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Brief Original Article

Knowledge, practice and perception of human-marsupial interactions in health promotion

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Abstract

Introduction: Approximately 60% of emerging pathogens originate from wild animals, with mammals being the main hosts. Among *Didelphis*, which are restricted to the Americas, the species *Didelphis aurita* and *Didelphis albiventris* are particularly widely distributed throughout Brazil, where they act as hosts for several pathogens transmissible to humans. The reduction of their natural habitat has resulted in the adaptation of these species to human environments. Animals hunting, due to food necessity or cultural habit, may increase pathogen exposure with a potential to zoonotic disease transmission.

Methodology: From November to December 2016, we administered semi-structured questionnaires in a rural community in northeastern Brazil to assess knowledge, practices and perceptions regarding human-didelphis interactions and possible exposure to zoonoses.

Results: There were 213 respondents. Based on photographs of *D. albiventris* and *D. aurita*, 91.2% and 78% respondents, respectively, identified the animal by the popular name "sariguê", 61% (130/213) believed the animal could convey any disease, 4.7% stated they did not, and 34% did not know. Opossum meat consumption was reported by 20.2% (43/213), of which 58.1% admitted disease transmission possibility. Only 15.9% of respondents had a secondary or higher education level. The distribution of these frequencies is discussed according to the respondents educational level.

Conclusions: The results reveal the need to carry out health educational activities, including better community knowledge regarding the possible exposure to pathogens due to marsupial consumption.

Key words: Zoonoses; health; opossum; hunting; perception; spillover.

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Introduction

Approximately 60% of the emerging pathogens from wild animals have zoonotic potential [1], especially viral agents, capable of triggering global epidemics [2], for example, RNA viruses have a high mutation rate, marked infectivity, and excellent ability to adapt to new hosts [3]. In this context, both hunting activities and natural habitats reduction by deforestation increase contact between wild animals and humans, facilitating pathogen transmission [2,4].

Mammals are the main hosts of zoonotic viruses [5], especially species belonging to the orders Rodentia (rodents), Chiroptera (bats) and Primates, to which much research is dedicated. On the other hand, little is known about the involvement of other orders of animals in the epidemiology of viral etiologies, such as the order Didelphimorphia (marsupials) [6]. Molecular and serologic studies detected *Lyssavirus* [7], *Hantavirus* [8] and *Flavivirus* [9] in several species of the genus *Didelphis*. De Oliveira Carneiro I, *et al*. [10] demonstrated the existence of a new Hepatitis A virus in *Didelphis aurita* captured in northeast Brazil. In addition to the virus, other pathogens are associated with the genus *Didelphis*, such as *Trypanosoma cruzi* [11], *Leishmania* sp. [12] and *Mycobacterium bovis* [13], which highlights the need for more research on human-marsupial interaction-pathogens.

The order Didelphimorphia comprises marsupial mammals of the Didelphidae family, which includes 98 species distributed in 19 genera, all with restricted occurrence in the Americas (http://www.iucnredlist.org). The genus *Didelphis* comprises six species, including *Didelphis aurita* (Brazilian Common Opossum) and *Didelphis albiventris* (White-eared Opossum), which are widely distributed in Brazil and play an important ecological

role in the seed spreading [14]. They are a generalist species with high prolificacy and adaptability to the anthropic environment [14,15], where they interact with other synanthropic [16] or domestic animals and humans [17]. The pathogen flow created from these interactions may contribute to the occurrence of human pathogen spillovers [18].

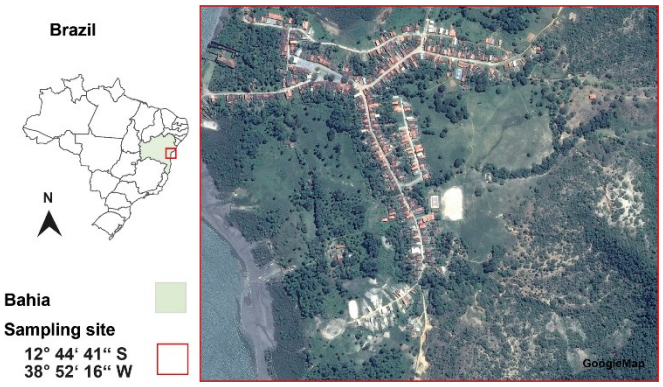
The interaction between *Didelphis* species and humans can occur through hunting for meat consumption or obtaining therapeutic products, being a cultural habit found in traditional communities in Brazil [15,17]. Studies of knowledge, perception and practices have helped to understand sociocultural factors involving exposure to zoonotic pathogens, which may contribute to preventive measures development [18–21]. In addition, social sciences study area increases knowledge of socially constructed behavior and concepts based on beliefs and experiences, and it characterizes local ecological factors and creates hypotheses for diseases emergence hotspots [18,22-23]. The present study was carried out in a rural community in northeastern Brazil, aiming to assess the community knowledge and perceptions regarding the marsupials *D. aurita* and *D. albiventris*, as well as to assess practices involving these species that could result in exposure to pathogens with zoonotic potential.

Methodology

The research was conducted in a rural community in northeastern Brazil (Figure 1). The area is dominated by the Atlantic Forest biome, which comprises forests with high biodiversity. The community has an approximate population of two thousand inhabitants, who engage in artisanal fishing, small farming (chickens, pigs, cattle), and subsistence agriculture. The history of food hunting by some residents motivated the choice of the study area, together with the fact that *Didelphis* are still scarcely studied. In addition, these animals were chosen because they have generalist and synanthropic habits and high prolificacy, which facilitates the infection and pathogens dispersion. The study was approved by the Ethics Committee in Maternity Climério de Oliveira, Federal University of Bahia (protocol number 1.799.309).

The estimated sample size was 179, considering an approximate population of two thousand people living in the village, a 5% error, a 95% confidence level and, an assumption, based on reports obtained in a previous visit to the community, of at least 15% of the community inhabitants eat marsupials. Volunteers were accessed randomly and after study explanation the

Figure 1. Map of the sampling site. Data acquired using QGis 2.18.15 (https://www.qgis.org/en/site/).



Informed Consent Form was presented if signed the volunteers were included in the study.

The semi-structured questionnaire aimed to obtain data regarding socioeconomic status, knowledge, perception, and practices of the community with respect to hunting/consumption of *Didelphis* and the possible transmission of diseases by these animals. The questionnaire was administered between November and December 2016. Before the interview began, respondents were presented with photographs of *D. albiventris* and *D. aurita* and were asked to report the common names given to these species in the region. The study of frequencies were performed using the Epi Info version 7 program [24].

Results

The total number of respondents was 213, which was 20% above the estimated minimum in the sample calculation. About half of the respondents were female 59.6% (127/213); the average length of community living was 36 years; the mean age of respondents was 42 years; 29.6% did not have formal education, 54.5% achieved primary education, 14.5% had secondary education, and 1.4% higher education; 74.6% of the respondents were fishermen, 10.8% were students, and 7% were retired/unemployed. Most reported having tap water in their residence (85%). However, only 18% reported having a sewage network, and 35.2% used a septic tank for waste. The community did not have a system to collect garbage, which was burned in the backyard of the houses.

Most of the respondents used the popular name of “sariguê” to name both *D. albiventris* (91.2%) and *D. aurita* (78%), after seeing the photographs. Other less frequent denominations were as follows: mouse (12.2%), saruá (3.7%), opossum (1.9%) and Brazilian porcupine (*Coendou prehensilis*) (0.9%). Only 4.2% of

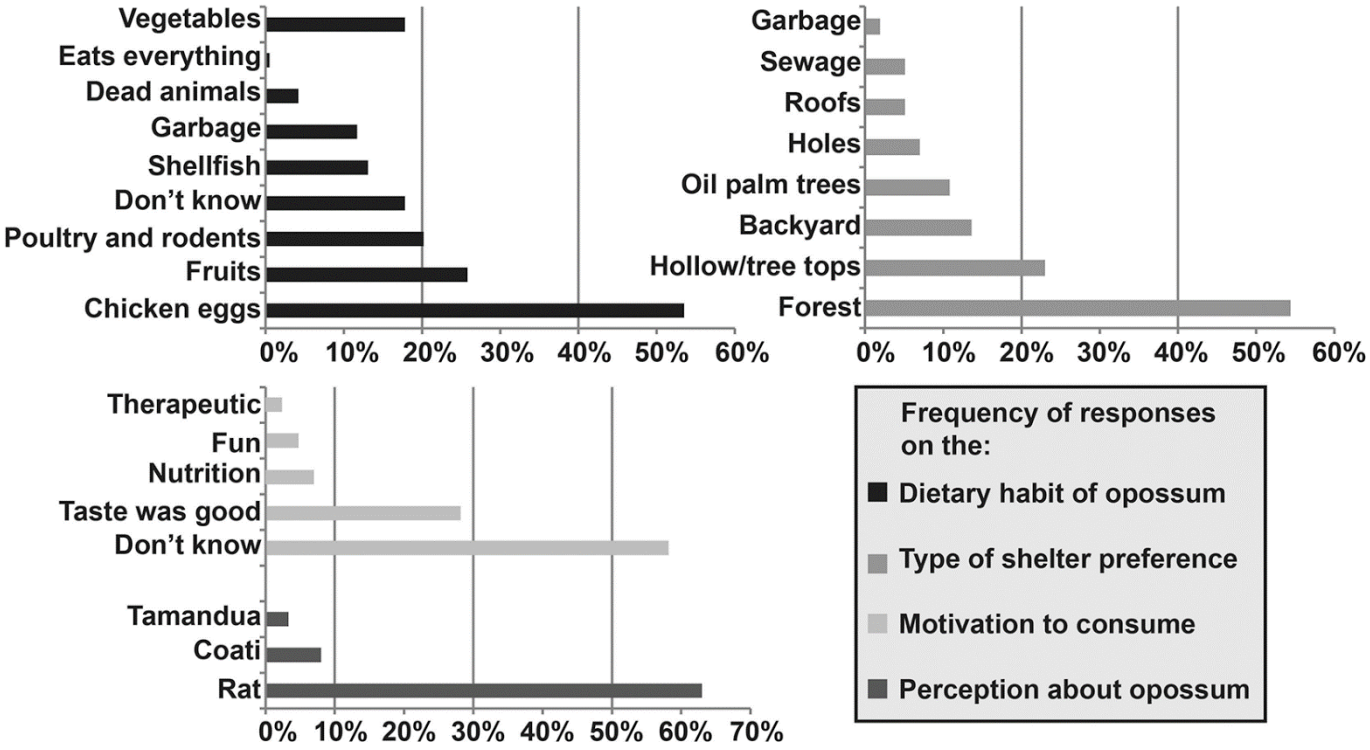
the respondents said the photographs were of animals of two different species.

When asked about the food habit of the opossum, respondents cited chicken eggs (53.5%), fruits (25.8%), poultry and rodents (20.2%), vegetables (17.8%), shellfish (13.1%), garbage (11,7%), dead animals (4.2%) and eats everything (0.5%), with 17.8% saying they did not know what the animal eats. When asked about the preference of shelter type used by opossum, respondents named forest (54.4%), hollow/tree tops (23%), backyard (13.6%), oil palm trees (10.8%), holes (7%), sewage (5.1%), roofs (5.1%) and garbage (1.9%). In the perception of the respondents, the *Didelphis* shown in the two photos resembled the rat (*Rattus* sp.) (63%), South American coati (*Nasua nasua*) (8%) and tamandua (3.3%), possibly referring to the *Tamandua tetradactyla* that lives in the region (Figure 2).

Of the 213 respondents, 43 (20.2%) reported having consumed opossum (Figure 3). Male subjects reported consumption of opossum meat more often (62.8%). Hunting was the most frequent way of obtaining opossum (72.1%), followed by donation (27.9%). Hunters used sticks and stones (83.7%) or craft traps (16.3%) to kill the animal. The most frequent form of meat preparation was cooking (44.2%). The taste was compared mainly to that of chicken (76.7%) and pork (11.6%). The frequency of consumption reported by the

Figure 3. Human-marsupial interaction: (A) Trap for didelphid capture; (B) Hunter with a specimen of *Didelphis albiventris* and (C) Preparation of the carcass for consumption. Author's photo.

Figure 2. Frequency of the answers given by the interviewees to questions about the dietary habits, type of shelter, motivation for consumption and perception associated with opossum.



respondents was low (19.2%), average (monthly) (2.3%) and high (weekly) (0.5%), and most did not give their opinion on the subject (78%). When asked about the motivation to eat opossum meat, most respondents (58%) did not know or did not respond, while others stated that the taste was good (28%), that it was the only food alternative (7%), it was for fun (4.6%) or it was for therapeutic purposes (2.4%).

In the perception section of exposure to pathogens, the respondents were questioned regarding the possibility of disease transmission through interaction with the opossum. The responses are displayed in Table 1, according to education level and history of ingestion of opossum meat.

Discussion

This study evaluated the knowledge, practice and perception regarding the hunting and consumption of marsupials and the possible transmission of diseases by these animals in the community studied, aiming to guide future communication strategies in health.

The studied community can be considered vulnerable due to the large number of people with little or no schooling (179/213), the precarious sewage network and the absence of garbage collection. Jane *et al*. [18], showed that the exposure/contact rate, the probability of transmission, and the duration of an infection were associated with social factors, including stress and poverty.

Most of the respondents did not differentiate the two species of *Didelphis* presented in the photos, naming them both as sariguê, which, in turn, facilitated the communication with the respondents during the application of the questionnaire. In other regions of the country, these marsupials are known as opossum, guaxica, guaxica fox, black mucura, white mucura, among others [15,17], which emphasizes the importance of considering the diversity of these regional denominations and other animal species when national communication campaigns on health or environmental education are developed, considering the territorial extension and cultural diversity of the country.

The testimony of the respondents regarding the food habits of the opossum was compatible with the generalist characteristics of these marsupials. Both species eat fruits, insects, small vertebrates, seeds and other sources of food, depending on the availability of the environment [14]. The marsupials play an important ecological role in seed dispersion [15], In addition, as they are wild animals, they are protected in Brazil by the Environmental Crimes Law (9605/1998). However, subsistence hunting is tolerated. Although 20.2% (43/213) of the respondents stated that they consumed beef, only 7% (3/43) did so out of necessity to supplement the diet. Actions aimed at raising the awareness of consumers regarding opossum meat, the ecological importance of these animals, as well as the problems that result from illegal hunting, could contribute to the abandonment of this practice.

Although didelphids can host several zoonotic pathogens, the opossum meat consumption is a habit present in several regions of Brazil. Studies on the prediction of emerging pathogens point to the ingestion of game as an important factor for the occurrence of pathogen spillovers for humans [25]. Epidemics, such as Ebola, SARS [26] and Lassa fever [27] began in communities with histories of host animals consumption such as primates, bats, and rodents.

A higher educational level was associated with an increased frequency of perception that the species can transmit diseases to humans. However, the same was

Table 1. Distribution of the answers to the following question: can opossum transmit diseases to humans? The answers are distributed according to the educational level of all the respondents (n = 213) and the group that affirmed consuming opossum meat (n = 43).

Educational level		Can opossum transmit diseases to humans?		
		Yes	No	Don't know
Total respondents, n (%)				
None	63 (29.6)	32 (50.8)	4 (6.3)	27 (42.9)
Primary	116 (54.5)	73 (63)	6 (5.1)	37 (31.9)
Secondary	31 (14.5)	22 (71)	0	9 (29)
Above secondary	3 (1.4)	3 (100)	0	0
Total	213 (100)	130 (61)	10 (4.7)	73 (34.3)
Respondents who consume opossum meat, n (%)				
None	15 (34.9)	3 (20)	1 (6.7)	11 (73.3)
Primary	23 (53.5)	18 (78.3)	2 (8.7)	3 (13)
Secondary	5 (11.6)	4 (80)	0	1 (20)
Above secondary	0	0	0	0
Total	43 (100)	25 (58.1)	3 (7)	15 (34.9)

not observed in the frequencies of the responses given by the 43 participants who consumed opossum meat. The majority of those who consume the animal also believe that the opossum can transmit diseases (Table 1). This fact suggests that perceptions regarding contracting disease risk are not sufficient to overcome other motivations, such as the taste of opossum meat, therapeutic superstitions, adventure/fun of the hunt, or preparation and consumption of meat between friends (62.8% of those who meat consumption were male). This apparent contradiction makes it possible to assume that the perception of opossum-related disease lacks concrete information derived from scientific knowledge, i.e., the fact that *Didelphis* act as hosts of diverse zoonotic pathogens. It is possible to suppose that some of the respondents who affirmed the possibility of disease transmission by the opossum were indirectly influenced by the frequent information regarding diseases transmitted by rats, such as leptospirosis, considering that 63% (134/213) of the respondents perceive the opossum as rats.

Conclusion

Based on the data presented, it is necessary to carry out observational analytical studies of the case-control or cohort type in order to accurately determine the risk of this interaction to the health of this community. What can be perceived is the frequency of exposure to a host animal of different pathogens, providing conditions favorable to spillover events, which allows the emergence of outbreaks of emerging diseases. This scenario could be mitigated, on the one hand, by increasing basic sanitation (sewage and garbage collection), by reducing the attraction of *Didelphis* to the human environment, as well as by policies to encourage formal education and communication in health and environmental education, aim to improve the overall quality of life of the community and discourage the habit of hunting and consuming wild animals.

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