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Combining data from consumers and traditional medicine practitioners to provide a more complete picture of Chinese bear bile markets

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Abstract

1. Understanding wildlife consumption is essential for the design and evaluation of effective conservation interventions to reduce illegal trade. This requires understanding both the consumers themselves and those who influence their behaviour. For example, in markets for wildlife-based medicines, both consumers and medical practitioners have a role in which products are consumed.
2. We used mixed methods to triangulate data on bear bile consumption from 3,646 members of the public, 80 pharmacy workers and 38 Traditional Chinese Medicine (TCM) doctors in four provincial capital cities across China. Bear bile can be sold legally in packaged TCM products made from farmed bile, or sold illegally, often as raw gallbladders from wild bears. We interviewed medical practitioners, and surveyed the public using both direct questions (DQ) and the Unmatched Count Technique (UCT), an indirect method used to improve reporting of sensitive behaviours. We applied a 'combined' UCT-DQ analysis to produce a more robust consumption estimate.
3. In all, 140 (3.8%) survey respondents directly reported recent (<3 years) bile consumption, but the combined UCT-DQ estimate was 11.2%. In total, 14 survey respondents (0.4% sample and 10% recent consumers) self-reported recent wild bile consumption. Almost a quarter of doctors and half of pharmacy workers had ever prescribed bile.

David Garshelis, Michael Hoffmann, Tien Ming Lee, Yingjie Qiu and Xiangdong Ruan Co-corresponding authors.

4. Around half of doctors and over a quarter of pharmacy workers said that bear bile was the best medicine in certain situations. More than half of doctors and over a third of pharmacy workers thought wild bile was more effective than farmed, although we found no evidence of wild bile being formally prescribed. Consumers could name specific treatment uses of bile but almost half of recent consumers did not know the source of bile they had consumed.
5. We show that gathering perspectives from different wildlife market actors can generate a more complete picture of trade. In China, bile consumption may be limited by its specific TCM treatment uses, but whether practitioner views on the greater effectiveness of wild bile are passed to consumers must be investigated further. With potential overlap between farmed and wild consumption, any interventions to change these markets must carefully consider how both consumers and practitioners may react.

1 | INTRODUCTION

Unsustainable and illegal wildlife trade (IWT) threatens species of plants, animals and fungi worldwide, making reduction of IWT a global conservation priority. Reducing IWT, while also strengthening legal, sustainable supply chains, requires an in-depth understanding of consumer behaviour, which is a growing focus of conservation attention (Veríssimo et al., 2020). To date, consumer data have been used to evaluate the success of interventions (e.g. Nuno et al., 2018), design targeted behaviour change (e.g. Doughty et al., 2019) and determine the most effective alternatives that can tempt consumers away from illegal products (Moorhouse et al., 2020). Despite its importance, studying demand for wildlife products can be extremely difficult, especially when considering the multiple cultural, personal, social and psychological factors that influence consumer behaviour (Veríssimo et al., 2020). These include nuances in consumer behaviour based on specific motivations for consumption, as well as differences in consumption based on demographic and cultural factors (Margulies et al., 2019; Thomas-Walters et al., 2020). While conservation interventions that do consider these factors may still fail to change consumer behaviour, a strong site-specific evidence base also allows robust impact evaluation to take place (Veríssimo et al., 2018), It is therefore imperative that the design and evaluation of conservation interventions are based on evidence rather than assumptions about wildlife consumption, and carefully account for these complexities (Hinsley & 't Sas-Rolfes, 2020).

The interplay between the various factors influencing consumer behaviour can be seen clearly in markets for traditional wildlife-based medicines, where consumers may be motivated to different degrees by health needs, desire to use long-established traditional remedies and recommendations from trusted sources (Cheung et al., 2021; Thomas-Walters et al., 2020). These markets can be challenging to study using self-reported data alone, as consumers may attempt to conceal their use of illegal or socially undesirable products (Davis, Crudge, et al., 2019). In addition, many consumers may be unable to provide accurate information, as they are often unaware of which species they have used or whether the products were wild-sourced or farmed (Doughty et al., 2019; Liu et al., 2016). This may be due to them focussing more on other factors, such as price, which makes the source of a product less important to them (Hinsley et al. submitted). However, it is also likely to be due to consumers deferring to external, trusted sources, including medical practitioners (Wang et al., 2020) or family members (Davis, Crudge, et al., 2019) when making treatment decisions. To date, relatively few studies of medical practitioners in wildlife-based medicine markets have taken place, but it is clear that the role of Traditional Chinese Medicine (TCM) practitioners in particular is likely to be significant in China (e.g. Cheung et al., 2018). Considering both consumer and practitioner viewpoints is therefore important for determining the characteristics of consumption in these complex markets (Wang et al., 2020).

To obtain a more complete picture of consumption in a complex medicinal market, we use a mixed-methods approach to triangulate data from the public, TCM doctors and pharmacy staff across four provinces in mainland China (Guangdong, Guangxi, Jilin and Sichuan). Our study focusses on bear bile, a TCM ingredient recorded in the first Chinese pharmacopeia in 649 A.D (Feng et al., 2009). Bear bile contains Ursodeoxycholic acid (UDCA), an ingredient with proven 'Western' biomedical efficacy for treating liver and gallbladder diseases as well as a variety of other ailments (Appiah et al., 2017; Vang et al., 2014). In TCM, bear bile is a cold medicine, used for clearing liver fire and heat (Cheung et al., 2021). It is included in medicines for a wide range of ailments, most often associated with the liver, gallbladder and eye (Feng et al., 2009). While hunting bears for their gallbladders (that contain the bile) is no longer legal in China, bear farms were introduced across Asia from the 1980s onwards to

supply the market for bear bile (Feng et al., 2009). Bile is routinely extracted from these captive bears without killing them. In China, dried bile powder is now the only legal product produced by farms, and is permitted for use only as an ingredient in over-the-counter or prescription processed TCM products, known as 'patent' products (National Pharmacopeia Committee, 2020). This means that no unprocessed bile products are legally sold. Since a government directive in 2004, approved legal patent products from registered farms have had to carry a certification sticker for ease of identification (www.forestry.gov.cn/sites/main/main/gov/content.jsp?TID=1080). In addition to the legal trade, there is also an illegal trade in China and neighbouring countries in whole or parts of gallbladders, and of raw bile products from wild or illegally farmed bears (e.g. Crudge et al., 2020). Defining legality by source is therefore not always straightforward, and in pre-COVID China, rapid expansion of wildlife farming and trade, coupled with the ineffectiveness of China's regulatory system to tell wild-sourced and captive-bred wildlife apart, created a loophole where some farms laundered wild animals, and local markets sold illegal wildlife (Jiao & Lee, 2021). This trade threatens wild bear populations across their range, especially the Asiatic black bear *Ursus thibetanus*, which is the prime target for the gallbladder market and the only legally farmed species in China (Garshelis & Steinmetz, 2016).

Understanding how and why people use bear bile products has direct relevance to debates around wildlife farming. This includes evaluating the direct conservation impacts of farming, such as cases where wild individuals are used to stock farms (e.g. bears in Vietnam; Crudge et al., 2020), and the indirect effects, often centred on whether the availability of legal products changes demand for wild-sourced products (Bulte & Damania, 2005; Dutton et al., 2011).

Questions around the effects of bear farming on wild-bile trade have been the focus of high-level policy discussions, resulting in an International Union for Conservation of Nature's (IUCN) World Conservation Congress Recommendation (WCC-2012-Rec-139) for a situation analysis to gain more information about the bear bile market (portals.iucn.org/library/node/44106). In addition to the conservation implications, bear farming has been the subject of intense scrutiny due to animal welfare concerns (e.g. Crudge et al., 2020), which may have long-term health implications on bile-extracted bears (Bando et al., 2019). Poor hygiene and welfare standards on bear farms also have relevance to current post-COVID-19 discussions around wildlife products and zoonotic disease risk, as captive bears have been shown to carry diseases that can be passed to humans (Wu et al., 2018). As well as being important from a policy context, issues around legality, disease, animal welfare and conservation are likely to have some effect on consumer and medical practitioner behaviour. While work has been conducted to understand bear bile markets in Southeast Asia (Crudge et al., 2020; Davis, Crudge, et al., 2019; Davis, Glikman, et al., 2019), China is the main consumer of bear bile and produces by far the most farmed bile. Additionally, the presence of legal, illegal, farmed and wild products in Chinese markets may affect other countries where bear bile is consumed.

We used large-scale surveys with members of the public and interviews with TCM practitioners to investigate consumption, prescription and perceptions of bear bile as a medicine in China. To date, the only estimate of prevalence of bear bile consumption in China is from 2012, when 23% ($n = 81$) of students and 30% of the public ($n = 204$) in a sample from Beijing reported having consumed bile at some point in a 22-year period (Liu et al., 2017). A nationwide survey in 2010 found that fewer than 20% of respondents had either consumed or knew somebody who had consumed bile, although consumption prevalence could not be estimated as these two questions were combined, and the time frame for use not clearly defined (Dutton et al., 2011). Furthermore, there have been no published studies of practitioner behaviour in the prescription or sale of bear bile in China. Therefore, we aimed to determine (a) to what extent, and in what situations, bear bile is used as a medicine in China; (b) who the consumers are and what the drivers of consumption are likely to be and (c) how farmed bile, wild bile and bile alternative products which may be promoted to reduce bile consumption are perceived by TCM practitioners (e.g. plant-based medicines; Moorhouse et al., 2020). Studies outside of China have found that some consumers may underreport bile use when asked directly, due to social desirability biases related to the illegality of wild bile trade (Davis, Crudge, et al., 2019). We therefore employed the Unmatched Count Technique (UCT) as an established method to improve anonymity and honesty in responses to our questions about consumption. We use our findings to draw conclusions on the bear bile market in China, the value of combining consumer and practitioner data to understand medicinal markets, and the complex factors that influence consumers in markets containing both farmed and wild products (Hinsley & 't Sas-Rolfes, 2020).

2 | METHODS

From March to June 2018, we carried out face-to-face surveys with members of the public (hereafter referred to as 'public surveys'), and key-informant interviews with TCM doctors and pharmacy workers to investigate consumption, prescription and perception of bear bile products (hereafter referred to as 'practitioner interviews'). We collected data in the provincial capital cities of Nanning (Guangxi), Guangzhou (Guangdong), Changchun (Jilin) and Chengdu (Sichuan). These provinces were chosen to represent combinations of proximity to: international borders with countries with known bile markets (Jilin [Russia], Guangxi [Vietnam]: Garshelis & Steinmetz, 2016); wild bear populations (Sichuan, Jilin: Gong & Harris, 2006); bear farms (Guangdong, Sichuan: based on advice from the China Association of TCM [CATCM]); and significant illegal wildlife markets (Guangdong, Guangxi: Zhang et al., 2008). In addition to these criteria, we tried to sample provinces that were in different parts of the country, meaning that Jilin in the Northeast was chosen over a southern province (e.g. Yunnan) with similar characteristics, as Guangdong and Guangxi are in the south, and Sichuan is in the Southwest.

We designed all survey and interview questions in English, translated them to Chinese and piloted them in Guangzhou in January 2018 (226 surveys, four interviews). We then refined the questions, and back-translated to English. No further changes were made to questions after this stage but we also tested the survey for half a day in each province, to ensure that questions were appropriate in local contexts and were being asked consistently (See Supporting Information 1 and 2 for all final questions).

All research was approved by the University of Oxford's Central University Research Ethics Committee Ref:R54657/RE002, and in China by collaborators at Sun Yat Sen University, the Academy of Inventory and Planning of the Chinese National Forestry and Grassland Administration (NFGA), and CATCM. Surveys or interviews were only started if informed consent was given, and respondents were assured that no personal details would be collected, that no answers would be linked back to them as an individual and that they could withdraw from the study at any time. Formal permits and permissions were obtained prior to the start of data collection in public areas or hospitals. All research assistants received one full day of training on how to conduct surveys and interviews, including sections on the importance of anonymity and ethics. They were also given daily morning and lunchtime briefings to reinforce their training during the study period and were accompanied during data collection by lead research assistants, who were on hand to answer any questions or help with any problems that arose.

2.1 | Public survey

We divided each city's districts by relative population density (very high, high, medium and low), and randomly sampled one from each category. We then used district population size to calculate proportional target sample sizes needed to reach approximately 1,000 surveys per city. We asked questions about bile use both directly and indirectly. The UCT's indirect questions have high statistical error, and our target sample size of 4,000 total surveys would yield a statistical power of >0.8 if consumption prevalence was at least 8%, with individual provincial samples reaching this power if prevalence was 16% (Ulrich et al., 2012). These values are below the only available consumption prevalence estimate for China (23%–30%: Liu et al., 2017), and recent estimates in Vietnam (18%–45%: Davis, Glikman, et al., 2019), suggesting our sample size was adequate. Data collection continued until the target sample size in each district was reached.

Research assistants approached people in public areas (including parks, shopping areas, residential streets), and conducted surveys on tablet computers using Open Data Kit software (Hartung et al., 2010). Assistants were asked to approach people as randomly as possible, with the aim being to achieve a sample with a broad range of demographic groups. We did not reveal the focus of the study until the questions about personal consumption, to avoid priming people to name bear bile during questions about potential treatments for eye infections and liver disease (chosen to represent key TCM-sanctioned uses for bile).

We used the UCT to estimate the prevalence of bear bile use or purchase in the 3 years before the survey (hereafter referred to as 'recent consumption'). A downside of the UCT is that it produces estimates with very large standard errors, and it can also be difficult to design in a robust way (Hinsley et al., 2019). Other specialised questioning techniques are available, and have been used to study the wildlife trade, including bear bile consumption (Davis, Crudge, et al., 2019). However, with improvements to analytical techniques that can combine answers to the direct and UCT questions, we decided to use the UCT rather than another similar method as it is simple to administer, is trusted by respondents to protect anonymity, works well with the large sample sizes we were aiming for and is well-suited to behaviours that are not extremely rare (Hinsley et al., 2019).

The UCT preserves anonymity by asking respondents to say how many of a list of behaviours they have engaged in, but not specify which ones (Hinsley et al., 2019). We randomly assigned respondents to either a control or treatment group, and showed them a list of either four non-sensitive statements for the control group ('*Visited a pharmacy*'; '*Bought pianzaihuang*' [a TCM medicine]; '*Bought or used cold and flu medicine*'; '*Made my own medicine*') or the same list plus a sensitive statement ('*Bought or used bear bile products*') in the treatment group. Ideally, control lists should include some behaviours with high and some with low prevalence, to reduce the likelihood that respondents would inadvertently reveal their behaviour by selecting all or none of the behaviours (Hinsley et al., 2019). We identified suitable control list items by asking pilot study respondents to read a long list of non-sensitive behaviours and select all that they had recently engaged in. We identified behaviours with very high prevalence (e.g. 'bought or used cold and flu medicine') and very low prevalence (e.g. 'made my own medicine') for use in the final list. We asked a second UCT question that used consumption of bear gallbladders as a proxy for wild-sourced (therefore illegal) products. While we note that other forms of wild products may be offered in some cases, in China the whole gallbladder is often sold to prove the authenticity of the product (although we note that gallbladders of other species can be used to mislead consumers). However, we discovered during analysis that, when used in a UCT context, the Chinese character for gallbladder could be ambiguous (see Supporting Information 3). We instead used answers to the direct questions about both wild bile and gallbladder use to draw broad conclusions about these products.

Following the UCT, we asked respondents directly to select products that they had bought or used in their lifetime from a list that included bear bile, and to say when this had occurred ('>3 years ago', '<3 years ago', 'would do so in the future'). Self-reporting consumption in this direct question (DQ) resulted in follow-up questions about use and purchase of different bear bile products (source and form used, place of purchase, reason for use). We then asked if they knew any bile users, and further questions about legality of wild bile, conservation status of wild bears and intended future bile consumption. Respondents not reporting bile use in the DQ (purported 'non-consumers') were then asked if they had heard of bear bile. Those

who had heard of bile then received all follow-up questions that did not focus solely on personal use while non-consumers who had not heard of bile answered only the final demographic questions. Once the survey was finished, we asked research assistants to provide feedback on each respondent's understanding of the survey.

We produced descriptive statistics for demographic variables, as well as for various behaviours associated with TCM and bear bile use. We also ran model-averaged logistic regressions to look at the relationships between key demographic and behavioural variables (Table 1) and awareness of bear bile, using R (R Core Team, 2020) and the package MUMIN (v 1.43.6), averaging all models with $\Delta AIC < 4$ (Barton, 2019). Awareness was defined as either selecting bile as a product used or bought in their lifetime, or answering yes to the question '*have you heard of bear bile?*'.

For the UCT, the difference-in-means of the control and treatment list is assumed to represent the proportion of the sample who selected the sensitive behaviour, so a confidence interval crossing zero would suggest no significant difference between the lists. For the DQ, the prevalence estimate is the number of people who reported that they had used bear bile, and indicated this was in the last 3 years. We used the R package LIST (Blair & Imai, 2019) to produce UCT prevalence estimates, and to determine whether these estimates were significantly different (at 95%) to the DQ. Furthermore, we used a relatively recent development of the LIST package that combines UCT and DQ answers from each respondent to reduce sampling variability, and produce a more robust prevalence estimate using the 'combinedListDirect' function (Aronow et al., 2015). For example, Aronow et al. (2015) assume that there are three latent classes of respondents, which when applied to our study would be (a) those who have not recently consumed bear bile (DQ = no, UCT = no); (b) those who have recently consumed and do not hide it (DQ = yes, UCT = yes); and (c) those who have recently consumed but who do try to hide it (DQ = no, UCT = yes). While the UCT can be used to differentiate 'a' from 'c' on an aggregate level, the DQ is required to identify 'b'. Combining the answers from both questions allows the proportion of all three groups to be determined, which can then be applied to the wider sample to produce a more robust prevalence estimate (Aronow et al., 2015). This approach relies on several assumptions of the UCT method holding true, and the combined estimate can also be used to check this via two 'placebo' tests that compare DQ and UCT answers for each person. We applied these to our data to test the assumptions that people do not falsely confess to using bear bile in the DQ or conceal bile use in the UCT (DQ = yes, UCT = no), and that the presence of the sensitive item does not affect respondents' DQ answer or the number of UCT control items that they report (see Supporting Information 4).

We fitted model-averaged logistic regressions to look at the effect of covariates in Table 1 on reported use of bear bile in the DQ, and on the UCT score. Multivariate analyses for the combined estimate are not yet possible (Aronow et al., 2015), so we applied the combined analysis separately to sub-samples of (a) residents of each study province; (b) male and female respondents and (c) respondents aged 18–34, 35–54 and over 55. Controlling for pre-treatment covariates in these models can increase efficiency, which is especially important in the UCT due to the large errors that are often seen with this method (Aronow et al., 2015). Although we randomly assigned respondents to control and treatment lists, controlling for the key variables that might influence UCT answers (Table 1) increases our confidence that UCT results reflect the prevalence of the behaviour, rather than the assignment of people with different characteristics to the control and treatment groups.

2.2 | Key informant interviews

We used the same district sampling method to calculate proportional target sample sizes needed to reach approximately 20 pharmacy-worker interviews in each city. We visited pharmacies in close proximity to each public survey location and interviewed the main staff member on duty. Where there were more than two pharmacies in the immediate area, the first and third closest shops to our public survey starting point were visited, skipping any pharmacy belonging to a chain already visited in that location. Pharmacy interviews had no time limit but interviews took place during work hours, so were also structured and short (usually 10–20 min). Pharmacy workers were not told that the interview would be about bear bile until after the first question, which was an open question about what they would suggest to people who came to their pharmacy with an eye infection. Further questions followed the same structure as the doctor interviews.

For the TCM doctors, we contacted TCM hospitals in each city via China Association of Traditional Chinese Medicine, and asked the management to suggest 10 doctors for our interviews. This doctor referral method is likely to generate biases, potentially reducing the likelihood that doctors would report involvement in prescription behaviour that was illegal or against hospital policy. We therefore used these data only as an indication of behaviours related to bear bile perceptions and prescriptions among doctors in a range of TCM disciplines. The hospital management limited all doctor interviews to the length of a normal appointment slot (usually 5–10 min) and we were not permitted to make audio recordings. We therefore used structured interviews to ensure that all points were covered with each interviewee, and that the answers could be easily recorded by the research assistants. Doctors were not told the questions before the interview but were aware that it was about bear bile. They were asked demographic questions and questions about their medical background, and about their prescription of bile, patient requests for bile products, and their views on the difference between wild bile and farmed bile, and herbal alternatives.

We produced descriptive summaries of all closed questions (e.g. years practising medicine), and coded the remaining open questions for analysis. Data were reviewed and coded by one Chinese native speaker, and then translated into English before being reviewed and checked by the original coder in discussion with one native English speaker. Any inconsistencies in coding were discussed and refined. Due to the structured nature of the interview, answers to many questions were short, and there

TABLE 1 Justifications for inclusion of each covariate and factor used as control variables in the combined analyses, and used in the models to explain awareness and use of bear bile

Variable	Levels	Description	Justification for inclusion
Province of residence	• Guangxi • Guangdong • Jilin • Sichuan • Other	Anybody, surveyed in any province, who reported living in one of the study provinces. All 'other' provinces combined due to small sample sizes	Provinces chosen due to combinations of characteristics that may influence bile use (wild bear populations, bear farms, IWT markets, proximity to international borders)
Age	• 18–24 • 25–34 • 35–44 • 45–54 • 55–64 • 65+	For models, the original levels of 65–74, 75–84, and 85+ combined into '65+', due to smaller sample sizes in these groups.	Younger people reported to consume more wildlife in Southern China (Zhang et al., 2008). Older people reported to use more bear bile products in Beijing (Liu et al., 2017)
Gender	• Male • Female	For models, the original category of 'Other' was removed due to small sample size ($n = 4$)	Men more likely to use TCM and bear bile in several studies (e.g. Drury, 2011; Zhang et al., 2008)
Education	• No higher education • Higher education	Due to small sample sizes, original levels of 'no school', 'primary school' and 'secondary school' were combined into 'no higher education', with 'BSc', 'Masters' and 'PhD' combined into 'higher education'	Wildlife consumption associated with higher education in Southern China (Zhang et al., 2008). Bear bile use associated with lower education in China (Dutton et al., 2011; Liu et al., 2017), higher education in Vietnam (Drury, 2011)
Employment status	• Not full time • Full time	For models, the levels of 'student', 'retired', 'unemployed', 'part time', 'house husband/wife' and 'self-employed' were combined into 'not full time' group due to small sample sizes for most	Higher incomes and certain types of employment have been linked to bile use in Vietnam (Drury, 2011)
Knowledge of TCM uses for bear bile	• Failed both tests • Passed at least one test	A combination of two questions asked to respondents before they knew that bile was the focus of the survey. A 'pass' was selecting bear bile as something that could be used to treat (a) an eye infection and/or (b) liver disease	Users of animal-based TCM products have been found to have little knowledge about product ingredients (Liu et al., 2016)
Recent TCM practitioner visit	• No TCM visits in last year • At least one visit in last year	All people who reported that their last visit to a TCM practitioner was in the last week, month, 6 months or year were combined	Consumption of animal-based TCM medicine for serious disease is likely to be mediated by medical practitioners (Liu et al., 2016)
Know somebody who uses bile (consumed models only)	• Know somebody • Do not know any bile users	Only people who responded yes to 'have you heard of bile' were asked this question, so we assumed that people who had not heard of bile did not know any bile user	Family influence has been shown to be an important driver of bile consumption in Cambodia (Davis et al., 2020)

was little debate about coding. In cases with longer answers, following discussion, some categories were sub-divided to provide more detail (e.g. where people stated that patients did not ask them for bear bile, we re-coded to differentiate between simple '*No*' and '*No but they do ask for advice*'). We then summarised the main themes related to each question, and selected example quotes to show the range of views within that theme.

3 | RESULTS

3.1 | Sample characteristics

For the public survey, we approached 4,374 people, obtaining a final sample of 3,646 completed responses, which we use for all analyses unless otherwise stated. Of the 728 people not included in the final sample, 483 refused to begin the survey, 22 agreed to begin the survey but did not meet age or residence criteria and 119 began the survey but did not complete UCT or DQ questions. In addition, 104 were removed after completion as they showed confusion and little understanding of questions, and the research assistants did not have confidence in their answers. The final sample in each province ranged from 860 respondents (Guangdong) to 942 (Sichuan). The sample was 49.5% female (49% male, 0.1% other), and the largest age group was 25–34 (25.2%), with 11.4% of respondents aged over 65. Our sample was, on average, better educated than the Chinese population (www.stats.gov.cn. See Supporting Information 5). Most respondents had visited a medical practitioner in the past year (56.4% $n = 2,055$), with 56.1% of these ($n = 1,152$) visiting only a Western practitioner, 15.2% only a TCM practitioner ($n = 312$) and 28.8% ($n = 591$) visiting both.

We interviewed 38 doctors (n = 10 each in Guangdong, Sichuan and Jilin, and n = 8 in Guangxi) and 80 pharmacy workers (n = 20 each in Sichuan and Jilin, n = 22 in Guangdong; n = 18 in Guangxi). Doctors had 0.5–50 years of experience (mean = 12.8) and pharmacy workers had 1–30 years (mean = 6.8). Five doctors specialised in fields where bile is most commonly used as a TCM treatment (liver disease: n = 4; ophthalmology: n = 1).

3.2 | Perceptions and awareness of bear bile

Less than half (42.8%) of survey respondents had heard of bear bile. Without prompting about the aim of the study, 19.2% of respondents identified bear bile as a potential treatment for an eye infection or liver disease, with 4.4% selecting it as a treatment for both. In addition, before interviewers mentioned bear bile, 15 of 80 pharmacy workers named bile when asked what they would suggest to a customer with an eye infection. When asked directly what bear bile was used for, more than three-quarters (n = 66) of pharmacy workers named liver or gallbladder diseases, eye problems or 'heatiness' (a term associated with a general feeling of being unwell).

Of the 1,521 survey respondents who answered questions about legality and wild bear status (these questions were only shown to people who had heard of bear bile), 85.9% (n = 1,306) thought that wild bear bile was illegal and 2.1% (n = 32) thought it was legal (12.0% did not know). In addition, 57.0% (n = 867) thought that wild bear populations were decreasing, 9.3% (n = 142) thought they were increasing and 1.8% (n = 28) thought they were stable (31.8% said they did not know).

Interviewees had mixed views on the importance of bear bile as a medicine and its substitutability with other treatments (Table 2). More than half of pharmacy workers (n = 47) and around one-third of doctors (n = 14) said that it was not possible to compare the effectiveness of bear bile with herbal drugs, as it depended on multiple factors including the nature and severity of the disease, the characteristics of the patients, how much of each medicine was used or what other medicines it was combined with. Five (of 38) doctors and five (of 80) pharmacy workers said that herbal alternatives were generally better than bear bile. Twelve (of 80) pharmacy workers and more than one-quarter (n = 11) doctors said that bear bile was better than herbal alternatives, and almost half of doctors (n = 17) said that bile was the best treatment for at least one medical problem, regardless of the alternatives available.

Over half of doctors (n = 21) and more than a third of pharmacy workers (n = 31) believed that wild bile was better than farmed. In addition, more than one-quarter of doctors (n = 13) and 14 (of 80) pharmacy workers said that there was no real difference or that farmed could be just as good as wild. While a small number of pharmacy workers said that farmed was best, no doctors said this. Reasons given for wild bile being more effective were mainly related to purity, better food and a natural environment for the bears, or the poor quality of farmed bile. One doctor (D11, Jilin) said that differences in purity could be easily addressed by prescribing larger quantities of farmed bile. One pharmacy worker (Ph7, Guangxi) noted that farmed was better because of the controlled conditions that bears were kept in.

3.3 | Bear bile consumption and prescription

When asked directly, 5.9% (n = 214) of survey respondents reported using/purchasing (hereafter 'consuming') bear bile in their lifetime, mostly for medicine (n = 140) but also for health improvement (n = 89) and gifts (n = 20). This included 53.8% of consumers (n = 115 of 214) using bile for eye-related treatments, 51.4% (n = 110) for detoxing/heatiness and 21.5% (n = 46) for liver diseases.

Considering only recent consumption (defined as <3 years ago), the UCT produced an estimate of 10.4% (*SE* 2.5) use, which was significantly higher than the 3.8% (*SE* 0.3%, n = 140) from the direct question (difference of 6.4% *SE* 2.5; see Supporting Information 6 for UCT answer distributions). Our combined estimate of 11.2% (*SE* 2.4) is our best estimate for recent bile consumption in the surveyed sample. Our UCT data passed both placebo tests, giving us further confidence that the assumptions underpinning our interpretation of the UCT answers are valid.

Almost half of the 140 recent consumers did not know or did not report the source of the bile they had consumed (n = 67). Of those that did report a source, most had used farmed bile only (n = 65), while smaller numbers reported using both farmed and wild bile (n = 4) or wild bile only (n = 3). In total, 14 people (0.4% of sample, 10% of recent consumers) reported either recent consumption of wild bile (n = 7) or wild-type products (i.e. gallbladder: n = 7); the UCT estimate of recent gallbladder consumption was higher but did not differ significantly from zero (combined: 4.9%, *SE* 2.9). Open questions to those who reported gallbladder use found that they were used as a cure or treatment for age-related eye disease (n = 2) because they had heard it was a good drug and wanted to try it (n = 1), they had received it as a gift (n = 1) and they had owned a gallbladder in wine for several years that they used occasionally (n = 1). Past gallbladder users who stated why they no longer used them said it was because bears are protected (n = 1), or because they had recovered and no longer needed the medicine (n = 2).

Half of pharmacy workers reported suggesting bear bile to customers, and four of the five liver and eye doctors had prescribed it (Table 3). Five doctors from other fields (TCM surgery: n = 2; TCM internal medicine: n = 3) had also prescribed bile. Four of these nine doctors who did prescribe bile noted that this was only as patent (processed) medicine and that they did not use bear bile as a raw ingredient. Of the 29 doctors who had not prescribed it, five said that this was because wild bears were protected and bear farms were cruel, for example, D2 (Guangxi) '*From doctor's perspective, we try to avoid using animal components, even if it is farmed, the process of taking bile is still cruel. There is word that 'if there is no demand, there is no killing'*'. This last sentence was presumably a direct reference to the WildAid campaign slogan aimed at reducing demand for illegal wildlife products: '*When the buying stops, the killing can too*' (https://

TABLE 2 Summary results of interview questions about bear bile and other medicines, posed to doctors and pharmacy workers in Sichuan (SC), Guangdong (GD), Guangxi (GX) and Jilin (JL)

Question	Answer		Example quotes (Doctor/Pharmacy number, Doctor specialism [* denotes bear bile relevant field], province)
Which is more effective: bile or herbal alternatives?	Doctors (n = 38)	Bear bile is better (11)	Can be compared when they belong to same kind of medicine and for the same kind of disease…usually, the effect of animal component will be better. (D25, Liver*, gastrointestinal disease, TCM Internal Medicine, GD)
		Too hard to compare (14)	'For some diseases, herbal can be used, but for some, bear bile is more effective. For example, for eye problems, you can also use either western medicine like antibiotics, eyedrops or herbal medicine. But for haemorrhoids, biliary disease, liver and gall, convulsions etc., it cannot be replaced.' (D30, Integrated TCM & biomedicine, Internal TCM. SC)
		Herbal can replace (5)	'It's hard to use one kind of herb to replace but it may be possible to use several kinds' (D12, TCM encephalopathy JL)
	Pharmacy (n = 80)	Bear bile is best (12)	'Because it is more expensive, so it should be more effective' (Ph28. JL); 'For eyes' problem, maybe the bear bile one is better' (Ph27. JL)
		Hard to say (47)	'The medicine should be matched to diseases. No kind of medicine is the best one' (Ph55. GD); 'It depends on how much you use' (Ph13. GX);
		Herbal is better (5)	'I am used to using herbal. The one that is affordable for the lay public is the best medicine.' (Ph59. GD)
Is there a situation where bear bile is the best medicine?	Doctors (n = 38)	Yes (17)	'Some serious diseases in the liver and gallbladder. I have read a report comparing the effects of bovine, pig and bear bile on non-alcoholic fatty liver disease and found that bear bile worked better.' (D37, Oncology, SC)
		No (11)	'Generally, there is no single medicine, especially for serious diseases. It will still be ok if we don't use it. I think there are a lot of alternatives, such as using buffalo horn instead of rhinoceros horn.' (D33, Integrated TCM & biomedicine, Respiratory. SC)
	Pharmacy (n = 80)	Yes (24)	'Those consumers who came to buy bear bile eyedrops said this medicine is effective.' (Ph33. JL)
		Hard to Say (17)	'No medicine can be called the "best"' (Ph57, GD)
Is there a difference between wild and farmed bile?	Doctors (n = 38)	Wild is better (21)	'There should be differences theoretically, but there may be no difference in reality…generally speaking, wild is better than farmed because the natural environment is better than a farm, leading to differences in purity and content' (D25, Liver, gastrointestinal disease*, Internal TCM. GD) 'Like buffalo horn replacing antelope horn, the effect is not as good as the wild.' (D2. Liver disease, dermatology. GX.)
		No real difference (13)	'The compositions are all bile. There is a little difference in the purity, but it can be balanced by the amount. For example, using 0.01 g of wild, then the amount of farmed could be slightly more.' (D11, Orthopaedics. JL)
		Farmed is better (0)	N/A
	Pharmacy (n = 80)	Wild is better (31)	'The living environment for the wild is better. The farmed one may be mixed with some other things' (Ph21. JL); 'It's hard to tell the reason. It is more natural. The food of farmed feed is also not good as the wild' (Ph30. JL)
		No difference (14)	'They will not be the same for sure. There will be some difference, but both can be effective' (Ph55. GD); 'It mainly depends on the level of purity' (Ph14. GX)
		Farmed is better (3)	'The quantity of farmed is easier to control and the management is also better' (Ph7. GX)

(Continues)

TABLE 2 (Continued)

Question	Answer (no. respondents)		Example quotes (Doctor/Pharmacy number, Doctor specialism [* denotes bear bile relevant field], province)
Have you prescribed (doctor) or suggested (pharmacy worker) bile to people?	Doctors (n = 38)	No (29)	'No, there is no such medicine in this hospital' (D12, TCM encephalopathy. JL)
		Yes (9)	'Yes, I prescribed patent medicine and Ursodeoxycholic acid' (D30, Integrated TCM & biomedicine, Internal TCM. SC) 'Rarely. animal composition drugs are less prescribed because of the immunogenicity. Bear bile and bear bile powder have special composition, there are state requirements for wildlife protection. Only when I was in the countryside to do clinics [not a doctor in a hospital], I would prescribe it depending on the disease. But still rarely.' (D13. Liver disease*. GD)
	Pharmacy (n = 80)	Yes (40)	'Yes, but there is only haemorrhoid cream here' (Ph80. SC); 'There is only eyedrops and tablets here, no other products' (Ph24. JL)
		No (38)	'No. There are no such products here. There were some eyedrops and capsules a long time ago. Because of national policy restrictions, there are few sources.' (Ph54. GD)
Do people ever ask you for bile?	Doctors (n = 38)	No (12)	'No, even if there was a patient who requested it, I would suggest they use the patent medicine [processed form]' (D25, Liver, gastrointestinal & digestive disease*, Internal TCM. GD)
		Yes (5)	'I met patients who heard of the effectiveness from others, then they came to ask me to prescribe this medicine. But this kind of situation is very rare.' (D2, Liver disease*, dermatology. GX)
		No, but ask advice (2)	'I met a patient who bought bear bile eye drops [from elsewhere] and came to ask whether he/she can use it.' (D26, ophthalmology*. GD)
	Pharmacy (n = 80)	Yes (34)	'Yes, there are some consumers who used before and thought it was good, then come back' (Ph10. GX); 'Most of them came for the medicines with prescriptions from the doctors.' (Ph22. JL); 'Yes. Those who used before and thought it is good or suggested by friends may want to use again' (Ph71, SC)
		No (19)	'The consumers rarely knew what they need. More come to ask for advice. Mainly for eyes red and swollen because of staying up late' (Ph12. GX)

wildaid.org/yao-ming-says-no-to-ivory-and-rhino-horn/). Almost half (n = 34) of pharmacy workers and five of 38 doctors reported being asked for bile products. Two doctors reported that, although they did not prescribe it, patients who had obtained bear bile independently had asked them for advice on how to use it. Pharmacy workers stated that patients asked for bile due to prescriptions from a doctor, recommendations from friends or experience using the product. No interviewees had been asked for wild bile specifically, although one pharmacy worker (Ph72, Sichuan) had been asked whether products on sale were wild or farmed. Of our sample of 80 pharmacy workers two reported that customers do not care about the source, and six said that effectiveness and/or a doctor's recommendation were all that mattered to customers, with one of these also mentioning that price was important.

3.4 | Who is consuming bear bile?

When asked directly, men, people in older age groups, Guangxi residents, people who knew other bile users and people who knew the common TCM treatment uses for bile were significantly more likely to have heard of bile and to report consuming it (Table 4). The conventional UCT indicated that bear bile consumers were more likely than non-consumers to know the common treatment uses for bile in TCM and, at 90% confidence interval, mid-age groups were more likely than the oldest and youngest to consume, and know others who also consumed.

In the DQ, 2.1% (*SE* 0.5) of Guangdong residents, 6.2% (*SE* 0.9) of Guangxi residents, 4.2% (*SE* 0.7) of Jilin residents and 2.6% (*SE* 0.6) of Sichuan residents reported recent consumption. The UCT and combined analysis estimates were higher than the DQ but not significantly so in any province, and the 95% confidence intervals for the UCT in Guangxi and both estimates in Jilin overlapped zero (See Supporting Information 7).

Recent consumption was reported in the DQ by more men (5.1% *SE* 0.6) than women (2.5% *SE* 0.4), and by more people aged 35–54 (4.7% *SE* 0.6; >55 = 5.7% *SE* 0.8) than 18- to 34-year olds (2.0% *SE* 0.4). Conversely, in the UCT and combined estimate, there were no significant differences between prevalence of recent consumption between any group; moreover, the UCT was significantly higher than the DQ for women (UCT: 11.5% *SE* 3.5) and 18- to 24-year olds (11.0% *SE* 3.6). (Figure 1). The combined analysis estimates of

TABLE 4 Model averaged results showing factors associated with having heard of bear bile and having consumed bear bile, with the latter showing both direct question (DQ) and Unmatched Count Technique (UCT) results. Some respondents did not complete all questions, so the sample size for each model is shown in parentheses. For full model averaging results, see Supporting Information 8–10. Shading denotes significance at least $p < 0.1$ with positive coefficients in yellow and negative in grey. Significance: $^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$; $^{****}p < 0.001$. *SE*s given in brackets

	Heard of bear bile ($n = 3,232$)	Consumption of bear bile in last 3 years ($n = 3,135$)	
Variable	**DQ Estimate (*SE*)**	**DQ estimate (*SE*)**	**UCT estimate (*SE*)**
Intercept	−0.83 (0.12)****	−4.82 (0.37)****	1.71 (0.04)****
Age (ordinal factor)			
Linear	0.40 (0.12)****	1.52 (0.36)***	−0.02 (0.07)
Quadratic	−0.04 (0.10)	−0.34 (0.35)	−0.11 (0.07)*
Cubic	−0.02 (0.10)	−0.04 (0.29)	0.02 (0.06)
Province of residence (Ref: Guangdong)			
Guangxi	0.25 (0.11)**	0.73 (0.32)***	NA
Jilin	0.06 (0.11)	0.17 (0.32)	NA
Sichuan	0.17 (0.11)	0.05 (0.36)	NA
Education level (Ref: No University)	0.63 (0.09)****	0.25 (0.24)	−0.02 (0.05)
Gender (Ref: Male)	−0.18 (0.08)**	−0.52 (0.22)**	0.07 (0.05)
Identified bile as a treatment for eye and/or liver disease (Ref: did not name bile as a treatment)	1.46 (0.10)****	2.22 (0.23)****	0.25 (0.07)****
Recently visited a TCM practitioner (Ref: Not visited)	0.11 (0.09)	0.09 (0.23)	−0.06 (0.05)
Employment (Ref: Not full-time)	0.06 (0.09)	−0.28 (0.29)	−0.03 (0.05)
Knows somebody who uses bile (Ref: does not)	NA (not included)	1.72 (0.22)****	0.14 (0.07)*

prevalence for each group were also consistent between genders and age-groups (men 11.4% [*SE* 3.5%], women 11.1% [*SE* 3.4%], 18- to 34-year olds 11.0% [*SE* 3.6], 35- to 54-year olds 9.5% [*SE* 4.1] and >55 years 13.5% [*SE* 5.5]).

The confidence intervals for the UCT and combined estimates for gallbladder consumption overlapped zero in all provincial or demographic sub-samples, except for the 35–54 age category (see Supporting Information 3). In this age group, the UCT estimate of 11.7% (*SE* 4.9) and the combined estimate of 11.6% (*SE* 4.9) for recent gallbladder use were significantly different from both zero and the DQ result of 0.18%. The combined estimate was higher than, but not significantly different from, the combined estimate for all bile use in this group (8.5% *SE* 4.1), suggesting either that all respondents of this age who had used bile had also used a gallbladder, or that this group was most likely to misunderstand the term for gallbladder used in this context.

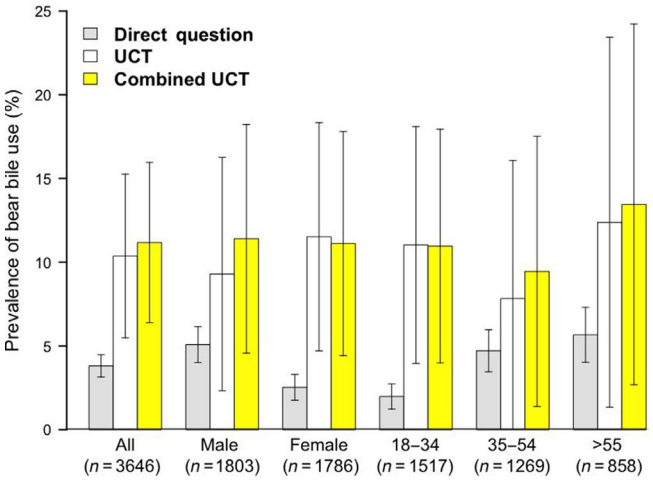

FIGURE 1 Prevalence estimates (with 95% confidence intervals) for the direct question, UCT, and combined UCT about recent (within 3 years) bear bile consumption, showing values for the whole sample and for sub-samples of all respondents in different gender and age groups (estimates produced using combined analyses, controlling for age [except in age sub-samples], gender [except in gender sub-samples], education level, knowledge of common uses for bile, recent visits to TCM practitioners, employment status and province of residence in China)

4 | DISCUSSION

Although bear bile is not widely prescribed in China, it was seen by many of the practitioners we interviewed as the best treatment for certain ailments, and based on our public surveys in four large cities, approximately 11.2% (*SE* 2.4) of people had recently used it. Although

the UCT probably addressed some social desirability biases, self-reported consumption is likely to be an underestimate of true bear bile use, as practitioners report that consumers do not take an active role in treatment decisions. This echoes previous findings that TCM consumers rarely know the ingredients of medicines they have used (Liu et al., 2016). We show that this uncertainty also extends to the source of these products, with many consumers in our study being unsure whether they had used farmed or wild bile. Although our consumption prevalence estimate should be treated as a minimum, data from doctors and pharmacy workers suggest that bear bile use in China is limited by its designation for specific ailments. In addition, even our highest best estimate of recent consumption (15.8%, based on the upper 95% confidence interval of our combined estimate) was lower than the 23%–30% of people in Beijing reporting consumption, although the latter was over a much longer period (1990–2012: Liu et al., 2017).

While our study was not necessarily representative of the whole of China, our findings from diverse provinces suggest that a significant number of people may be consuming bile products and many practitioners considered it to be an important medicine. Conversely, most of the general public we sampled were unaware of this product and fewer still knew what it was used for. Our sample was urban, and TCM use is known to be very different in rural areas (Oyebode et al., 2016). However, urban areas such as the ones that we sampled are important centres of wildlife consumption, including illegal or high-end wild products (Drury, 2011). Therefore, we cautiously suggest that tens of millions of people in China's cities may be consuming bear bile, the vast majority of whom are likely to be using relatively cheap, legal farmed products. Both consumers and doctors in our study confirmed that patent medicines dominate the market, and these products often contain very small quantities of farmed bear bile powder. For example, the 2020 TCM pharmacopeia includes medicines such as Xiongdan Jiaonang, which uses 50 g of bear bile powder in a recipe for 250 tablets, or Xiongdan Jiuxin Wan which uses 0.2 g of bear bile powder to produce 1,000 pills (National Pharmacopeia Committee, 2020). Some consumption will also be of wild-sourced (therefore illegal) products, although few consumers reported this, and no practitioners said that they prescribed these products. It is not possible to estimate the real consumption prevalence of wild bile, due to the potential for underreporting from consumers attempting to conceal illegal behaviour, overreporting by those who have inadvertently used fake products and misreporting by those who were unaware of the source of bile used. However, even if only some of those reporting wild bile use in our sample had done so, this would still be a serious conservation issue for wild bears if consumption was at similar levels in other Chinese urban populations.

Drawing conclusions about the characteristics of bile consumers in China is not straightforward, as our findings suggest that consumption may not be restricted to particular demographic groups. Interventions such as behaviour change campaigns often target specific demographic groups due to findings of higher self-reported consumption (e.g. men: Offord-Woolley, 2017; Randolph et al., 2019). Our DQ did suggest that men, older people and Guangxi residents may be more likely to consume, but these distinctions were not borne out in the UCT, where only those in mid-age groups and those who knew other bile consumers were more likely (at 90% confidence intervals) to use or buy bile. In addition, around three-quarters of under 35-year olds who had consumed bile did not report this in the direct question: this underreporting was potentially linked to them seeing TCM as less 'progressive' and modern than western biomedicine (Oyebode et al., 2016). Similarly, women also underreported bile consumption, reflecting findings of sensitivities around bile use among women in Vietnam (Davis, Glikman, et al., 2019). This could be linked to findings that women tend to answer direct questions in ways that make them appear more ethical than they are, due to being broadly more affected by social desirability biases than men (Yang et al., 2017). This may include over-stating how much they consider animal welfare issues when making purchasing decisions (Lusk & Norwood, 2010), although differences in focus on animal welfare between male and female consumers have not been observed in Chinese studies on the meat industry (Li et al., 2018). Whether these findings are due to the increasing sensitivity around animal welfare in China or other factors, they demonstrate that underestimating levels of, and reasons for, consumer heterogeneity may undermine the effectiveness of targeted interventions (Margulies et al., 2019). We suggest that self-reported consumption, even of legal products like farmed bile, should not be the only data used to inform these interventions.

While demographic factors were less important, we show that bear bile consumers had better knowledge of the treatment uses of bear bile than non-consumers, and knowing other people who consumed bile may be associated with consuming bile themselves. Previous studies in China have shown that consumers are unaware of the species included in different TCM products (Liu et al., 2017). Our study also suggests that consumers may pay little attention to product source, with almost half of consumers in our sample being unsure whether they had used wild or farmed products, and others reporting using product forms that did not match with sources (e.g. wild bile in tablet/capsule form). This may be due to consumers not taking an active role in treatment decisions, instead relying on external advice. Practitioners in our study reported that few patients ask for specific products, and no consumers asked them about sourcing, with some noting that consumers prioritised factors such as perceived effectiveness instead. As knowing other bile consumers was linked to consumption, advice may also come from social contacts, such as family members, who are known to be important drivers of bear bile consumption in other countries (e.g. Cambodia: Davis, Crudge, et al., 2019; Davis et al., 2020). Consumer preferences for either wild or farmed products have been widely reported (e.g. Dutton et al., 2011; Moorhouse et al., 2020), but our findings indicate that consumer decisions are unlikely to be driven solely by product source, instead being influenced by a range of factors such as accessibility, legality or social legitimacy (Hinsley & 't Sas-Rolfes, 2020).

If consumers focus on effectiveness and external influence to make their treatment decisions, our findings of widespread views among practitioners that wild bile is more effective than farmed could be cause for concern. Severe punishments are likely to deter formal

practitioners from prescribing illegal products (Cheung et al., 2018). In addition, the few survey respondents who had used an illegal gallbladder reported sourcing them only from informal places (e.g. markets), supporting practitioner claims that they did not prescribe or sell these products. However, some doctors reported that patients had asked them for informal advice about bear bile, meaning that practitioners could still influence patients' views outside of the formal processes. Practitioner views are also key to understanding the potential success of alternative products that aim to reduce wild bile use (e.g. Appiah et al., 2017). For example, some of the practitioners we surveyed highlighted the better food and environment of wild-living bears as a reason why wild bear bile is better (Table 2). This could be leveraged as a way of incentivising the improvement of welfare standards in bear farms and limiting demand for bile from low-welfare farms outside of China. Other studies of consumers have suggested that herbal products could be used to reduce demand for bear bile (Moorhouse et al., 2020), but practitioners in our study clearly saw these products as very different, with mixed views on their substitutability. Some studies of TCM practitioners exist (e.g. Cheung et al., 2018), but few have focussed on practitioner preferences and how this might be reflected in their prescriptions and advice; this should be a priority for future work. While we acknowledge that the link between awareness and behaviour is not simple, some doctors in our study were aware of conservation and animal welfare issues and reported that this had affected their prescription decisions. We recommend that sustainability and legality issues related to the use of wild products should become a required component of formal TCM doctor training.

The context of consumption is important to consider, and our findings from China show clear differences in consumption habits compared with neighbouring countries with bear bile markets. Even considering variations in methodology and sampling, our DQ estimate of any lifetime consumption (5.9% [5.1%–6.6%]) and combined estimate of recent consumption (11.2% [6.5%–15.8%]) are far below a DQ estimate of 18%–45% in Vietnam (Davis, Glikman, et al., 2019). They are also slightly lower than findings in Laos (DQ: 9.5% Davis et al., 2016) and Cambodia (DQ: 9.5%; UCT: 15.2%, Davis, Crudge, et al., 2019). Differences could be due to bile being used for a much wider range of ailments in the medicinal systems of some SE Asian countries (e.g. Cambodia: Davis, Crudge, et al., 2019). However, it may also be due to consumers in China, where bile is widely available in packaged products, being less aware of which products contain bear bile. In contrast, in Vietnam, bile is commonly obtained illegally directly from farms and traded in its raw form in labelled vials (B. Crudge, pers. comm.), meaning that consumers are likely more aware of its origins. While consumption in China may be lower, bear farming in Laos reportedly expanded after greater regulation was introduced to the industry in China (Davis et al., 2016), suggesting that these markets are not independent. For conservation more broadly, efforts should be made to design targeted interventions based on specific types of consumption, which we now know vary between markets for the same wildlife products in different countries.

Consumer studies in wildlife markets are essential to develop the understanding needed to underpin effective conservation interventions aiming to reduce consumption behaviour (Veríssimo et al., 2020). We stress the benefits of considering the motivations and behaviours of both consumers and those who influence their behaviour. Bear bile consumption in China is influenced by complex factors, and we show that both consumers and practitioners play an important role in shaping demand. Currently, most Chinese bear bile consumers are unlikely to be focussed solely on product source, and their reliance on practitioner advice is likely to restrict them to farmed products. However, informal advice from practitioners or reliance on family members' guidance could influence some consumers to seek out wild bile, and the circumstances in which this might take place should be a research priority.

Our study provided information on the intersection of the legal and illegal markets for bear bile in China from different actor perspectives. Further work to examine consumption and sale in purely illegal and informal markets is clearly warranted. While it is not possible to predict what might happen if the availability of farmed bile radically changed in China, or if new legal alternatives were introduced, our results indicate that the medicines derived from bear bile are used by a very large number of people who are likely to rely on advice from practitioners. Conservationists and animal welfare organisations aiming to change the trade must consider the extent to which bear bile is ingrained in Chinese culture and tradition, as well as in everyday medicinal use by many people. They must also recognise that abrupt changes in its legal status or availability may have large-scale unpredictable consequences in consumer or medical practitioner behaviour that, if not carefully considered, may have a negative effect on wild bears. This may be particularly relevant when considering consumption of bear bile and similar products post-COVID-19, as legal frameworks and public perceptions around the consumption and farming of different wildlife products are complex and already changing (Koh et al., 2021). Including diverse perspectives in studies of wildlife markets can lead to a more complete picture, which will guide the design and evaluation of efforts to redirect demand away from illegal or unsustainable products.

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CONFLICT OF INTEREST

A.H., B.M., D.G. and M.H. are members of the IUCN SSC Bear SG, of which D.G. is Chair; A.H., B.M., D.G., E.J.M.-G. and T.M.L. are members of the IUCN SSC Sustainable Use and Livelihoods SG; M.H. works for a conservation organisation; X.R. and J.Z. work for a Chinese government administration; Y.Q. works for a TCM industry body. A.H. received funding for the project from Bears in Mind.

AUTHORS' CONTRIBUTIONS

A.H., T.M.L., D.G., M.H., B.M., Y.Q., X.R., J.Z., S.H. and E.J.M.-G. developed the ideas for the project, designed the methodology and contributed towards the formulation of the questions; S.H. led on project logistics in China and with H.C. collected interview data and coordinated survey data collection, with supervision from A.H., T.M.L., X.R., Y.Q. and J.Z.; A.H. analysed the surveys, and with S.H. analysed the interviews; A.H. led on the writing of the paper with input from T.M.L., E.J.M.-G., D.G., M.H., B.M., X.R., A.K.Y.W. and S.H. All authors gave final approval for publication.

DATA AVAILABILITY STATEMENT

We have archived anonymised data used in the models in the Oxford University Research Archive at https://ora.ox.ac.uk/objects/uuid:2e9ac374-7139-43cb-98a5-55eaebacdeb6 (Hinsley, 2021).

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SUPPORTING INFORMATION

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

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