farmed or wild, China	0.01287	7.434	< 0.001	10.71	13.23
attitude factor 3 on farmed or wild, China	0.0181	5.098	< 0.001	10.53	11.75
attitude factor 4 on farmed or wild, China	0.02577	6.048	< 0.001	7.37	8.41
attitude factor 5 on farmed or wild, China	0.017569	−0.373	> 0.1	19.85	19.75
attitude factor 1 on farmed or wild, Vietnam	0.02084	−2.604	0.01	17.47	16.74
attitude factor 2 on farmed or wild, Vietnam	0.01319	4.957	< 0.001	9.43	11.23
attitude factor 3 on farmed or wild, Vietnam	0.02229	−2.159	0.05	14.09	13.55
attitude factor 4 on farmed or wild, Vietnam	0.0269	0.527	> 0.1	8.07	8.17
attitude factor 5 on farmed or wild, Vietnam	0.01959	−1.909	0.1	20.26	19.79

Factor Analysis Groups: (1) Duty towards conservation and welfare when purchasing traditional medicinal products; (2) The value of human health weighed against conservation and animal welfare; (3) Shops only being permitted to sell products that were not harmful for conservation or animal welfare; (4) Quality and genuineness of ingredients in traditional medicine products; (5) The acceptability of substitutes in traditional medicines.

surveyed in either China or Vietnam. This may be different amongst actual consumers. However, recent studies that considered farmed or wild wildlife products (e.g. bear bile) have found that stated preference for wild product does not reflect actual consumption, with actual consumption being more likely dictated by product availability (Davis, Glikman, et al., 2019). Despite both nationalities having similar overall preference for tiger over lion, we detected national differences in preference for the origin of those products. Amongst Chinese respondents we found that males were more likely to choose tiger over lion and farmed over wild sources. However, we found no gender differences amongst Vietnamese respondents. Gender differences in preferences for wildlife products have been recorded to differ geographically (e.g. Davis et al., 2020). We also note that gender differences may not be present when sensitive questioning techniques are used to explore tiger product usage (e.g. Davis et al., 2020). Overall, Vietnamese respondents exhibited a higher first-choice preference for wild than did Chinese respondents (China: 47 %; Vietnam: 54 %; X-squared = 9.5223, df = 1, p = 0.00203). This finding may arise from different levels of barriers (such as social or legal factors) to buying wild products, or a higher efficacy value attributed by users. For example, legal deterrents to illegal tiger trade in China are severe, with the possibility of death sentences being imposed for trafficking (Moyle, 2009). This is not the case in Vietnam (EIA, 2019a) and Davis et al. (2020) found that tiger products are still widely used in Vietnam despite being illegal. In addition, conservation awareness appears to be increasing in China (Zhang & Yin, 2014). Our results showed that respondents in both China and Vietnam felt high levels of duty towards conservation and animal welfare, with Vietnam showing a higher level than China. However, the conservation and welfare-based attitudinal factor did not influence choice of lion or tiger, indicating that respondents may not differentiate between these

species with respect to conservation and welfare. In Vietnam, respondents that chose a wild product were less likely to state high levels of duty towards conservation and welfare, suggesting that farmed felid bone may be viewed as a more conservation and welfare sensitive option. However, the welfare of commercially captive-bred felids is often questionable – with well documented welfare concerns (e.g. World Animal Protection, 2019). Nevertheless, factor analysis aligned attitudes towards both conservation and welfare in a single factor; indicating that in our sample of respondents from Vietnam farming may be equated with both more favourable conservation and welfare impacts. In China duty towards conservation and welfare had no effect on choice of farmed or wild products. Indeed, Chinese respondents have been shown to hold generally less favourable opinions that farmed wildlife product (bear bile) is beneficial to conservation than respondents of other Asian nationalities (Laos) (Davis et al., 2016). Such potential national differences in belief of conservation efficacy of farming of felids requires additional research attention.

We found that respondents in China and Vietnam who believed that human health was more important than conservation and welfare were more likely to choose lion bone than tiger, and farmed than wild origin. We therefore speculate that lion bone and tiger bone may be considered to have different medicinal relevance and possibly different general uses – particularly considering the long history of tiger bone in TM and the elevated role of tiger bone products as status symbols (Graham-Rowe, 2011). Further in-depth work, preferably qualitative, is required to explore specific differences in uses of tiger and lion bone products.

Among Chinese respondents lion bone was more popular with younger ages, although we note that we have no way to know whether these preferences translate into actual purchase. Younger respondents were also more likely to state that they buy TMs frequently than were

Table 6
Binomial logistic regressions for effect of attitude factors on choice of lion or tiger bone wine.

Model	SE	z	p	Tiger mean	Lion mean
attitude factor 1 on lion or tiger, China	0.023222	0.283	> 0.1	16.66	16.66
attitude factor 2 on lion or tiger, China	0.01585	−4.24	< 0.001	11.55	13.31
attitude factor 3 on lion or tiger, China	0.0237	−4.093	< 0.001	10.88	12.01
attitude factor 4 on lion or tiger, China	0.03249	−4.049	< 0.001	7.69	8.59
attitude factor 5 on lion or tiger, China	0.02246	−0.664	> 0.1	19.75	20.03
attitude factor 1 on lion or tiger, Vietnam	0.0264	0.569	> 0.1	17.09	17.03
attitude factor 2 on lion or tiger, Vietnam	0.017	−1.724	0.05	10.27	11.06
attitude factor 3 on lion or tiger, Vietnam	0.02741	1.539	> 0.1	13.84	13.6
attitude factor 4 on lion or tiger, Vietnam	0.03632	−1.585	> 0.1	8.07	8.38
attitude factor 5 on lion or tiger, Vietnam	0.02449	2.105	0.05	20.12	19.45

Factor Analysis Groups: (1) Duty towards conservation and welfare when purchasing traditional medicinal products; (2) The value of human health weighed against conservation and animal welfare; (3) Shops only being permitted to sell products that were not harmful for conservation or animal welfare; (4) Quality and genuineness of ingredients in traditional medicine products; (5) The acceptability of substitutes in traditional medicines.

older ages. The underlying reason behind greater support for TMs amongst younger respondents is not clear. Younger ages had higher stated income in China thus it remains a possibility that younger ages may have more disposable income than older age groups, permitting them to buy higher-priced TMs, such as wildlife products (Liu et al., 2016), more frequently, but this explanation remains speculative as it was not asked in the survey, and it is likely that income questions were subject to deceit.

We speculate that higher frequency of TM purchase and usage, and preference for lion bone wine – which is legal and available for sale in China – is connected to a younger age group and their preferences. However the value and role of lion in social practices is largely unknown and requires further investigation (t Sas-Rolfes, 2019). These age-related preference patterns were not found in Vietnam. In fact we found an increasing regularity of TM usage amongst older respondents in Vietnam. We assume that older respondents are more likely to require regular medication. Therefore such an observation might be thought logical. We might speculate that wildlife derived products are more generally accessible in Vietnam. Indeed, Drury (2011) suggests that an ageing population in Vietnam will place greater demand on wildlife derived medicinal products. Vietnam also has integration of herbal TM elements into its formal health systems (Wahlberg, 2006). Thus responses to our TM questions could also reflect use of formal medicines. We had no way to separate formal from informal traditional medicine types in our questioning and future work could usefully focus on developing this distinction.

Farmed lion is a legal product in China and Vietnam and although we found no significant effect of income on choice of lion or tiger, or wild or farmed origin in either country some responses may reflect the real-world ability to legally purchase the product whereas other responses may represent aspirations instead of real purchases. In addition, since the survey predominantly focused on middle-class respondents, wealthier and upper class consumers of big cat bone wines may have been missed as previous studies indicate consumption is more likely to occur in higher social and income strata (Graham-Rowe, 2011; Gratwicke et al., 2008). However, individual wealth is not necessarily a hard-barrier to purchase of wildlife products (for example through syndicated buying or personal connections (van Uhm & Wong, 2019)), and Davis et al. (2020) found reported levels of tiger product consumption to be prevalent in a low-middle income sample of urban Vietnamese. As we were unable to include pricing in the choices presented to respondents, disentangling purchasing ability of respondents in this study is limited. Detailed investigation of pricing is an important avenue of investigation in further exploration of the interaction of lion and tiger products.

We detail the caveats to the interpretation of this study's results in the Limitations section of the Methods and we re-iterate that there are a number of reasons why respondents may not follow through their stated product choices in real-world purchasing - and indeed it remains possible that no respondents in this sample of the general urban public were actual purchasers and users of felid bone wine products, although Davis et al. (2020) found that approximately 11 % of an urban Vietnamese sample were tiger product consumers. Nevertheless, this study provides the first experimental investigation of preference for lion and tiger bone wine products in China and Vietnam. The results we present may be used to direct further, more extensive, investigations of consumer preferences in the poorly understood lion-tiger trade system and to provide preliminary discussion of the implication for farmed lion trade as follows: only approximately 9% of respondents in both China and Vietnam chose farmed lion as their first choice of bone wine (China: 9.8 %; Vietnam: 8.4 %), the lowest proportion of all options. This finding could indicate that farmed lion may not be an adequate substitute for wild tiger, but more detailed investigation of actual consumers - including consideration of price and product availability - is required before making judgement. This study and others (e.g. Williams et al., 2017; Outhwaite, 2018; Everatt et al., 2019) indicate that there is

demand for lion bone in China and Southeast Asia, but it is likely that continuing prevalent illegal trade in tiger (Davis et al., 2020) is the greater current conservation threat (Bauer et al., 2016; Goodrich et al., 2015). Due to the complexities of lion bone marketing it is possible that some stated tiger use is actually lion, or other felids. In such cases a supply of farmed lion may, unbeknown to customers, relieve pressure on wild tigers, though demand stimulation and other impacts (e.g. lion welfare) should also be considered (Coals, Burnham, Loveridge et al., 2019). Our results showed no specific demographic indicators of tiger preference, as did Davis et al. (2020) who only found increasing age to be a predictor of usage. Further work is therefore required to typify consumers of lion and tiger products, especially in Vietnam.

The fidelity of respondents to the farmed designation could indicate that farmed bone trade does not directly stimulate the trade in wild felid bones (though other factors should be considered - see Kirkpatrick & Emerton, 2010). Our results indicate that the majority of respondents who preferred farmed tiger or lion would choose another farmed felid product as their second choice over a wild product, which suggests limited potential for transfer between product origins. However, we remain aware that availability and legality may be key real-world determinants of which product type is purchased. Further uncertainty is introduced when the real-world trade interactions of lion and tiger bone products are considered. Although such interactions are poorly understood we can characterise three main designations of lion that consumers may encounter, all of which have been documented in East Asia (EIA, 2017b): tiger sold as lion (to deceive law enforcement), lion sold as tiger (to deceive consumers), and lion sold as lion (honest sale – however the extent to which wild lions are laundered as farmed lions in Asia is entirely unknown). This uncertainty complicates investigation of product preferences, and it is therefore unclear whether customers are fully aware of which product they are receiving and whether they would be able to make a truly informed choice in the real-world market (although there is evidence that there are mechanisms by which purchasers ensure the genuineness of the product they are buying; Nowell, 2010; van Uhm & Wong, 2019). Nevertheless, the complexity in the lion-tiger trade system indicates that a generally accepted prerequisite for the use of farmed products to displace wild-caught sources - that farmed and wild products should be easily distinguishable in markets (Challender et al., 2019; Phelps et al., 2014) - is most likely not met.

5. Conclusion

Reaching conservation-based regulatory decisions on the contentious issue of the farmed lion trade requires, amongst other things, detailed understanding of the interactions of farmed and wild lion and tiger bone (Coals, Burnham, Loveridge et al., 2019; Coals, Burnham, Loveridge et al., 2019). We carried out the first quantitative preference survey of lion and tiger bone wine in China and Vietnam to generate preliminary information. Our findings showed that, amongst the urban public, tiger was greatly preferred over lion bone wine in both China and Vietnam. Vietnamese respondents showed a greater preference for wild bone wine than did Chinese respondents. Although we cannot be sure what proportion of respondents are actual consumers (if any) we suggest that tiger remains the preferred species in China and Vietnam. We found reported preference for wild lion bone in approximately 9% of our sample. Although evidence for intercontinental trade of wild lion bones is, to-date, limited (e.g. Everatt et al., 2019), we believe careful attention should be given to potential markets for wild lion bone in China and Vietnam. There is therefore a necessity for close and careful monitoring of wild lion poaching and trade.

We observed differences in proportions of product types chosen and preferences of demographic groups between countries and thus highlight the importance of country-specific considerations in the planning of future research, and conservation interventions. We especially note the apparent preference for lion bone wine amongst a younger age group in China, the reasons for which were not clear and require further

research. We suggest that given the great preference for tiger over lion in both countries that lion is unlikely to fully replace tiger as a bone wine product. However there are a multitude of factors contributing to product purchase by consumers that we did not consider. Important future studies could usefully focus upon the influence of price and availability on actual consumers' preferences for lion and tiger bone products.

Finally, we highlight the real-world complexity surrounding the labelling and marketing of tiger and lion bone products and the challenges of disentangling them. We believe that far more complete and context-specific understanding of the interactions of lion and tiger products are required before robust policy decisions can be made.

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CRediT authorship contribution statement

Peter Coals: Conceptualization, Methodology, Formal analysis, Writing - original draft. **Tom P. Moorhouse:** Conceptualization,

Methodology, Formal analysis, Writing - original draft. **Neil C. D'Cruze:** Conceptualization, Methodology, Writing - review & editing. **David W. Macdonald:** Writing - review & editing, Supervision. **Andrew J. Loveridge:** Conceptualization, Writing - review & editing, Supervision.

Declaration of Competing Interest

The authors report no declarations of interest.

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Appendix A. Locations of respondents

Vietnam		China	
Region	Number of respondents	Region	Number of respondents
An Giang	8	Anhui Province	5
Ba Ria-Vung Tau	4	Beijing	12
Bac Giang	6	Beijing Municipality	99
Bac Kan	1	Changchun	1
Bac Lieu	1	Changsha	1
Bac Ninh	6	Chengde	1
Ben Tre	3	Chengdu	3
Binh Dinh	8	Chongqing	1
Binh Duong	11	Chongqing Municipality	11
Binh Phuoc	3	Chuzhou	1
Binh Thuan	3	Dalian	2
Ca Mau	3	Dongguan	1
Can Tho	16	Fujian Province	8
Cao Bang	5	Fuzhou	2
Da Nang	32	Gansu Province	1
Dak Lak	6	Guangdong Province	64
Dak Nong	2	Guangxi Zhuang Autonomous Region	3
Dien Bien	1	Guangzhou	13
Dong Nai	20	Guizhou Province	1
Dong Thap	5	Haikou	2
Gia Lai	2	Hainan Province	3
Ha Giang	3	Hebei Province	17
Ha Nam	5	Heilongjiang Province	4
Ha Tinh	2	Henan Province	5
Hai Duong	4	Hubei Province	10
Hai Phong	20	Hunan Province	6
Hanoi	179	Inner Mongolia Autonomous Region	2
Ho Chi Minh	259	Jiangsu Province	26
Hoa Binh	5	Jiangxi Province	4
Hung Yen	5	Jilin Province	3
Khanh Hoa	12	Jinan	4
Kien Giang	4	Jinzhou	1
Kon Tum	2	Kunming	1
Lai Chau	3	Liaoning Province	18
Lam Dong	9	Liuzhou	1
Lang Son	2	Luoyang	1
Long An	10	Nanchang	1
Nam Dinh	7	Nanjing	4
Nghe An	6	Not available	421
Ninh Binh	5	Qingdao	1
Ninh Thuan	4	Sanya	1
Not Available	208	Shaanxi Province	7

Phu Tho	6	Shandong Province	28
Phu Yen	2	Shanghai	7
Quang Binh	6	Shanghai Municipality	105
Quang Nam	7	Shanxi Province	5
Quang Ngai	4	Shenyang	2
Quang Ninh	4	Shenzhen	3
Quang Tri	3	Shijiazhuang	1
Soc Trang	6	Sichuan Province	18
Son La	1	Tianjin	1
Tay Ninh	3	Tianjin Municipality	12
Thai Binh	4	Wenzhou	1
Thai Nguyen	11	Wuhan	8
Thanh Hoa	6	Xi'An	3
Thua Thien-Hue	15	Xinjiang Uygur Autonomous Region	1
Tien Giang	8	Yunnan Province	2
Tra Vinh	4	Zhejiang Province	25
Tuyen Quang	1	Zhengzhou	4
Vinh Long	4	Zhuhai	1
Vinh Phuc	3		
Yen Bai	2		

Appendix B. Survey questions

Question	Possible response(s)	
Are you male or female?	Male Female	
Please write your age in the box below		
In which of these bands is your monthly household income before taxes and deductions?	China Below 2000 RMB 2,000 – 4,999 RMB 5,000 – 7,999 RMB 8,000 – 9,999 RMB 10,000–14,999 RMB 15,000–19,999 RMB 20,000 RMB or above Prefer not to say	Vietnam Below 4000 VND 4000 – 5999 VND 6000 – 7999 VND 8000 – 9999 VND 10,000–11,999 VND 12,000–14,999 VND 15,000 VND or above Prefer not to say
What is the highest educational qualification you have?	School certificate Diploma First degree (B.Sc/B.A etc) Masters degree PHD Higher	
Which of these statements best describes you?	Living on my own Living with other adults and no minors (15 or under) Living with a child/children all of whom are aged 15 or under	
How many generations are there living in your household	One Two Three More than 3	
What is your occupation? n.b. if you are retired and not living on state pension, please give your former occupation	Government official Professional (Physician, lawyer, teacher, engineer, etc.) Senior Management Staff Office worker (white-collar) Technician (grey-collar) Technical worker (blue-collar) Worker/service personal Self employed (including business owner) Unemployed Retired	
Which of these describes you best? Please choose more than one statement if you need to	I regularly buy Traditional Medicine I occasionally buy Traditional Medicine I don't buy Traditional Medicine	
Which of these describes you best? Please choose more than one statement if you need to	I regularly use Traditional Medicine I occasionally use Traditional Medicine I don't use Traditional Medicine	
Who do you buy Traditional Medicine for?	Myself	

How do you get the Traditional Medicine you use?	Other family members Other people I buy it myself Someone else buys it for me but I pay As a gift from others From a traditional medicine practitioner
Where do you get most information about Traditional Medicine products?	From family members/friends From the internet From the TV I don't recall getting any information about Traditional Medicine
There are 4 types of Bone Wine available, which of these would be your preferred choice? (Presented with pictures in Fig. 1)	Wild lion bone wine Farmed lion bone wine Wild tiger bone wine Farmed tiger bone wine
Now, which of these would be your preferred choice? (remove previously selected option)	Wild lion bone wine Farmed lion bone wine Wild tiger bone wine Farmed tiger bone wine
Finally, which of these would be your preferred choice? (remove previously selected option)	Wild lion bone wine Farmed lion bone wine Wild tiger bone wine Farmed tiger bone wine
Behaviour change treatments (reported in Moorhouse et al., 2020) Which would you buy	Lion bone wine Tiger bone wine Bear bile Pangolin scales Pangolin wine Cao ho cot None of these
Who would you buy it for? Indicate for each product selected.	Myself Family Gift
Please show how strongly you agree or disagree with each of the things people have said below. (Presented in random order)	Human health is more important than animal welfare Human health is more important than species conservation It is okay for traditional medicines to use rare or threatened animals Medicines with substitute ingredients are better for animals than those with traditional ingredients I would be happy to buy medicine made with substitute ingredients if prescribed by a TCM practitioner If they worked just as well I would choose medicines with substitute ingredients Medicines with synthetic ingredients are as safe as the traditional formulations I have a duty to only buy medicines that do not harm animal welfare I have a duty to only buy medicines that do not harm species conservation If traditional medicines were bad for animal welfare shops wouldn't be allowed to sell them If traditional medicines were bad for species conservation shops wouldn't be allowed to sell them I carefully choose which medicines to buy to avoid harming animals The quality of traditional medicines is well regulated Traditional medicines always contain the ingredients they claim to

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