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Consumption of Domestic Cat in Madagascar: Frequency, Purpose, and Health Implications

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ABSTRACT The domestic cat *Felis catus* has a long history of interaction with humans, and is found throughout the world as a household pet and a feral animal. Despite people's often sentimental association with cats, cat meat is sometimes consumed by them; this practice can have important implications for public health. In Madagascar, a least developed country that has experienced recent political instability, cat consumption is known to occur, but remains poorly understood. To improve our understanding of cat consumption practices in Madagascar we interviewed 512 respondents in five towns. We used semi-structured interviews to: 1) clarify the preference for, and prevalence, correlates, and timing of, cat consumption; 2) describe methods used to procure cats for consumption; 3) identify motives for consuming cat meat; and, 4) evaluate to what extent patterns of cat-meat consumption are influenced by taboos. We found that, although cat was not a preferred source of meat, many (34%) Malagasy respondents had consumed cat meat before, with most (54%) of these indicating such consumption occurred in the last decade. We did not detect a link between consumption of cat meat and recent access to meat (a proxy for food security). Cat meat was almost never purchased, but rather was obtained when the owners consumed their own pet cat, as a gift, or by hunting feral cats. Cat meat was usually consumed in smaller towns following cat–human conflict such as attacks on chickens, but in the large capital city, cat meat was procured primarily from road-killed individuals. These results suggest cat-meat consumption is typically an opportunistic means to obtain inexpensive meat, rather than principally serving as a response to economic hardship. These results further suggest cat handling and consumption may present a potential pathway for transmission of several diseases, including toxoplasmosis, that may warrant heightened public health efforts.

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Humans and cats have a long history of interaction, with the first evidence of human–cat coexistence appearing approximately 8,000 years ago at a Neolithic site on the isle of Cyprus (Tennent et al. 2010). It is thought that the wildcat, *Felis silvestris*, may have initially been domesticated by humans to limit rodent population growth as agricultural settlements developed (Faure and Kitchener 2009). Domestic cats, *Felis catus*, were further spread by the Romans (Daniels et al. 1998). There are reports of early domestic cats being worshipped and treated as minor deities by ancient Egyptians, affiliated with devilry by middle-aged civilizations, and being used as a status and fashion symbol for wealthy 18th-century Europeans (Tennent et al. 2010). In many areas of the world today, domestic cats (hereafter referred to as cats) are kept for companionship and pest control (Menotti-Raymond et al. 2003). The wide geographic spread of the cat as a household pet (hereafter, pet cats; i.e., cats that associate closely with humans) has given rise to feral cats, which may reproduce in the wild, do not rely or rely only to a limited extent on humans for food and shelter, often cannot be safely handled by humans, and are often derived from lost and abandoned pet cats (Robertson 2008). Despite differences in behavior and appearance, pet cats and feral cats are one species; both interbreed (Daniels et al. 1998) and are considered types of domestic cat (Levy and Crawford 2004).

Despite their often sentimental associations with humans (Medina 2007), cats are consumed (Schwabe 1996) for different reasons throughout the world and it is likely that millions of pet and feral cats are consumed globally per year; one report estimated that 4 million cats are consumed annually in Asia alone (Bartlett and Clifton 2003). In Cameroon, cat meat is consumed because it is believed that it will bring good luck (Ngwa-Niba 2003), while cats are raised and eaten for cultural reasons by farmers in Switzerland (Hall 2013). Cats may also be a preferred food for individuals who have the economic flexibility to choose their protein sources, as wealthy individuals in China have also reported consuming cat meat (Yiu 2012). In addition to this, the consumption of cat meat has occasionally been linked to food insecurity, with one researcher describing it as a "famine food" (Medina 2007). For instance, French soldiers reported consuming cat during the Second World War (Medina 2007), Peruvians host an annual festival to honor their ancestors who were forced to consume cat meat for sustenance (Golgoswki 2011), and Italians have also resorted to consuming cat when other meats were not available (Clancy 2010). Finally, although cat meat has been consumed historically—a recipe for cat can be found in one of the oldest cook books known in Europe from the 15th century—the sociocultural norms surrounding its consumption may be changing given that the status of animals as "edible" or "inedible" changes in time and space (Medina 2007). For example, as cats are increasingly viewed as pets, they may not be viewed as suitable for consumption (Medina 2007). Therefore, it is likely that cat-meat consumption differs based on social norms, economic circumstances, and personal preferences.

Cat consumption practices may have important public health consequences. It might have a positive effect on health if it provides protein, iron, or other vital nutrients to human populations that otherwise lack sufficient nutrient-rich food. However, the consumption of cat meat may also provide a means of disease transmission. Although cat meat does not ordinarily pose a health threat if prepared appropriately (Sukthana 2006; Golgoswki 2011), consumption of undercooked cat meat may lead to infections in humans, as is the case for other undercooked meats (Sukthana 2006). For example, cat and other meat left unrefrigerated could

encourage growth of the bacterium *Clostridium botulinum,* which produces the potentially lethal botulinum toxin (Galey et al. 2000).

Further, the capture and handling of cats and cat carcasses prior to consumption could also result in disease transmission. For example, cats are hosts for ticks (particularly the species *Haemaphysalis elliptica*), which are vectors of diseases (Horak, Heyne and Donking 2010) such as the spirochaete *Borrelia crocidurae*, which causes relapsing fever (Vial et al. 2006). The prevalence of tick-borne relapsing fever within African countries has been as high as 7.5% in pregnant women and 5% in children under 5 years old, with mortality rates reaching 38% of infected infants (McCall et al. 2007). Avian influenza is another feline-borne disease that has been lethal to humans and can be transmitted via indirect contact (Thiry et al. 2007). Finally, cats function as one of the primary hosts of the parasitic protozoan *Toxoplasma gondii*, which causes toxoplasmosis and can be fatal to humans with weakened immune systems or result in serious deformities such as blindness and neurological damage among infants (Tenter, Heckeroth and Weiss 2000). *Toxoplasma gondii* antibodies are present in 74% of adult cats and the disease is transmitted to humans through contact with infected cat feces or feces-contaminated sources (Tenter, Heckeroth and Weiss 2000). With the exception of *Toxoplasma gondii*, which uses felids as its host during sexual reproduction, none of these diseases are transmitted to humans solely by cats, but cats in some cases serve as important vectors.

The disease risk to humans from cats may be higher in developing countries than in other regions because these locations often have: 1) a higher incidence of immunocompromised individuals in the population (60% of the globe's HIV-positive individuals reside in sub-Saharan Africa, Fortson 2011); 2) poor hygiene practices (Brown 2000); 3) higher rates of consumption of undercooked meat (Sukthana 2006); 4) less efficient means of detecting and treating some diseases (WHO 2009); and 5) poor access to basic medical care upon falling ill (WHO 2009). For instance, toxoplasmosis is the third most common cause of death to AIDS patients in large urban areas of Cote d'Ivoire and the Democratic Republic of Congo (Lucas et al. 1993), and more broadly is considered a Neglected Tropical Disease—a common ailment that affects the poorest 500 million people in sub-Saharan Africa (Hotez and Kamath 2009).

This aspect of the human–cat relationship—the consumption of cat meat—has been understudied; in many developing countries it is unclear how frequently cats are consumed, why they are consumed (Podberscek 2009), and how cat meat is obtained. To our knowledge, there are no studies examining this subject in sub-Saharan Africa, and most information regarding the consumption of cat meat in other parts of the world is limited to anecdotal and/or media reports (Podberscek 2009). To assess the health consequences of cat-meat consumption, therefore, an improved understanding of the frequency and purpose of cat-meat consumption is needed.

One developing country where the consumption of cats may have important health consequences is the western Indian Ocean island of Madagascar. Madagascar has a rapidly growing human population with an annual growth rate of 2.6% (CIA Factbook 2014) and was described as undergoing an HIV epidemic in the early 2000s (Leutscher et al. 2003). Political instability in recent years has caused a severe decrease in foreign aid to the country (Harris 2011), with estimated losses of over $400 million in foreign aid by 2012 following a political coup d'état in 2009 (Ploch and Cook 2012). These recent events may further impoverish an already poor population in which over 90% of the people live on less than 2 USD per day (World Bank 2013). In part for these reasons, many Malagasy people are food-insecure, and Madagascar has high rates of adolescent malnutrition (50%) compared with its sub-Saharan

African counterparts (Fotso 2007). In response to such circumstances, Malagasy people often resort to exploiting the resources in their immediate surroundings for subsistence (Le Manach et al. 2012). Given the economic hardships faced by these people, and given that cats can be found across many regions in Madagascar (Junge et al. 2008), with few large terrestrial predators to limit feral-cat populations (Apps 1983), one could expect that food-insecure communities in Madagascar might consume cat as a means to alleviate food insecurity.

It should be noted that little is known about human–cat interactions in Madagascar. People do keep cats as pets in Madagascar (KER, pers. obs.) although there are no data regarding the rates of ownership. However, it is known that 88% of urban households in the capital city of Madagascar own pet dogs—mostly as guard dogs (Ratsitorahina et al. 2009)—while data from rural Malawi showed that 35 of 100 surveyed households owned a total of 41 cats (Morris 1994). In addition, there are almost no data on feral cat populations in Madagascar (Van't Woudt 1990), although they are present on the island (Junge et al. 2008).

Households in other areas of sub-Saharan Africa have been known to shift from eating fish, eggs, and livestock, to cheaper and more easily accessible sources of protein (Wodon and Zaman 2008). In Madagascar, domestic meat (i.e., meat such as chicken and beef that is derived from animals raised by farmers and ranchers) is preferred over non-domestic alternatives such as bushmeat (Jenkins et al. 2011), which is derived from unregulated or illegal hunting of wild animals (van Vliet and Mbazza 2011). However, domestic meat can be more expensive than bushmeat (Jenkins et al. 2011). As such, bushmeat is sometimes used by Madagascar's rural and urban poor to supplement diets, a trend that has been seen in other African countries (Brashares et al. 2011; Jenkins et al. 2011; Nasi, Taber and van Vliet 2011).

One study in a rural Malagasy community showed that children in families that supplemented their diets with bushmeat had significantly higher blood-iron levels than those that did not (Golden et al. 2011). The study noted that without access to bushmeat, the rural community could expect a 29% increase in the levels of childhood anemia, with a disproportionately high number of poor households impacted (Golden et al. 2011). These results suggest that, despite their lower desirability and resultant lower price, cheaper meat sources such as bushmeat can nonetheless provide important nutritional benefits. However, cat meat has been omitted from previous meat consumption studies in Madagascar (e.g., Razafimanahaka et al. 2012), despite the presence of cats in many areas of the country (Junge et al. 2008) and their status as a possible source of meat among Malagasy people (Tucker 2007). This may be because cat meat is not typically consumed in western cultures (Medina 2007) and non-local researchers may not have studied all potential food sources if they were considered "inedible" in their home cultures (MacClancy, Henry and Macbeth 2007). Thus the extent to which cat consumption may be used as a fallback food by poor, food-insecure Malagasy communities remains unclear.

Patterns of meat consumption in Madagascar are sometimes difficult to elucidate, because they are strongly affected by ethnic and religious taboos (Jenkins et al. 2011; van Vliet and Mbazza 2011). Taboos—also known as fadys—are sometimes regionally adhered to, but can also be village- or family-based, or impact just a few individuals or even a single individual within a household (Lambek 1992). Studies of urban areas of western Madagascar have revealed taboos and strong dislikes for many of the readily available sources of meat, including domestic pigs, bush pigs, goats, lemur, and fruit bats (Randrianandrianina, Racey and Jenkins 2010). Meat-related taboos are not unique to Madagascar; a variety of hypotheses have been raised to argue why or why not meat is consumed in developed and developing countries and involve a wide range of religious, philosophical, and theoretical explanations (reviewed by Morris 1994).

However, it remains unclear whether there are similar ethnic and religious taboos—or even strong preferences or dislikes—for the consumption of cats in Madagascar.

We aimed to examine the consumption of cats in central Madagascar. Our objectives were to: 1) quantify the preference for, and prevalence, correlates, and timing of, cat consumption; 2) describe methods used to procure cats for consumption; 3) identify the motives for consuming cat meat; and, 4) evaluate to what extent patterns of cat-meat consumption are influenced by taboos.

For the first objective, we hypothesized that, given that references to cat-meat consumption are uncommon in the literature, (1A) relatively few people would have consumed cats and (1B) few people would list cat as a preferred meat source. In addition, based on reports from elsewhere in Africa of consumption of non-preferred, inexpensive meat in both rural (Brashares et al. 2011) and urban (Nasi, Taber and van Vliet 2011) areas, and given that the Malagasy economy was damaged following political crises in 2002 and 2009 (Ploch and Cook 2012), we hypothesized that: (1C) the consumption of cat meat would decrease when residents of an area became more food secure (Jenkins et al. 2011), and that (1D) most reports of cat-meat consumption would be recent, and would have occurred within the last 10 years. For our second objective, due to the lack of anecdotal observations of cat meat being sold in Malagasy food markets (KER & ARW, pers. obs.), we hypothesized that (2A) cats would be consumed after a period of ownership or after being hunted as a feral cat, as opposed to purchase through a market. For the third objective, resulting from the diet shifts observed in Madagascar and elsewhere in sub-Saharan Africa during difficult periods (Wodon and Zaman 2008), we hypothesized that (3A) the purpose of cat-meat consumption would be to reduce food insecurity during periods of economic hardship. For our last objective, due to the wide prevalence and regional variation in taboos associated with other types of meat consumption in Madagascar (Randrianandrianina, Racey and Jenkins 2010; Jenkins et al. 2011; van Vliet and Mbazza 2011), we hypothesized that (4A) there would be taboos associated with consuming cat, but that these would vary by town.

Methods

Research Permissions

Survey materials were approved by the Temple University Institutional Review Board (Protocol Number: 21414, May 2013) and field research was conducted under the authorization of the Madagascar Ministry of Water and Forests (Permit number: 071/13/MEF/SG/DGF /DCB.SAP/SCB, May 18 2013). We also received regional and local approvals for research from elected officials at all study sites, prior to the onset of data collection.

Social Surveys

Semi-structured interviews (Rietbergen-McCracken and Narayan 1998) were conducted with 512 people in five towns of central Madagascar (Table 1), from June to August 2013. This formed part of a larger meat consumption survey. We sampled random households in each town, stratified by administrative unit. To ensure independence of sampling, we interviewed only one adult per household who self-identified as a head-of-household (i.e. had major buying power for household goods). Interviewees were asked to participate in the study using face-to-face recruitment, no identifying information was collected, and verbal informed consent was received prior to beginning each interview. If an eligible individual refused to participate or if no one was present, we moved on to the next household. Interviews were conducted

Table 1. Population, sample size, and percent of individuals who had consumed cat meat, by town. Total means are shown with 95% confidence intervals.

Town Name	Population (Ilo Program 2003)	Number of Interviews Conducted	Percent of Individuals Who Had Consumed Cat Meat	Mean Number of Times Cat Meat Was Consumed in Lifetime	Mean Length of Time Since Last Consumption (Years)	Percent of Individuals with Taboos Against Consuming Cat Meat
Andriba	32,000	122	43.44%	3.11	7.32	3.27%
Ankazobe	13,085	63	25.40%	2.00	N D	0.00%
Antananarivo	1,054,649	199	26.13%	2.50	13.37	0.05%
Antsiafabositra	8,328	70	47.14%	3.48	8.50	10.00%
Mahatsinjo	15,000	58	25.86%	2.00	28.00	3.45%
Total	—	512	33.59 ± 9.43%*	2.62 ± 0.58	14.29 ± 9.31*	3.35 ± 3.57%*

*Indicates significant differences between study sites. ND = no data were available.

in the interviewee's language of choice (French or the local Malagasy dialect). Interviewees were asked general questions about their meat consumption habits, including: 1) "What are your preferred types of meat?" and 2) "Do you have any meat-related taboos?" Individuals were also asked about their meat consumption in the past three days (i.e., "Can you list the different types of meat that have you consumed in the past three days? Which of these meats did you purchase?"); this was used as a proxy for estimating an individual's food security, under the assumption that individuals who had eaten and purchased meat recently were more food secure than those who had not.

In addition, interviewees were asked questions specific to cat consumption, including: 1) "Have you ever consumed cat (pet and feral individuals)?" If the answer was yes, we asked: 2) "How often have you consumed cat?" 3) "When did you last eat it?" 4) "Where did you eat it?" 5) "Did you buy it? If yes, when, where, and for how much?" 6) "Did you catch it? If yes, when, where, and how?" and 7) "Did you consume this for a specific reason, for a special occasion, or in unusual circumstances?" In Madagascar, both pet and feral cats are understood to be the same species, and are both referred to using the Malagasy name "Saka." Malagasy respondents also recognized domestic cats, including pet and feral individuals, as distinct from wildcats (*F. silvestris*).

Analysis

Summary data are shown as means (mean ± 95% confidence interval), with towns as the replicates. Pearson's Chi-Squared Tests of Independence and nonparametric Kruskal-Wallis Rank Sums Tests were used to test for significant differences within and between towns.

In cases where respondents reported that they had procured cat meat through purchase, we present price-related data in Malagasy Ariary (MGA) with the US Dollar (USD) equivalent in parentheses (based on June 1st 2012 and June 1st 2013 exchange rates of 2,100 MGA and 2,197 MGA to 1 USD, respectively; United Nations Treasury 2014).

Results

Preference for, and Prevalence, Correlates, and Timing of, Cat Consumption

Contrary to our hypothesis (1A), many interviewees (33.59% ± 9.43) had consumed cat meat at least once in their lifetime. At least 25% of individuals in all five towns had consumed cat (Table 1), though the proportion of individuals who had ever consumed cat meat did vary by town (Pearson's Chi-Squared Tests of Independence $\chi^2_{(4)} = 19.578$, $p < 0.001$). The least populous town of Antsiafabositra had the highest percentage of respondents who had consumed cat before (47.14%), while Ankazobe, the closest town to Madagascar's capital city, had the lowest (25.40%). Cat had been consumed an average of 2.62 (± 0.58) times by the 87.5% of respondents who were able to provide an estimate; this did not differ significantly by town (Kruskal-Wallis Rank Sums Test, $\chi^2_{(4)} = 2.685$, $p = 0.612$). In accordance with hypothesis (1B), when asked an open-ended question about their preferred type of meat, nobody listed cat (either pet or feral), though individuals freely listed over a dozen different types of domesticated, hunted, and fished meats.

There were no indications that food security affected local consumption of cat meat (hypothesis 1C). An individual's recent access to meat (a categorical variable indicating whether a respondent had purchased meat or not in the three days prior to the interview) did not change alongside the prevalence of cat-meat consumption reported in 2013, that is, in the 5–8-month period prior a respondent's participation in the survey (dependent variable was the

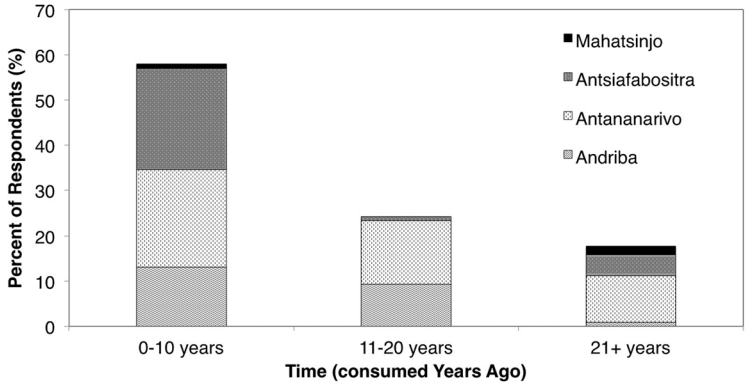

Figure 1. Time of last consumption of cat meat, by town.

presence/absence of a respondent's consumption of cat meat in this time period; Pearson's Chi-Squared Tests of Independence, $p \geq 0.18$ for all towns).

Most individuals (63.1%) who had consumed cat meat provided us with the year of their last consumption event, though we did not ask this question in Ankazobe. In accordance with our hypothesis (1D), more than half of respondents had consumed cat in the last 10 years (54.07% ± 19.25). However, 17.98% (± 19.06) of interviewees last consumed cat meat in the last 11–20 years, and over one-quarter had done so more than 20 years previously. Further, the mean length of time that had passed since the consumption of cat meat was 14.29 years (± 9.31; Table 1), though this varied significantly by town (Kruskal-Wallis Rank Sums Test, $\chi^2_{(3)} = 9.927$, $p = 0.019$; Figure 1).

Methods of Procurement of Cats for Consumption

Most individuals (85.2%) identified the method by which they procured their cat meat. In accordance with hypothesis (2A), most individuals consumed cats that they had raised as pets (53.92% ± 4.57) and many reported catching cats (16.88% ± 10.33). Nonetheless, many received the meat as a gift (27.78% ± 7.04) and a few individuals had bought (1.12% ± 1.08) cats for food. Cat meat was most commonly procured from an individual's own pet cat in all towns, whereas the method used least to procure cat meat in all towns was purchase.

Individuals who had caught cats for consumption (n = 19 overall) were also asked to provide additional details. The most common means used to catch cats was using a rope trap (5 respondents in 3 towns). Cats were also caught by hand (4 respondents in 2 towns), using a dog (3 respondents in 3 towns), with sticks or stones (2 respondents in 1 town), or by putting out bait (1 respondent).

Individuals who had purchased cat meat before (n = 2 overall) were asked to provide detailed information regarding the purchase. One individual had purchased cat meat in Antananarivo in 2012 for 1,000 MGA (0.48 USD) per piece of meat (amount unspecified, but less than one whole animal). The second individual purchased cat meat in Andriba in 2013 for 6,000 MGA (2.73 USD) per animal (this animal had been killed in traffic).

Purpose of Cat-Meat Consumption

Contrary to hypothesis (3A), only one individual indicated that a cat was eaten as a substitute for other meat when no other meat was available. Other respondents claimed to have eaten cat(s) because the animal(s) had: eaten a chicken or human food (n = 39), been killed by traffic

or found dead (n = 21), grown fat (n = 15), become old, injured, or behaved badly (n = 12), or because the owner had: too many pet cats (n = 2), been drinking alcohol (n = 1), or simply wanted to eat cat (n = 1). One individual in Andriba reported getting a cat as a gift in order to the use the oil of the cat to treat asthma.

Such explanations varied between the four smaller towns and Antananarivo (the country's capital and by far its largest town). In most towns, cats were most likely to be consumed after they ate human food or chickens (47.81% ± 17.72). In contrast, in Antananarivo, cats were most likely to be consumed after being killed in traffic (54% of the time).

Prevalence of Taboos Associated with Cat Consumption

In accordance with our hypothesis (4A), the proportion of respondents with taboos prohibiting them from consuming cat meat differed by town (Pearson's Chi-squared Test of Independence, $\chi^2_{(4)} = 19.685$, $p < 0.001$), although the proportion of respondents having such taboos overall was low (3.35% ± 3.57). None of the respondents (n = 11) who indicated having a personal taboo against the consumption of cat meat had ever consumed the meat before. A few respondents (n > 10) expressed strong dislike for the meat, with one respondent stating that he/she preferred not to eat it due to the status of the cat as a pet.

Discussion

We found that, although cat meat is not a preferred meat source for most individuals in the towns we surveyed in Madagascar, 34% of our interviewees had consumed cat meat at least once in their lifetime, with most consumption occurring in the last decade. Individuals with lower food security (i.e., interviewees who had purchased meat in the three days prior to the interview) were not more or less likely to eat cat, though at least one individual ate it as a substitute for other meat. Cat meat was generally not purchased in markets; rather it was typically obtained when an owner killed his/her own pet cat, as a gift, or by catching cats. The gift of cats and/or cat meat (28% of respondents received cats as a gift) is not surprising given that 36% of urban dog owners in Madagascar received their dogs as a gift (Ratsitorahina et al. 2009). Some regional variation was evident, with consumption rates, motivation, and proportion of respondents with taboos against cat meat all varying by town. In addition, the high rate of consumption following a wildlife–human conflict (i.e., when cats ate human food or chickens) in rural areas may indicate that cats were primarily killed to protect other food resources that are of value, followed by opportunistic consumption of the cat. Similar motivations have been noted in the killing of larger predators following human–wildlife conflicts (e.g., Hazzah et al. 2013) and in Malawi, animals that are killed for reasons other than consumption are usually consumed anyway (Morris 1994). In the large capital city of Antanarivo, consumption of cat meat also appeared to be mostly opportunistic, with consumption primarily following unintentional killing of cats by vehicle collisions.

Unlike in prior research examining bushmeat consumption (Golden et al. 2011), we did not detect a link between cat consumption and food insecurity. Further, like bushmeat consumption (Golden et al. 2011), cat consumption is unlikely to provide a sufficient, sustainable means of tackling hunger, given the large scale of food insecurity issues in Madagascar. Nonetheless, few people had taboos against cat consumption, and while cats in Madagascar are often viewed as household pets (i.e., not food items; Junge et al. 2008), many Malagasy people appeared to be willing to consume cat meat when it was available. Similarly, consumption of pet lemurs may also be occurring in Madagascar for similar reasons (Zinner

et al. 2001; Reuter et al. 2015). Further, of the interviewees who reported their method of procurement, most consumed cats that had been raised either by themselves or a neighbor. These results suggest that the occasional, opportunistic consumption of cat meat we detected may provide an irregular, but valuable, source of meat-based protein that—unlike much bushmeat—is legal and easily accessible to Malagasy people, even those living in urban areas. It is noteworthy that some respondents indicated eating cat meat when other food options were absent or after a pet cat consumed food resources. Perhaps the lack of a side dish to accompany rice—a staple food item in Madagascar (Dostie, Haggblade and Randriamamonjy 2002)—is considered inadequate and cat meat is used in the absence of other food options for social reasons; in Malawi, meat is served as the preferred side dish to accompany grain staples, and when these side dishes are inadequate, they are "scorned" (Morris 1994).

The handling of cat meat prior to consumption, especially following the death of the animal after being struck and killed by a vehicle, can pose health risks to consumers. Nelder and Reeves (2005) found that ectoparasites—vectors for multiple zoonotic pathogens, including Lyme disease and Tick-borne Relapsing Fever (*Borrelia duttoni)*—were present in over two-thirds of 96 road-killed carcasses studied in South Carolina, USA. These carcasses can serve as ideal hosts for many species of ticks, especially in tropical environments (Spolidorio et al 2012). Given these risks, individuals that handle deceased cats for longer periods—especially if the cat is killed via a vehicle collision—could be at an increased exposure risk to ectoparasite-borne diseases prior to the consumption of the meat.

The public health implications of these tick-borne pathogens found on road-killed vertebrates and, to a lesser extent living cats, are not insubstantial. For example, 7.4% of patients in a hospital in the Democratic Republic of Congo were diagnosed with Tick-borne Relapsing Fever (Dupont et al. 1997). Increasing human contact with wild animals in African countries could lead to more frequent transmission of tick-related pathogens (Muyembe-Tamfum et al. 2012). This may be especially true in locations such as Madagascar, where people consume road-killed carcasses, including cats. In addition, it is likely that the risks of consuming cat meat—whether it is undercooked or has been improperly handled prior to consumption—will be higher in certain social groups, including groups at the lowest end of the socioeconomic scale and those containing individuals who are immunocompromised. For example, in areas of Madagascar, where HIV prevalence among females could be as high as 15% (Baral et al. 2012), toxoplasmosis might pose a major health risk (Sukthana 2006); concurrent infection of HIV and *Toxoplasma* has been a public health concern since the 1980s and is increasing (Sukthana 2006).

The risks of consuming cat meat could be mitigated in several ways. Appropriate cooking techniques can reduce the likelihood of contracting a pathogen after eating infected cat (and other) meat. For instance, deceased cats may test positive for the Type C botulinum toxin resulting from growth of populations of the *Clostridium botulinum* bacterium in the cat carcass (Galey et al. 2000). However, cooking the meat at an appropriately high temperature can destroy the contaminant, thereby removing the risk of infection that comes with eating undercooked botulinum-infected meat (Motarjemi 2002). Providing education and raising awareness about the risks of consuming improperly handled meat could be effective in reducing rates of disease not only from cat meat but from food-borne illness more generally. Specifically, outreach programs could build on existing taboos held by some communities which often discourage the consumption of animals which died of natural causes (KER unpublished data), or by providing health and safety information about why the consumption of meat in some

circumstances (especially road-killed vertebrates) should be approached with care. Finally, the education about, and development of, non-meat protein sources may also be appropriate where cat meat is consumed to supplement nutrient-poor diets. In these cases, plant-based proteins could be more sustainable to produce than meat (Pimentel and Pimentel 2003) and may be a culturally appropriate means to improve nutrition, even among Malagasy people with religious and ethnic backgrounds that favor meat-restricted diets (KER pers. obs; Walsh 2007).

It should be noted that the risks of consuming road-killed or feral animals discussed in this article are not limited to feral and domestic cats; it is reasonable to assume that these risks are also inherent, to a certain extent, to the consumption of other animals. However, given that there are no data on the frequency with which road-killed or feral animals are consumed in Madagascar, additional research studies are needed to address these gaps in knowledge. For example, it would be advantageous to study whether feral and pet dogs are also consumed, given that only 7% of pet dogs in Madagascar are vaccinated against rabies and handling of dogs might pose a risk (Ratsitorahina et al. 2009). While the majority of urban households in the capital city own pet dogs (Ratsitorahina et al. 2009) and it is conceivable that consumption may occur, this has not been studied. This is particularly interesting given that there are taboos against the consumption of dogs in Madagascar (KER, unpublished data) and that these taboos—and those held against eating cats—may be diminishing in their cultural relevance, given that some food taboos and social norms in the country are weakening (Jones, Andriamarovololona and Hockley 2008).

To conclude, cat meat is consumed across many cultures and continents, but studies on the frequency, purpose, and consequences of consuming this protein source remain few; to our knowledge, this is the first study to examine the issue in sub-Saharan Africa. Although cat meat was not preferred and consumption was infrequent, consumption was nonetheless widespread; one-third of the people we interviewed in central Madagascar had consumed it at least once in the past, and cats were consumed by respondents in all towns examined. Although most respondents who had consumed cat meat had done so during the most recent decade in which political upheavals have led to economic hardship in Madagascar, we did not find evidence that cat-meat consumption was driven by food insecurity. Further, cat meat does not usually seem to be consumed when other meat sources are scarce. Rather, consumption appeared opportunistic: following cat deaths from human–wildlife conflict in more rural areas and vehicle collisions with cats in the large city of Antananarivo. Nonetheless, cat consumption may result in part from a lack of access to preferred meat options, and although cat consumption would not be a sufficient or sustainable solution to food insecurity issues in Madagascar, it could potentially also be used as an occasional inexpensive protein source in both rural and urban areas. Our finding of widespread though infrequent consumption of cat meat in Madagascar, coupled with the likely heightened susceptibility of the population to disease, suggests a need for further study into the public health consequences of handling and consuming cat in the country, particularly in regards to handling road-killed cats and consuming undercooked meats.

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