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Policy analysis

Reduce or redirect? Which social marketing interventions could influence demand for traditional medicines?

Tom P. Moorhouse[a,*], Peter G.R. Coals[a], Neil C. D'Cruze[a,b], David W. Macdonald[a]

[a] Wildlife Conservation Research Unit, Department of Zoology, University of Oxford, Recanati-Kaplan Centre, Tubney House, Abingdon Road, Tubney OX13 5QL, UK
[b] World Animal Protection, 222 Grays Inn Road, London WC1X 8HB, UK

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ABSTRACT

The global trade in wildlife is a threat to species conservation and animal welfare. A key driver is demand for traditional medicines (TMs). We present an initial experimental survey of demand reduction and demand redirection interventions aimed at changing the behaviour of TM consumers in China and Vietnam. Treatment respondents (n = 1600) were shown TM products, with messages outlining their conservation, welfare or human health impacts, and asked their intention to buy these products in the future. Control respondents (n = 400) were shown nothing. All respondents were then shown a 'herbal' (plant-based) substitute, and asked how likely they would be to buy it. Respondents were finally shown a list of TMs and asked to select those they would buy.

Of treatment respondents 62.7% stated they would stop buying TMs, but when later offered a list of TMs, 52.2% selected at least one to buy. Frequent buyers exhibited a smaller treatment response than occasional buyers (56.4% versus 67.1%, said they would stop buying), and a larger gap between this and their later decision to buy TMs (a 32.8% versus 14.0% difference). With respect to herbal substitutes, 88.9% of regular buyers selected high purchase likelihoods, compared with 73.5% of occasional purchasers, proportions unaffected by experimental group.

Information campaigns may have a limited effect in reducing demand, particularly among frequent users of TMs. Frequent purchasers, however, exhibited the greatest enthusiasm for herbal substitutes. Future approaches to protect wildlife should test the effectiveness of working with TM practitioners to redirect demand onto alternative, non-animal TM ingredients.

1. Introduction

The global trade in wildlife is a substantial, and growing, threat to global biodiversity, species conservation and animal welfare (Grieser-Johns and Thomson, 2005; Pires and Moreto, 2011; Fernandes-Ferreira et al., 2012; Baker et al., 2013; Dutton et al., 2013; Challender and MacMillan, 2014). The extinction risk for individual species in this trade is a function of the value of their products: once mean product values exceed a threshold (estimated as $12,557 kg^{-1}), price alone confers a high risk of extinction (McClenachan et al., 2016). Of the 14 products with the highest reported prices listed by McClenachan et al. (2016), half are ingredients of traditional medicines and health supplements (hereafter 'TMs'). The five most expensive (2013 prices) had a per-kilogram value higher than gold (then US$39,000 per kilo) and four of these (tiger penis bone, bear gall bladder, rhinoceros horn and deer musk) were TM ingredients. The sixth most expensive, tiger bone, is also a TM ingredient and had a per kilo value of US$27,000. Pangolin scales had media-reported values of US$650 in 2019 (WildAid, 2019), which would have placed them twelfth on the above list, and the sixth most expensive of products traded as TMs (c.f. McClenachan et al., 2016). Use in TMs clearly confers on animal products a high financial value. This is a key driver of both legal and illegal global wildlife trade, posing a high risk for species of extinction in the wild (Baker et al., 2013).

Much of the demand for TM ingredients arises in China and Vietnam. This is true of the global trade in pangolins (Pantel and Chin, 2009; Challender, 2011; Challender et al., 2014; Nijman et al., 2016). Scales (removed by boiling live animals and carcasses in water; D'Cruze et al., 2018) and pangolin wine (created by steeping carcasses or scales in alcohol; Nijman et al., 2016) are used within TMs, and their flesh is consumed in restaurants (Pantel and Chin, 2009). A primary threat to wild tigers is the illegal trade of tiger bones for TMs (Nowell and Xu,

* Corresponding author.
E-mail addresses: tom.moorhouse@zoo.ox.ac.uk (T.P. Moorhouse), NeilDCruze@worldanimalprotection.org (N.C. D'Cruze), david.macdonald@zoo.ox.ac.uk (D.W. Macdonald).

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2007; Goodrich et al., 2015), for which the majority of demand comes from Chinese consumers (Nowell and Xu, 2007; Bale, 2018). Asiatic black bear *Ursus thibetanus* and sun bear *Helarctos malayanus* are both listed as Vulnerable by the IUCN, with significant threats being hunting and trade, in particular for bear bile, again for consumption as TMs in China and Vietnam (Crudge et al., 2018; Davis et al., 2019).

Efforts to stem illegal and/or unsustainable wildlife trade have traditionally focussed on tackling the supply of products, through enforcement and regulation (Challender and MacMillan, 2014; Veríssimo et al., 2012). There is, however, an increasing, additional, focus on measures to reduce consumer demand through educational and public awareness campaigns (Courchamp et al., 2006; Dalberg, 2012; Baker et al., 2013; Veríssimo and Wan, 2019). At present, however, the relative effectiveness of consumer approaches often remains untested and under-reported (Olmedo et al., 2018; Veríssimo and Wan, 2019; Veríssimo et al., 2018). A recent study concluded that of 236 such campaigns, only a quarter reported on outcomes (e.g. changes in the target audience regarding, for example, knowledge, attitudes or behaviour) and < 9% reported on conservation impacts (Veríssimo and Wan, 2019). Many campaigns lack a theory of change for how interventions could influence consumers' behaviour (Olmedo et al., 2018; Wallen and Daut, 2018) or have project designs that are not adequate to test the effect of interventions on the target audience (Veríssimo and Wan, 2019).

Creating positive outcomes for conservation and animal welfare through changing consumers' choices will often require removing barriers that prevent environmentally desirable behaviours (Wallen and Daut, 2018). Wallen and Daut (2018) state that such barriers may occur at the level of individuals (e.g. ignorance that a purchase is illegal or that there is a legal alternative) or be embedded within broader sociocultural or political contexts. Hauser et al. (2018) similarly distinguish between behaviour interventions that target individuals' beliefs and those that target wider societal barriers that individuals may experience.

Following Hauser et al.'s (2018) terminology, targeting beliefs may change behaviour if the audience has received incorrect information, and would change its mind if provided with accurate information. Interventions to reduce demand for specific TMs could involve, for example, disseminating information about the animal welfare (e.g. Hauser et al., 2018) or conservation (e.g. Davis et al., 2016; Liu et al., 2016) impacts of consuming TMs, as well as about their safety and effectiveness. Information in itself does not necessarily motivate individuals to alter their behaviour, however (Stern, 2000). Marketing and behavioural economics approaches may therefore be required to test which, if any, messages or interventions are likely to be effective on the target population (e.g. Moorhouse et al., 2017; Olmedo et al., 2018).

If interventions fail to alter beliefs it may be more fruitful to examine what wider barriers may prevent consumers from changing their behaviour (Hauser et al., 2018; Wallen and Daut, 2018). One key barrier to reducing TMs' impacts on some species' conservation and individual animals' welfare is that for some TM products there may be no readily available, or widely socially accepted, non-animal substitute. A barrier-focussed approach could therefore examine consumers' willingness to accept TMs made from substitute, or alternatively sourced, ingredients. In recent decades such substitute TMs have been available, but typically from the farming of wild species (e.g. Dutton et al., 2011; Kikuchi, 2012; Ferreira et al., 2016; Tensen, 2016). Many tiger farms exist across China, Lao PDR and Vietnam (Bale, 2018). There is also a substantial international trade with China and Vietnam in lion bones - as substitutes for tiger bone - which has led to the farming of lions, particularly in South Africa, and the fear that this encourages poaching of wild lions (Williams et al., 2015; Coals et al., 2019). Similarly bear bile farms in Vietnam have previously fed domestic and Chinese markets. Such farms, however, bred few bears and at least used to supplement their stock from the wild (Foley et al., 2011; Livingstone et al., 2018). Farmed equivalents of wild products have been shown to be less popular with consumers (Dutton et al., 2011) and to raise substantial welfare concerns (Davis et al., 2016; Livingstone and Shepherd, 2016), especially given the non-domesticated nature of the target species (Tensen, 2016). In addition, these products may not only fail to mitigate impacts on wild populations but could stimulate demand for wild-sourced TMs (Nowell and Xu, 2007; Dutton et al., 2011; Tensen, 2016; Davis et al., 2019). As an alternative to farmed substitutes, providing sustainably sourced substitute TMs made with plant-based ingredients (e.g. Kikuchi, 2012) would obviate animal welfare problems and reduce the likelihood of the substitute igniting demand for wildlife.

The success of attempts to redirect demand onto substitutes depends on their acceptability to consumers. Evidence of the acceptability of farmed-animal alternatives suggests that Chinese consumers are increasingly willing to choose substitutes to protect endangered wildlife - especially for highly publicized endangered wildlife, such as tiger bone and bear bile (Liu et al., 2016). Attitudes of Vietnamese consumers are less studied, but recent work has shown that bear bile, for example, remains popular within Vietnam and that campaigns to reduce demand for it have been largely ineffective - due to a widespread belief, embedded by social networks, in its health benefits (Davis et al., 2019). These observations raise the possibility that a dual approach may be more effective than demand reduction campaigns alone. Information campaigns could raise awareness of the threats to endangered species, and simultaneously redirect consumers toward effective herbal substitutes. The two prongs of this approach could culminate in reduced negative impacts on individual animals and their wild populations. The potential effectiveness of such an approach, however, requires rigorous testing in both countries.

In this study, we present an experimental survey investigating the potential effectiveness of approaches to reduce the size of the trade. We use three representative, animal-based TMs: pangolin scales/wine, tiger and lion bone wine, and bear bile. We provide initial tests of the effectiveness of the following, non-exclusive approaches: 1) information campaigns aimed at *demand reduction* by highlighting impacts on species conservation, animals' welfare or human health on respondents' likelihood of purchasing wild-animal-derived TMs; 2) *redirecting demand* onto TMs made from substitute herbal ingredients; 3) information campaigns designed to promote the legitimacy, effectiveness or safety of herbal substitutes TMs among consumers.

Our study comprises an initial experimental survey of regular, occasional and non-buyers of TMs in China and Vietnam, to ascertain which if any, of the above approaches, and in what combinations, could reduce negative impacts on both individual animals and their wild populations.

2. Methods

2.1. Survey methodology

We created an experimental online survey to determine: a) whether demand reduction messaging (hereafter 'treatment messaging'; see Table 1) about the impacts of animal-original TM products would decrease respondents' likelihood of choosing similar products in the future, and whether particular types of messages may be more effective; b) how willing respondents would be to accept substitute, plant-origin TM products (hereafter 'herbal substitutes'); c) whether this willingness is increased by the provision or content of treatment messaging; d) whether positive messages accompanying herbal substitutes would increase their desirability, and; e) whether the attitudes of irregular or non-consumers are more flexible than those of regular consumers.

We surveyed 2000 respondents, comprising 1000 Chinese respondents in China and 1000 Vietnamese respondents in Vietnam. All questions were professionally translated into respondents' local language, and translations independently verified by native speakers. All respondents answered six initial questions about their sex, age,

Table 1
The experimental treatment messages accompanying tiger and lion bone wine, bear bile and pangolin scales and wine for respondents who select farmed and wild origin products, respectively. Respondents are then shown an appropriate herbal substitute accompanied by either neutral or positive messaging.

Product source	Treatment type	Product		
		Bear bile	Bone wine	Pangolin scales/wine
Farmed	Animal welfare	Farmed bears are kept in conditions that severely harm their welfare	Farmed [lions/tigers] are kept in conditions that severely harm their welfare	–
	Legality	It is illegal to own or buy any products made from farmed bears	It is illegal to trade, buy or own products made from lion bones	–
	Human health	Some bile from farmed bears may contain harmful ingredients	Some bone wines are not genuine, and may contain harmful ingredients	–
Wild	Species conservation	Hunting wild bears for their bile is a major conservation threat	Hunting [lions/tigers] for bones is a major threat to their conservation	Hunting pangolins for medicines is a major conservation threat
	Legality	It is illegal to own or buy any products made from wild bears	It is illegal to trade, buy or own products made from lion bones	It is illegal to trade, buy or own products made from pangolins
	Human health	Some wild bear bile is fake, and may contain harmful ingredients	Some bone wines are not genuine, and may contain harmful ingredients	Some pangolin [scales/wines] are not genuine, and may contain harmful ingredients
Herbal (substitute)	Control/neutral (usage)	Its uses include treating fevers, inflammation and conjunctivitis	Its uses include strengthening muscles and bones and treating arthritis	Uses include enhancing blood flow and improving kidney function
	Positive	This is proven to be safer and more effective than bear bile	This is proven to be safer and more effective than wines made from bones	This is proven to be safer and more effective than pangolin [scales/wine]

educational level, income and occupation. They were then asked how often they buy TM (options “I regularly buy traditional medicine”, “I occasionally buy traditional medicine” and “I don't buy traditional medicine”). They were asked how they get the medicines they use (options: “I buy for myself”, “Somebody buys it for me, but I pay”, “As a gift from others”) and, who they buy for (“Myself”, “Other family members”, “Other people”) and where they get most of their information about TM.

For the experimental survey, respondents were divided into treatment (n = 1600) and control (n = 400) groups, stratified equally between countries. The treatment group was larger than the control group to allow for experimental blocking to test for potential cumulative effects of repeated treatment messages (see below). All respondents were asked questions about three products - bone wine (either tiger or lion), bear bile, or pangolin wine or scales - in turn and in random order. Each product was available in different versions. Bone wine products were available as farmed lion, wild lion, farmed tiger, or wild tiger (Fig. 1a, b). Bear bile products were available as wild or farmed bear bile (Fig. 1f, h). Pangolin products were available as wine or scales (Fig. 1d, i). For each product all versions were shown to respondents, who were asked to select their preferred choice. Then (if more than two versions existed) they were asked for their second and third preferences. In each case the products' images mimicked the typical appearance of those products in China and Vietnam, as appropriate (see Fig. 1).

Following selection of respondents' preferred product version, treatment routes were split between treatment and control group members. Treatment group members were shown an image of their first-choice product version, accompanied by a random selection of one of three types of treatment messaging about it. These treatment messages detailed the impact of that product on species conservation/animal welfare (as appropriate), human health, or legal status (see Table 1). For each treatment message respondents were asked, “Based on the information you are given about [the product], how would it affect your behaviour”, and asked to respond by selecting from a five point Likert-type scale (“I would buy it a lot more often”, “I would buy it a bit more often” “It would make no difference”, “I would buy it less often” and “I would stop buying it”). They were then shown the remaining two types of treatment message in random order and each time asked to rate its effect. Control group members were shown their first-choice version without any treatment messages and were not asked any of the above questions.

All respondents, regardless of treatment route, were then shown a herbal substitute for their first-choice product (Fig. 1c, e, g, j) and asked to rate how likely they would be to buy it, on a five point Likert-type scale (“I would definitely buy it”, “I would be very likely to buy it”, “I am not sure”, “I would be very unlikely to buy it”, “I would definitely not buy it”). For control group members this question directly followed product version selection, whereas for treatment group members it followed respondents' repeated rating of the effects of different treatment messages.

For all respondents the image of the herbal substitute was accompanied either by neutral (control) information about its uses, or by positive information about its efficacy and safety (Table 1). For each respondent the above survey structure was repeated for each of the remaining two TM products, in keeping with respondents' designated treatment groups.

As a check of the efficacy of the messaging information, at the end of the survey we asked respondents “Which of these would you buy for yourself?”, and permitted them to select as many or few products as they desired to buy for themselves, for family, or as a gift, from a list comprising “tiger bone wine”, “lion bone wine”, “pangolin scales”, “pangolin wine” and “bear bile” or “none of these”. The total survey time was 5 min.

In summary, for all three TM products, treatment group respondents were shown the product accompanied by treatment messages, and rated their response to these, while control group respondents were shown

Fig. 1. The images of TMs and herbal substitutes presented to respondents. TM images are bone wines (a–b), pangolin wines (d, e), bear bile (f, h) and pangolin scales (i) and their respective herbal substitutes: bone wine (c), bear bile (g) and pangolin scales (j). Images were manipulated to represent the form of each TM that would be familiar to respondents from each country. For bone wines, the liquid was lighter in colour for Chinese respondents (a) and darker for Vietnamese respondents (b–c), with a representation of either lion (a), tiger (b) or herbal substitute (c) as appropriate. For bear bile, bottle shape differed between Chinese (h) and Vietnamese (f–g) respondents, and was labelled with a representation of a bear (f–h) or herbal substitute (g). Pangolin wines and scales did not vary between countries, and showed either an image of a pangolin (d, i) or herbal substitute (e, j) as appropriate. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

the product without messaging. All respondents were then shown a herbal substitute, accompanied by either neutral or positive messaging, and asked how likely they would be to purchase it. Finally, all respondents were shown a list of products and asked to select which they would buy for themselves, family and as a gift.

The survey was designed in collaboration with, and conducted by, a professional market-research company (Touchstone Partners Limited, http://www.touchstonepartners.co.uk) who coordinated respondent recruitment online through proprietary market research panels. Our sample size of 2000 respondents, half in each country, 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), and replacing these with additional respondents until the desired sample size was reached. Panellists were familiar with online surveys but not contacted so frequently as to have become unrepresentative of the wider population. All research was subject to ethical approval, reference R57894/RE001, Oxford University CUREC.

2.2. Statistical analyses

When analysing responses to treatment messaging, we excluded data from those who initially stated that they never buy TMs. This was because two of the response options ("I would stop buying it", and "I would buy it less often") would not apply, and the treatment messages were intended to alter the behaviour only of TM buyers. Products (bone wine, bear bile, pangolin) were shown in random order. The analysis therefore needed to account for the fact that for the first product

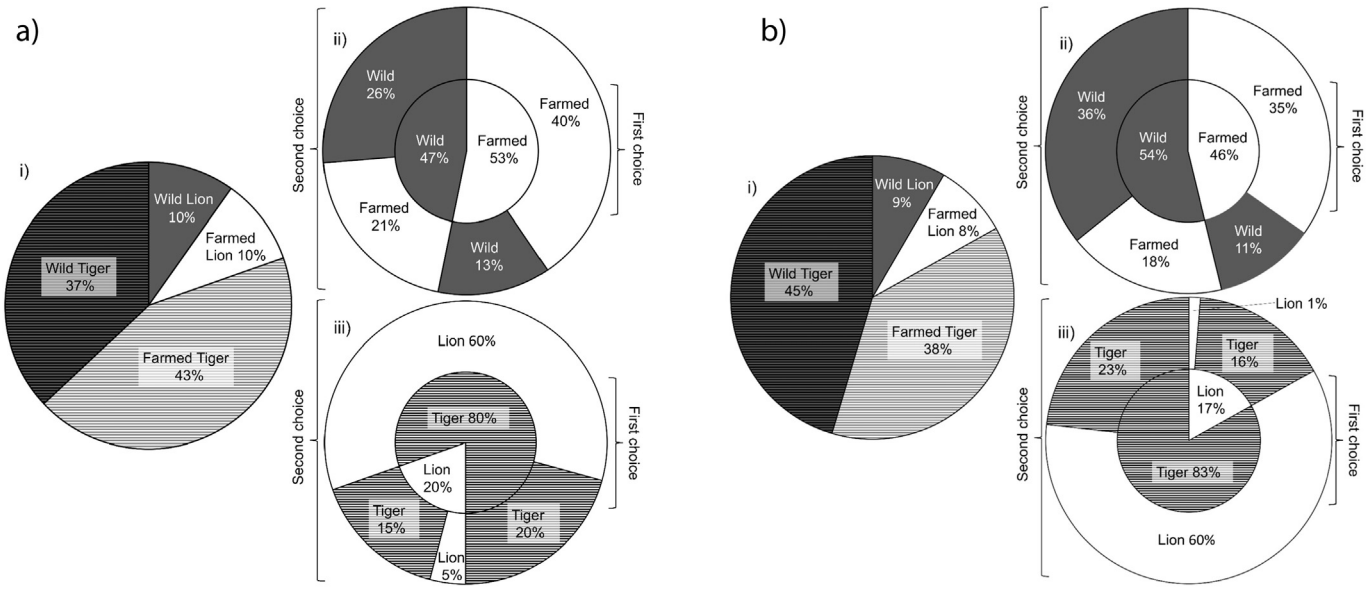

Fig. 2. Respondents' first choice of bone wine product, for:
a) Chinese respondents (n = 1000), showing: i) the percentage of respondents' first selections that were of lion and tiger from wild and farmed sources; ii) the same data, limited to wild versus farmed for respondents' first (inner ring) and second (outer ring) choices; iii) the same data limited to lion versus tiger for respondents' first and second choices.
b) Vietnamese respondents (n = 1000), categories as above.

respondents would have no experience of the treatment messages, whereas messages for subsequent products would be familiar. Within each product, we also accounted for the order in which message treatments (conservation, welfare, personal harm) were shown, because repeated treatment messages could, *a priori*, have a cumulative effect on respondents' attitudes. To achieve this we analysed each message within each product separately (i.e. separate analyses of the effect of the first, second and third messages shown to respondents for, for example, bone wine). We therefore conducted nine separate ordinal logistic regression analyses (implemented in Program R; Christensen, 2015; Christensen and Christensen, 2015). The response variables were respondents' self-selected probability of changing their frequency of buying the product (a five point Likert-type scale from "I would stop buying it" to "I would buy it a lot more often"). Available explanatory variables were respondents' age, sex, income index (on a 1–7 scale), nationality, purchase frequency (occasional or frequent buyers), the nature of the message (three levels: conservation, personal harm, animal welfare), and whether the product was the first, second or third that the respondents had rated. Additional factors for bone wines were whether it was tiger or lion, wild or farmed. For bear bile, we included whether the origin was wild or farmed. For pangolins, we included whether the respondents favoured scales or wine.

We wished to test whether treatment messaging about products influenced respondents' future intention to buy TM (in response to the question "Which of these would you buy for yourself?"). We excluded respondents who initially stated that they do not buy TM, and so analysed data only from occasional and regular buyers. We conducted separate ordinal logistic regression analyses for each response (self, family or gift), with a binary response variable (whether respondents selected at least one product, versus no products). Available explanatory variables were whether the respondent had seen treatment messaging about TM products in previous questions (n = 1600) or was a control respondent (n = 400), as well as their sex, age, income, nationality and frequency of purchase of TM. We included interaction terms to determine whether treatment messaging had different effects on respondents of different nationalities, or on respondents who purchased more regularly.

We wished to test whether treatment messaging about each TM product made respondents more likely to buy an herbal substitute, and also whether positive messaging accompanying the herbal substitute would be effective at promoting desire to buy it (Table 1). We conducted a repeated measures ordinal logistic regression, for which the response variable was respondents' self-selected desire to buy the herbal substitute for each product shown. Available explanatory variables were whether the respondent was in the treatment or control groups, whether they were shown positive or neutral messaging for the herbal substitute (Table 1), their sex, age, income, nationality and TM purchase frequency, the product in question and whether the product was the first, second or third they had been shown.

3. Results

3.1. Overview

We secured responses from 1000 Chinese and 1000 Vietnamese respondents. The majority categorised themselves as occasional TM buyers (60.2% of Chinese respondents and 70.6% of Vietnamese respondents). Regular buyers comprised 28.4% and 14.8% and non-buyers 11.4% and 14.6% of Chinese and Vietnamese respondents, respectively. Among Chinese respondents, stated frequency of buying TMs varied with respondents' age: among respondents over 35 years of age (n = 500) 22.2% self-identified as frequent buyers, while among those aged 18–34 (n = 500) 35.4% identified as frequent buyers, comprising 53.0% of 18–24 year olds (n = 117) and 30.2% of 25–34 year olds (n = 383). Chinese 18–24 year olds indicated higher likelihoods of purchasing for other family members (59.0% compared with a mean of 50.6% across older age categories) and of making purchases for other, non-related people (22.9%, compared with a mean of 3.3% across older age categories). Among Vietnamese respondents, the percentage of frequent buyers in any age group was within 2% of the overall mean (14.8%) for this country. Among Chinese respondents, therefore, there was a clear trend for the youngest consumers to state that they were frequent buyers of TM, but also for a larger proportion of their purchases to be made for people other than themselves.

3.2. Respondents' product preferences

Respondents picking their first choices of bone wine type (wild versus farmed, tiger versus lion) demonstrated a preference for tiger products, with approximately 80% of all respondents choosing these: 43% of Chinese and 38% of Vietnamese respondents chose farmed tiger, and 37% and 45%, respectively, chose wild tiger, with only 18.2% of respondents overall choosing lion products (Fig. 2a, b). Approximately equal percentages of respondents from both countries selected bone wine from farmed and wild animals as their first choice: 53.2% of Chinese respondents selected farmed bone wine, and 46.2% of Vietnamese respondents (Fig. 2a, b).

With respect to their second choices, 76.1% and 75.3% of Chinese and Vietnamese respondents who chose farmed wine as their first choice, also picked farmed wine as their second, requiring them to switch the species (from tiger to lion or vice versa) (Fig. 2a, b). Of those who selected wild origin bone wine as their first choice, 43.8% and 33.5% (Chinese and Vietnamese respondents, respectively) selected wild origin wine of the other species as their second (Fig. 2a, b). Broadly, therefore, 40% of respondents appeared to make their first choice based on a preference for farmed-origin wine, and changed species accommodate this preference in their second choice; and approximately 20% selected based on a preference for either tiger or lion, and changed origin (farmed versus wild) to accommodate their species preference; Fig. 2a, b.

Preference for wild (rather than farmed) bone wine increased slightly with respondents' frequency of TM purchase: 50.0% of non-buyers and 48.3% of occasional buyers preferred wild bone wine, whereas 58.6% of frequent buyers preferred wild bone wine (binary logistic regression, effect of purchase frequency, $z = 2.61$, $p = 0.009$). There was no evidence that this relationship varied with respondent's nationality in a separate model in which this interaction was entered (effect of country*purchase frequency, $z = 0.19$, $p = 0.847$). Preference for lion over tiger bone wine was higher among frequent buyers (29.6%) than occasional (15.2%) and non-buyers (14.6%) (binary logistic regression, effect of purchase frequency, $z = -5.21$, $p < 0.001$). There was no evidence that this relationship varied with respondents' nationality in a separate model in which this interaction was modelled (effect of nationality*purchase frequency, $z = 1.36$, $p = 0.174$).

Overall, respondents slightly preferred farmed to wild bear bile (47.9% of respondents selected wild-sourced bile as their first option), but this varied between countries such that 43.4% of Chinese and 52.4% of Vietnamese respondents preferred wild-sourced bile (binary logistic regression, effect of country $z = 4.55$, $p < 0.001$). Regular buyers were more likely to prefer wild to farmed bear bile (50.2%) than were non-buyers (46.5%) or occasional buyers (47.4%). There was no evidence that this relationship varied with respondent's nationality in a separate model in which this interaction was modelled (effect of country*purchase frequency, $z = 0.83$, $p = 0.408$).

With respect to pangolin products, 62.5% of respondents preferred pangolin wine to pangolin scales, and this did not vary with nationality (62.8% of Chinese respondents versus 62.1% of Vietnamese respondents). There was little evidence that preference for wine over scales varied between non-buyers and frequent buyers, with group mean percentages for each buyer class falling within 2% of the overall mean.

3.3. Effect of treatment messaging on respondents' self-stated likelihood of purchase

Excluding respondents who self-identified non-buyers, in response to treatment messaging a mean of 81.7% of respondents across all products said they would either stop buying TM or buy it a lot less often (82.2% for bone wine messaging, 82.2% for bear bile messaging, and 80.6% for pangolin messaging; Fig. 3). Of these, a mean of 62.7% of respondents said they would stop buying altogether. Only an overall mean of 10.2% said that they would buy these products either "more often" or "a lot more often" (9.7%, 10.2% and 11.0% for bone wine, bear bile and pangolin, respectively, Fig. 3).

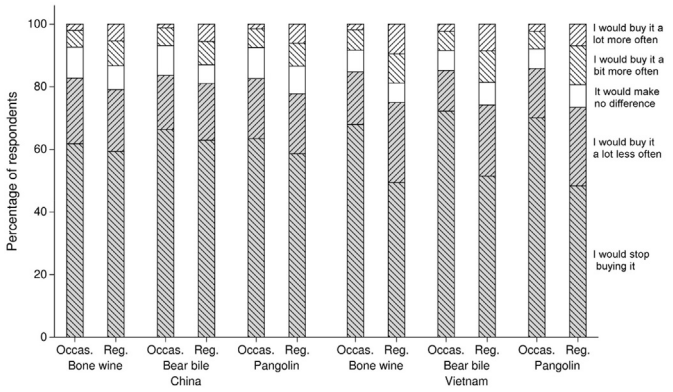

Fig. 3. Treatment respondents' stated likely reduction in buying a given TM product. Bottom to top, hashed, shaded sections represent "I would stop buying it" and "I would buy it a lot less often", unhashed sections represent "It would make no difference", and hashed, unshaded sections represent "I would buy it a bit more often" and "I would buy it a lot more often". Occasional and regular Chinese buyers, n = 488 and n = 223 respectively for each product. Occasional and regular Vietnamese buyers, n = 555 and n = 129.

There was no consistent evidence that any one type of message was more effective at lowering respondents' desire for any product. The effect of message type (conservation, welfare, human harm) was non-significant in six of nine analyses (see Table 2a–c), and the effect size of message type was small. The maximum difference in percentage of respondents selecting any category of response varied from 2.4% to 5.6% across all analyses of bone wine messages, 0.9% to 4.8% for bear bile messages, and 2.4% to 3.3% for pangolin messages.

For all TM products, the effectiveness of messages increased with respondents' exposure to previous treatment messaging within the study. The percentage of respondents stating they would stop buying a given product, or buy it much less often, in response to the first message they saw about it, was positively correlated with whether it was the first, second or third product shown (Table 2a–c, effect of product order on the first message for each TM product). For bone wine messages, the proportion of respondents stating they would buy less often or stop buying increased from 72.7% (first product) to 85.1% (third product). The effect sizes for bear bile (76.9% first product to 81.3% third product) and pangolin (78.3% first product to 82.2% third product) were smaller.

The size of the effect of messaging was not influenced by respondents' nationality or income in any analysis (Table 2a–c). Female respondents were marginally more affected than male respondents by treatment messaging (Table 2a–c), but the mean difference in male and female percentages choosing to "stop buying" or "buy less often" was 2.4% across all products.

Respondents who self-identified as occasional TM purchasers selected higher likelihoods of reducing their consumption than did frequent purchasers (Fig. 3). Across all three products, a mean of 84.2% of occasional purchasers said they would decrease or stop consumption, compared with 77.4% of frequent purchasers (an overall mean difference of 6.8%, comprising means of 8.1%, 6.2% and 6.0% for bone wine, bear bile and pangolin, individually).

Respondents who preferred wild to farmed bone wine and bear bile were less affected by treatment messaging (Table 2a–c): a mean of 85.6% of respondents who preferred farmed bone wine and bear bile said they would stop buying or buy much less often, compared with a mean of 78.6% of respondents who preferred wild bone wine and bear bile.

Table 2
Likelihood ratio tests of factors affecting respondents' stated likelihood of a given treatment message altering their frequency of purchasing each product; for a) bone wine, b) bear bile and c) pangolin products. Statistics quoted to three significant figures.

Source	df	First message		Second message		Third message	
		LRT	p	LRT	p	LRT	p
a)							
Age	1	2.75	0.097	6.56	0.012	3.004	0.0830
Sex	1	13.4	< 0.001	15.2	< 0.001	15.6	< 0.001
Income index	1	2.47	0.116	1.46	0.227	1.12	0.286
Country	1	0.130	0.719	0.00260	0.960	3.35	0.0670
Purchase frequency	1	13.8	< 0.001	16.1	< 0.001	21.8	< 0.001
Wild or farmed	1	14.08	< 0.001	15.8	< 0.001	19.4	< 0.001
Tiger or lion	1	0.856	0.355	4.35	0.0370	3.75	0.0529
Message	2	11.9	0.0026	1.92	0.383	3.45	0.178
Product order	1	17.3	< 0.001	6.02	0.0141	6.80	0.00913
b)							
Age	1	4.39	0.0361	5.23	0.0223	6.78	0.00920
Sex	1	21.2	< 0.001	12.9	< 0.001	12.72	< 0.001
Income index	1	5.18	0.0229	2.10	0.147	1.05	0.306
Country	1	0.0826	0.774	0.00110	0.973	2.64	0.104
Purchase frequency	1	13.5	< 0.001	18.6	< 0.001	10.5	0.00118
Wild or farmed	1	10.2	0.00140	17.7	< 0.001	21.0	< 0.001
Message	2	5.59	0.0611	2.68	0.261	12.7	0.00176
Product order	1	5.52	0.0188	1.16	0.282	0.0188	0.891
c)							
Age	1	5.25	0.0220	9.08	0.00258	4.47	0.0345
Sex	1	12.2	< 0.001	8.06	0.00453	11.7	< 0.001
Income index	1	5.50	0.0190	0.456	0.499	0.444	0.505
Country	1	1.54	0.214	0.474	0.491	0.855	0.355
Purchase frequency	1	13.2	< 0.001	21.0	< 0.001	17.2	< 0.001
Wine or scales	1	2.67	0.102	8.48	0.00359	4.76	0.0293
Message	2	0.625	0.732	2.78	0.249	10.0	0.00671
Product order	1	7.06	0.00788	0.145	0.703	0.299	0.585

3.4. Effect of treatment messaging on future plans to buy TM for self or as a gift

Answering the question "Which of these would you buy for yourself" - excluding non-buyers - 62.0% of control respondents (n = 395) selected at least one product, compared with 52.2% of treatment respondents (n = 1395), a 9.8% difference (Fig. 4). A higher proportion of frequent than occasional buyers selected at least one product (a mean of 76.4% versus 46.8%, effect of buying frequency, LRT 130.53, d.f. = 1, p < 0.001; Table 3). The effect of treatment messaging appeared to be larger on occasional than regular buyers: for occasional buyers 11.3% fewer (44.6% versus 55.8%) treatment than control respondents selected at least one product, while for regular buyers the difference was 7.5% (75.0% versus 82.5%). This difference, however, was not statistically significant (effect of buying frequency*treatment, d.f. = 1, LRT = 0.3345 P > 0.56).

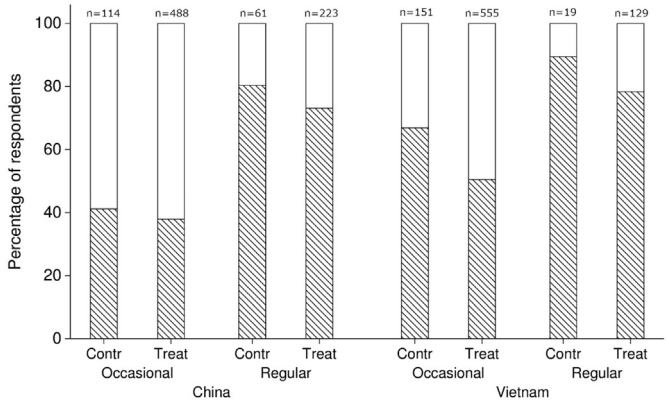

Fig. 4. The proportion of control and treatment respondents selecting at least one product to buy (hashed sections) versus no products (unhashed sections), in response to the question "Which of these would you buy for yourself?".

Table 3
Likelihood ratio tests of factors affecting respondents' likelihood of selecting at least one TM product to purchase for themselves. Statistics quoted to three significant figures.

Source	df	LRT	P
Age	1	6.96	0.00833
Sex	1	12.7	< 0.001
Income index	1	9.02	0.00267
Purchase frequency	1	131	< 0.001
Country*treatment messaging	1	3.96	0.0466
Purchase frequency*treatment messaging	1	0.000700	> 0.978

The treatment effect was greater on Vietnamese respondents: a 13.7%, compared to a 5.0% (for Chinese respondents) treatment difference (effect of treatment*nationality, LRT = 3.958 d.f. = 1, p = 0.0466; Fig. 4) in a separate model in which this term was included. Older respondents were less likely to select products (39.6% of respondents in their twenties selected no products, versus 50.0% of respondents over 50; LRT effect of age 6.9615, d.f. = 1, p = 0.008), and respondents on higher income were more likely to (56.2% of respondents in the bottom half of the income brackets versus 43.73% in the highest brackets selected no products; LRT effect of income 9.0202, d.f. = 1, P = 0.003; Table 3). Men were more likely to buy than women (43.8% versus 47.8% selected no products, respectively; LRT effect of sex = 12.701 d.f. = 1, p < 0.001; Table 3).

In response to the question "Which of these would you buy for your family?", 68.9% of control respondents selected at least one product (6.9% more than who would buy for their own consumption, c.f. above), versus 57.3% of treatment respondents (LRT effect of treatment = 19.919, d.f. = 1, p < 0.001, in an analysis also containing respondents' age, sex, nationality, income and purchase frequency). There was no evidence for an interaction between the effect of messaging and country (effect of treatment*nationality, LRT = 2.460, d.f. = 1, p = 0.117). In response to the question "Which of these would you buy as a gift?", 61.2% of control respondents selected at least one product, compared with 49.2% of treatment respondents (LRT effect of treatment = 19.774, d.f. =1, p < 0.001 in a model also containing respondents' age, sex, nationality, income and purchase frequency. As with purchases for the family, there was no evidence for an interaction between the effect of messaging and country (effect of treatment*nationality, LRT = 0.815, d.f. = 1, p = 0.36).

In summary, compared with control respondents, 9.8% fewer treatment respondents selected at least one type of TM to buy for themselves, 11.6% fewer selected at least one TM to buy for family and 12.0% fewer selected at least on TM to buy as a gift.

3.5. Desire to buy herbal substitutes

An overall mean of 81.2% of occasional and regular TM buyers indicated that they would definitely buy, or be very likely to buy, a herbal substitute instead of each product (bone wine, pangolin scales or wine, bear bile; Fig. 5). Overall 11.6% selected "I am not sure", and 7.2% "be very unlikely to buy" or "definitely would not buy"; Fig. 5). Responses were not affected by whether respondents were from control or treatment groups (i.e. had seen treatment messaging about the original product; LRT effect of treatment = 0.104, P > 0.74), nor by whether accompanying messaging about the herbal product was neutral or positive (LRT effect of treatment < 0.001, P > 0.99). Desire to buy

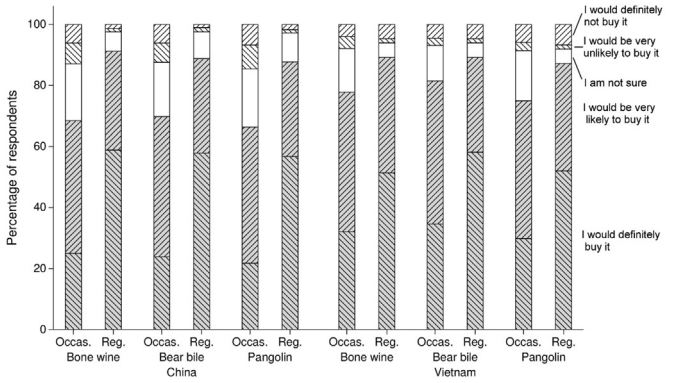

Fig. 5. Likelihood of purchase of herbal substitute products among occasional and regular Chinese and Vietnamese buyers of TMs. From bottom to top, hashed, shaded sections represent "I would definitely buy it" and "I would be very likely to buy it", unhashed sections represent "I am not sure" and hashed, unshaded sections represent "I would be very unlikely to buy it" and "I would definitely not buy it". Occasional and regular Chinese buyers, n = 488 and n = 223 respectively for each product. Occasional and regular Vietnamese buyers, n = 555 and n = 129.

a herbal substitute varied markedly between regular and occasional buyers (Fig. 5): 88.9% of regular TM buyers gave a positive response and 4.0% a negative response, versus 73.5% and 10.4%, respectively, for occasional buyers (effect of TM buying frequency, LRT = 14.256, $p < 0.001$; Table 4a; Fig. 5). By comparison, for non-buyers (which we excluded from analysis) these figures were 48.6% and 26.7%. Respondents' willingness to buy varied slightly between products, with responses to substitutes for bear bile (75.6% positive, 10.2% negative) more positive than for pangolin (71.4% positive, 12.1% negative) or bone wine (73.6 positive, 11.1% negative; LRT effect of product = 37.433, $p < 0.001$; Table 4a).

Willingness to buy a substitute was higher among younger respondents (e.g. for respondents under 30, 77.5% positive, 8.7% negative; for respondents over 60, 69.7% positive, 18.7% negative; Table 4a) and respondents with a greater income (top three income classes, 78.3% positive 8.9% negative; bottom three classes, 61.7% positive, 17.7% negative) and for Vietnamese than Chinese respondents (75.8% positive, 9.8 negative, versus 71.4% positive 12.4% negative; Table 4a). There was no significant effect of respondents' sex or the order in which respondents were shown products (Table 4a).

There was no evidence that the form or source of any product had any significant effect on respondents' desire to buy a herbal substitute: whether respondents selected bone wine from lion or tiger or farmed or wild sourced, or bear bile from wild or farmed bears, or pangolin wine or scales had no significant effect on likelihood of buying herbal substitute for the product (Table 4b–d). In each case, as above, desire to buy a herbal substitute correlated with respondents' age, income and TM purchase frequency (Table 4b–d), but respondents' nationality affected purchase desire only for bear bile products.

In summary, among all respondents, irrespective of messaging, a large majority (81.2%) indicated that they would be very likely to, or would definitely, buy herbal substitutes for TM containing animal parts, and this majority was higher (88.9%) among regular buyers.

4. Discussion

We tested the effectiveness of attempts to *reduce* demand for TMs through providing information about their detrimental impacts, and of attempting to *redirect* demand through providing substitute products. These approaches are, respectively, analogous to targeting respondents' beliefs and targeting the existing barriers to sustainable consumption in the beliefs, barriers, context model presented by Hauser et al. (2018). Treatment messaging, which targeted respondents' beliefs about the social desirability of purchasing TMs, led to a disparity between what respondents stated they would do, and their choices when later asked which TMs they would still buy. Excluding non-buyers, 62.0% of treatment respondents stated that the messaging would make them stop buying TMs, but when later asked which TM products they would buy, 52.2% still selected at least one product. Treatment messaging had a limited effect, insofar as the percentage of treatment respondents selecting at least one TM was 9.8% lower than of control respondents. This effect size was, however, smaller than respondents originally indicated. A further issue is that frequent buyers had a smaller response to treatment messaging than did occasional buyers (56.4% versus 67.1%, respectively, said they would stop buying), and exhibited a larger gap between their stated response and later selections of products to buy: 23.6% versus 53.1% selected no products, differences of 32.8% and 14.0%, respectively from their stated response.

Our demand reduction messaging had limited effectiveness, especially on frequent purchasers. We speculate that the messaging may have contradicted a number of our respondents' cultural and personal beliefs about the social desirability and effectiveness of TMs. If frequent purchasers held such beliefs more strongly this would explain why they

Table 4
Likelihood ratio tests of respondents' stated desire to purchase a herbal substitute for each TM product in a) repeated measures analysis of all TM products, b) analysis only of responses to bone wine TMs, c) analysis only of bear bile TMs and d) analysis only of pangolin TMs. Statistics quoted to three significant figures.

Source	df	LRT	P
a)			
Age	1	17.4	< 0.001
Sex	1	0.138	0.711
Country	1	4.20	0.0400
Income	1	24.0	< 0.001
Treatment messaging	1	0.104	0.747
Purchase frequency	1	212	< 0.001
Herbal messaging	1	0.00102	> 0.992
Product	2	37.4	< 0.001
Product order	1	0.178	0.673
b)			
Age	1	13.6	< 0.001
Sex	1	0.201	0.655
Country	1	2.02	0.155
Treatment messaging	1	0.579	0.447
Income	1	20.8	< 0.001
Purchase frequency	1	188	< 0.001
Wild or farmed	1	1.26	0.262
Tiger or Lion	1	1.39	0.239
Herbal messaging	1	0.00301	0.954
Product order	1	1.07	0.300
c)			
Age	1	11.8	< 0.001
Sex	1	1.56	0.211
Country	1	13.2	< 0.001
Treatment messaging	1	1.68	0.195
Income	1	24.3	< 0.001
Purchase frequency	1	178	< 0.001
Wild or farmed	1	2.11	0.146
Herbal messaging	1	3.07	0.0798
Product order	1	7.47	0.00627
d)			
Age	1	15.3	< 0.001
Sex	1	0.638	0.424
Country	1	3.11	0.0778
Treatment messaging	1	0.300	0.584
Income	1	21.2	< 0.001
Purchase frequency	1	176	< 0.001
Wine or scales	1	0.00803	0.928
Herbal messaging	1	0.0490	0.825
Product order	1	6.29	0.0121

exhibited the least change in both their stated response to the messaging and in their subsequent purchase decisions.

By contrast our results revealed a substantial desire among respondents for herbal substitutes to TMs, particularly among frequent purchasers: 88.9% of regular buyers said they would definitely or be very likely to buy it, compared with 73.5% of occasional purchasers. This desire was not affected by experimental treatment group, or any additional messaging about the herbal substitute. A plausible explanation for respondents' stated desire for herbal substitutes is that such substitutes do not challenge beliefs surrounding TMs' cultural function or desirability, and do not require consumers to stop buying TMs. Instead, providing substitutes could tackle a substantial barrier to reducing the impact of TMs on animal conservation and welfare, by providing plant-based TMs that have cultural credibility (i.e. that are recognised as desirable by consumers).

Our study demonstrates the potential for social marketing campaigns to redirect demand for animal-derived TMs onto herbal substitutes, rather than attempting to reduce demand through messaging. This conclusion, however, has a number of caveats. First, this study was intended to be an initial test of approaches, online, to discern which were likely to be successful. The results are conservative in the sense that if approaches do not work online, in the abstract, they are also unlikely to work in reality. Our study was intended to provide a good basis for initially excluding some approaches and revealing the most promising candidates. It remains possible that our respondents could exhibit a gap between their stated intention to purchase herbal substitutes and their actions in real life when provided with a choice of TMs from different origins. We cannot exclude this possibility, especially in the light of a number of examples, particularly from China, highlighting the difficulty of replacing wild animal medicinal ingredients with alternatives.

Dutton et al. (2011) found that the Chinese public's willingness to pay for wild bear bile was higher than for farmed alternatives. A widespread belief exists in China that farming of wildlife for TM ingredients is better for conservation. A recent survey found that 63% of Chinese respondents said that tigers should be farmed in China, with the main reason being that farming was important for "the continuation of the populations and reintroduction to the wild" (Liu et al., 2015). Dutton et al.'s (2011) finding could be interpreted as wild bear bile being more desired by consumers despite their belief that farmed bear bile would provide benefits for conservation. Since their study was conducted (in 2008), however, awareness of conservation issues has grown, particularly in China. A survey by Zhang and Yin (2014) showed that between 2004 and 2012 the proportion of respondents in Beijing who were in favour of protecting wildlife increased from 48.6% to 88.3%, while the percentage willing to permit conditional utilisation of wildlife decreased from 42.6% to 13.7%, although other cities demonstrated less substantial shifts in opinion (but see below).

Our findings did not indicate a marked preference for wild versus farmed ingredients among respondents. The percentage of regular buyers opting for wild-sourced ingredients was 58.5% for bone wine and 50.2% for bear bile, and for occasional buyers these figures were 48.3% and 47.4%. Similarly three quarters of respondents who chose farmed bone wine preferred to change the species of the wine (tiger to lion or vice versa) than the source (wild or farmed). Taken together these observations may indicate that a growing public awareness of conservation issues in China could be creating a social norm among TM consumers, that they should choose TMs made with substitute ingredients to reduce their impact on wildlife. While such consumers may be misinformed about the conservation benefits of farmed substitutes (Nowell and Xu, 2007; Tensen, 2016) or unaware of the animal welfare consequences, they do appear willing to change their consumption choices. This accords with the findings of Liu et al. (2016), who concluded that TM consumers balance their preference for wild sourced medicines against the need to choose substitutes to protect endangered wildlife - especially for highly publicized endangered wildlife, such as tiger bone and bear bile.

Our survey was conducted online and so our respondents represented a demographic that had access to, and were familiar with, the internet. While the study of Zhang and Yin (2014) demonstrated a substantial shift in opinion in favour of conservation in Beijing and Shanghai, a number of other cities showed a far smaller increase (e.g. the proportion of respondents in favour of protecting wildlife increased only from 22.7% to 30.2% in Guangzhou). It is possible, therefore, that attitudes among different urban and rural demographics may depart from those in our study. A possible counter-argument, however, is that the above increase in support for conservation witnessed in Beijing and Shanghai may have stemmed from successful and continuous public awareness education campaigns led by various governmental agencies and civil society during the Beijing Olympics in 2008 and the Shanghai World Expo in 2010 (Zhang and Yin, 2014). Taken together these factors suggest that our conclusions may be less likely to apply in rural areas, but that raising public awareness of conservation could propagate the circumstances under which the public would be more willing to accept substitute products.

Few comparable studies are available on Vietnamese demographic groups. A recent study of bear bile use, however, indicated that urban Vietnamese consumers were moving away from farmed bear bile but not from consumption altogether. The authors concluded that farmed bear bile had established this TM as a common household medicine and so drove demand for wild-origin bile, which was considered to be more effective (Davis et al., 2019). In our study the similarity of response of Vietnamese and Chinese respondents gives hope that our conclusions are likely to be applicable in urban centres of China and Vietnam. Davis et al.'s (2019) findings, however, raise the important caveat that any herbal substitutes would have to be selected to avoid inadvertently stimulating fresh markets for the original, animal-origin product (and should also avoid using endangered plant species). Such effects could potentially be mitigated by ensuring that any herbal alternative is effective, and that the public widely believe it to be so.

For TMs from substitute herbal ingredients to be desired or accepted by consumers they must work within the same symbolic context as the original (e.g. Ferreira et al., 2016), and so be recognised as legitimate components of medicinal and health product traditions in both China and Vietnam. There is hope that this can be achieved. Much of traditional Chinese medicine has historically relied on herbs and other plants (Kikuchi, 2012), and herbal alternatives to many animal-origin TMs already exist. As an example Kikuchi (2012) lists *Coptis* spp. as a potential alternative to bear bile. To achieve reformulations of TM products that would be acceptable to consumers, however, will certainly require the active participation of TM professionals (e.g. Cheung et al., 2018), scrutiny to avoid directing trade onto plant species that are a conservation concern, and thorough field testing prior to their being used as the basis for any social marketing initiative.

5. Conclusions

In conclusion, our study comprised an initial test of whether demand reduction messaging alone could be sufficient to significantly lower demand for animal origin TMs. Our results indicate this it is unlikely to be sufficient, particularly among core consumers, given the negative correlation between our respondents' stated real-life TM purchase frequency and their reaction to such messaging. Conversely, respondents' enthusiasm for herbal substitutes, which was greatest among regular purchasers, argues for social marketing approaches to strongly invest in the possibilities of working with TM practitioners to redirect demand onto alternative, non-animal TM ingredients. Our findings provide an empirical basis to argue for real-world trials of such an approach.

CRediT authorship contribution statement

Tom P. Moorhouse:Conceptualization, Methodology, Formal analysis, Writing - original draft, Writing - review & editing, Funding acquisition.**Peter Coals**:Conceptualization, Methodology, Formal analysis.**Neil C. D'Cruze**:Conceptualization, Methodology, Writing - review & editing, Funding acquisition.**David W. Macdonald**:Conceptualization, Writing - review & editing, Supervision, Funding acquisition.

Declaration of competing interest

The authors declare no conflict of interest. The study was conducted in receipt of a grant from World Animal Protection, but on the condition that source of the funding would have no bearing on the conduct of the researchers, the design of the study, nor on the analysis or interpretation of the resultant data.

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