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ORIGINAL ARTICLE

EPIDEMIOLOGY OF HONEYBEE STING CASES IN THE STATE OF *CEARÁ*, NORTHEASTERN BRAZIL

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SUMMARY

In the American continent, honeybee envenomation is a public health problem due to the high incidence and severity of the cases. Despite its medical importance, there is a lack of epidemiological studies on this topic in Brazil, especially referring to the Northeastern states. The present study has aimed to describe the epidemiological features of honeybee envenomation cases in the state of the *Ceará*, Northeastern Brazil, from 2007 to 2013. Data were collected from the Injury Notification Information System database of the Health Department of *Ceará*. A total of 1,307 cases were analyzed. Cases were shown to be distributed in all the months of the studied years, reaching higher frequencies in August. The majority of cases occurred in urban areas and involved men aged between 20 and 29 years. Victims were mainly stung on the head and torso, and they received medical assistance predominantly within 3 hours after being stung. Local manifestations were more frequent than systemic ones. Most cases were classified as mild and progressed to cure. The high number of honeybee sting cases shows that *Ceará* may be an important risk area for such injuries. Moreover, the current study provides data for the development of strategies to promote control and prevention of bee stings in this area.

KEYWORDS: Africanized honeybee; Brazil; *Ceará*; Envenomation; Venomous animals.

INTRODUCTION

European honeybees of the subspecies *Apis mellifera mellifera* were first introduced to Brazil in 1839, in the Southeast region. Subsequently, subspecies *A. mellifera carnica* and *A. mellifera ligustica* were introduced in the Southern region. In 1956, African queen honeybees (*A. mellifera scutellata*) were brought to Brazil with the aim of increasing hive productivity, since European honeybees had low productivity and were not well adapted to this tropical region. In 1957, 26 queens and their swarms of Africanized honeybees accidentally escaped into the wild and initiated crossing with the European subspecies, creating a fertile hybrid called the Africanized HoneyBees (AHBs)[1,2]. This hybrid species adapted well to the flora and climate conditions of the Americas, enabling conquest of much of this territory, at a rate of 300-500 km per year. They reached the French Guiana in 1975, Colombia in 1980, Costa Rica in 1983, Mexico in 1986 and the United States of America in 1990[3]. When compared to colonies of European origin, AHBs have stronger defensive behavior, smaller colony sizes, and less selectivity in nest sites. They also have a high reproductive rate and migratory behavior[2]. Because of these characteristics, AHBs are frequently involved in envenomation cases, thus becoming a public health problem in Brazil and other countries in America[2,4].

Honeybee envenomation is characterized by distinct clinical manifestations, depending on the victim's sensitivity to the venom and the number of stings[5]. The most frequent honeybee envenomation is the one in which an individual who is not sensitized to the venom is affected by one or a few stings. In these cases, clinical manifestations are limited to a local inflammatory reaction, including pain, swelling, erythema and itching. These symptoms spontaneously disappear within 24 hours, without medical care. Another clinical presentation is the one in which an individual previously sensitized to one or more venom components manifests immediate hypersensitivity. This condition may be triggered by only one sting and requires urgent medical care; symptoms vary from mild local inflammatory reactions to severe allergic reactions, which may lead to glottis edema, intense urticaria and bronchospasm accompanied by anaphylactic shock[2,5]. The third presentation is the one in which the victim is attacked by swarms, thus suffering multiple stings. In this case, the victim should be quickly hospitalized and monitored closely. The systemic reaction is due to the large volume of venom injected during the massive attack. Initial symptoms include diffuse widespread swelling, inflammation of the skin, headache, weakness and dizziness[2,5]. When the number of stings is greater than 50, nausea, vomiting and diarrhea may also occur. After the initial manifestations, hypotension, tachycardia, respiratory distress, acute renal failure, disseminated intravascular coagulation, and multiple organ dysfunction may develop[2,5]. The lack of AHB-specific antivenom makes this kind of envenomation even more complex, thus reinforcing the importance of an effective treatment.

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Despite its medical importance, the epidemiological features of honeybee envenomation in Brazil, especially referring to the Northeastern region, remain poorly understood, since there is a lack of epidemiological studies in this region, many cases are underreported and epidemiological data collection is deficient. In an attempt to address this shortcoming, the current study aimed to describe the epidemiological features of honeybee sting cases in the state of *Ceará*, Northeastern Brazil, from 2007 to 2013.

MATERIALS AND METHODS

Study area

The state of *Ceará*, whose capital is *Fortaleza*, is a federal unit that integrates the Brazilian Northeast region. It is composed of 184 municipalities, with a population of 8,452.381 inhabitants and a population density of 56.76 inhabitants/ km^2. Approximately 75% of its residents live in urban areas. It covers an area of 148,825.6 km², occupying 9.5% of the Northeastern territory, and 1.7% of the Brazilian area[6]. The majority of its territory (97%) is located within the "Drought Polygon", an area that is affected annually by prolonged periods of drought. Almost the entire region has a low rainfall rate, high average temperatures, acute water deficits, generally thin and often salty soils, and *caatinga* vegetation[7].

Data Acquisition

An epidemiological retrospective study was performed with the aim of describing and analyzing the honeybee envenomation cases recorded in *Ceará* from 2007 and 2013. Data were collected from the Injury Notification Information System (SINAN) of the *Ceará* Health Department. Demographic and population data from the Brazilian Institute of Geography and Statistics were used to calculate the incidence rates of honeybee sting cases. Statistical analyses were performed using Chi square, ANOVA and Tukey tests carried out using the software SPSS® version 19.0 (Statistical Package for Social Sciences) for Windows. The level of significance was $p < 0.05$. The following epidemiological variables were analyzed: year, month and area (urban or rural) of the occurrence; gender and age of the victim, and part of the body stung; time elapsed between sting and medical assistance, clinical manifestations, severity and progression of the case. Even though only the secondary data provided by SINAN were analyzed, with no identification of the victims, the present study was submitted to and approved by the Ethics Research Committee of the Federal University of *Campina Grande* (protocol number 853.926/2014).

RESULTS

A total of 1,307 honeybee envenomation cases were recorded by the Health Department of *Ceará* from January 2007 to December 2013, representing an average of 187 cases per year. The average incidence rates per 100,000 inhabitants were 1.50, 1.0, 1.80, 1.50, 4.30, 2.80 and 3.0 cases from 2007 to 2013, respectively. Four deaths were recorded, and the lethality rate was 0.3%. Honeybee sting cases were distributed in 87 out of the 184 municipalities of *Ceará*. The highest numbers of cases were recorded in *Fortaleza* (n = 237; 18.13%), *Russas* (n = 206; 15.76%), *Jaguaribe* (n = 161; 12.32%), *Limoeiro do Norte* (n = 134; 10.25%), *Sobral* (n = 75; 5.74%), *Canindé* (n = 59; 4.51%), *Reriutaba* (n = 51; 3.90%), *Maracanaú* (n = 28; 2.14%) and *Barbalha* (n = 28; 2.14%). In the other municipalities, the index was lower than 2.0%. Figure 1 shows that cases occurred in all the months of the studied years, with significant increase in the number of cases between the months of May and October (n = 834; 63.80%), followed by a gradual decrease of cases from November to April (n = 473; 36.10%) ($x^2 = 104.17$; $p < 0.01$). The months of August (n = 207; 15.80%) and February (n = 55; 4.20%) were those with the highest and the lowest number of cases, respectively. Table 1 shows that the frequency of cases involving men (n = 839; 64.20%) was higher than in women (n = 468; 35.8%), with significant difference between genders ($x^2 = 105.31$; $p < 0.01$). The highest frequency of stings was found in individuals aged between 20 and 29 years (n = 336; 25.70%), followed by 30 and 39 years (n = 218; 16.70%). The frequency of cases was higher in urban (n = 793; 60.70%) than in rural areas (n = 451; 34.50%), with significant difference between areas ($x^2 = 94.03$; $p < 0.01$). Table 2 shows that the frequency of stings on the head (n = 514; 39.30%) was statistically different (F = 10.94; $p < 0.01$) from those on the torso (n = 141; 10.80%), hand (n = 133; 10.20%) and arm (n = 131; 10.0%). The most frequent time interval elapsed between sting and medical care was three hours (n = 736; 56.30%). Table 3 shows that the majority of cases were classified as mild (n = 1,027; 78.60%), while some cases were moderate (n = 154; 11.80%) and a few cases were severe (n = 11; 0.80%). Most cases progressed to cure (n = 1,176; 90.0%), and four deaths were recorded. Table 4 shows that the most frequent local symptoms were pain (n = 1,094; 92.16%), edema (n = 967; 81.46%), ecchymosis (n = 106; 8.90%), erythema (n = 30; 2.40%), itching (n = 26; 2.20%) and hyperemia (n = 23; 1.98%); whereas the most frequent systemic symptoms were vagal (n = 55; 34.16%) and neuro-paralytic (n = 32; 19.87%) manifestations, headache (n = 26; 16.1%), dyspnea (n = 12; 7.45%), fever (n = 12; 7.45%) and dizziness (n = 10; 6.21%).

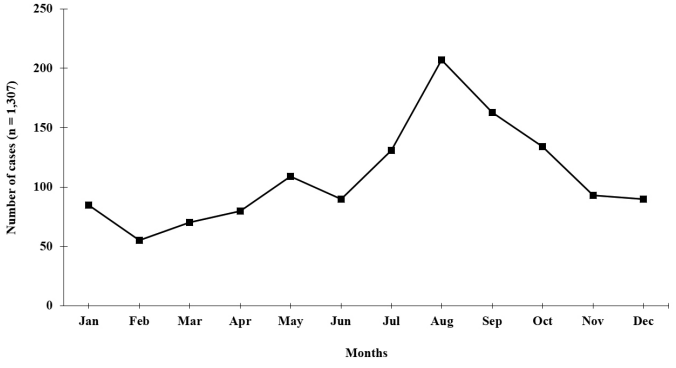

Fig. 1 - Distribution by month of honeybee sting cases in the state of *Ceará*, from 2007 to 2013.

DISCUSSION

According to the Brazilian Health Ministry, an expressive increase in the number of honeybee sting cases has been reported in Brazil during the last years, rising from 1,438 in the year 2000 to 9,717 in 2013, with a total of 77.066 cases in this period[8]. An increment has also been observed in the number of deaths, which rose from three in 2000 to 37 in 2013, totaling 249 deaths[9]. The South region has the highest incidence of cases (8.7/ 100,000 inhabitants), followed by the Southeast (5.5/ 100,000 inhabitants), Northeast (4.4/ 100,000 inhabitants), North (3.1/ 100,000 inhabitants) and Midwest (2.7/ 100,000 inhabitants)[10]. These findings indicate that honeybee sting cases occur in all the country regions. Despite its medical importance, there is a lack of epidemiological studies

Table 1
Distribution of honeybee sting cases in *Ceará*, from 2007 to 2013, according to the victims' gender, age and geographical location of the case

Gender	Number of cases	%
Male	839	64.2
Female	468	35.8
Victim's age (years)		
0 |—| 9	216	16.5
10 |—| 19	184	14.1
20 |—| 29	336	25.7
30 |—| 39	218	16.7
40 |—| 49	136	10.4
50 |—| 59	94	7.2
60 |—| 69	65	5.0
≥70	58	4.4
Geographical location of the case		
Urban	793	60.7
Rural	451	34.5
Periurban	21	1.6
Unknown	42	3.2
Total of cases	**1,307**	**100%**

Table 2
Distribution of honeybee sting cases in *Ceará*, from 2007 to 2013, according to the anatomic site of stung, time elapsed from sting until medical care

Part of the body stung	Number of cases	%
Head	514	39.3
Torso	141	10.8
Hand	133	10.2
Arm	131	10.0
Feet	79	6.0
Forearm	55	4.2
Leg	46	3.5
Finger	42	3.2
Thigh	25	1.9
Toe	18	1.4
Unknown	123	9.4
Time from sting until care (hours)		
0 |—| 1	356	27.2
1 |—| 3	380	29.1
3 |—| 6	130	9.9
6 |—| 12	65	5.0
12 |—| 24	99	7.6
>24 hours	122	9.3
Unknown	155	11.9
Total of cases	**1,307**	**100%**

Table 3
Distribution of honeybee sting cases in *Ceará*, from 2007 to 2013, according to the severity and progression of the case

Severity	Number of cases	%
Mild	1,027	78.6
Moderate	154	11.8
Severe	11	0.8
Unknown	115	8.8
Progression		
Cure	1,176	90.0
Death	4	0.3
Unknown	127	9.7
Total of cases	**1,307**	**100%**

on honeybee sting cases in Brazil, especially referring to the Northeast region. In addition, many different social and environmental changes occurring in that region during recent decades have indicated the need to update the knowledge on this topic.

The present study shows that there was a significant increase of honeybee sting cases in *Ceará* from 2007 to 2013, with an average of 187 cases per year. The annual average incidence rate was of 2.30 cases/ 100,000 inhabitants, which is in agreement with that reported by the Brazilian Health Ministry. Honeybee sting cases were distributed in 87 out of the 184 municipalities of *Ceará*, indicating that there is a wide distribution and permanence of honey bees in many regions of the state. The development of honeybee colonies is highly influenced by environmental conditions, such as rainfall, temperature, wind speed and patterns of floral resource availability. These conditions may affect the distribution and abundance of honeybee colonies in the wild environment[11,12]. AHBs are adapted to seasonally arid habitats and may respond more strongly to rainfall patterns than to photoperiod. This response to rainfall may reflect the ability of AHBs to rapidly respond and exploit transient "flushes" in floral resource availability[13]. The distribution of cases in all the months of the studied years may be attributed to the stable climate conditions of the region, characterized by low rainfall, high luminosity and high average temperature (about 28 ºC). Under such conditions, bees are more active, both to search for food and to defend the hive, thus promoting swarming and consequently favoring the stings on humans[11]. However, a significant increase in the number of cases from June to October has also been observed. In *Ceará* and other northeastern states of Brazil, this period coincides with the rainy season, when there is great offer of food, mainly provided by the flowering of herbaceous and bush plants. The abundance of pollen, nectar and water probably increases the mobility of bees in the environment,

Table 4
Distribution of honeybee sting cases in *Ceará*, from 2007 to 2013, according to the local and systemic symptoms

Local symptoms	**Number of cases**	**%**
Pain	1,094	92.1
Swelling	967	81.4
Ecchymosis	106	8.9
Erythema	30	2.5
Itching	26	2.1
Hyperemia	23	1.9
Total of cases	**1,187**	**100%**
Systemic symptoms		
Vagal manifestations	55	34.1
Neuroparalytic manifestations	32	19.8
Headache	26	16.1
Dyspnea	12	7.4
Fever	12	7.4
Dizziness	10	6.2
Total of cases	**161**	**100%**

bringing them closer to humans and consequently increasing the risk of stings. When AHBs are in activities outside their hives, they offer no risk of stinging people unless they feel threatened. However, stings may occur when someone breaks into your comfort zone and they defend their territory. The increased number of sting cases during the rainy period was also observed in other areas of the Northeast[14], as well as in the South of Brazil[15,16]. Taken together, these results suggest that there is a seasonal pattern to the frequency of honeybee envenomation cases in *Ceará*, with a significant increase in the rainy season. In face of this seasonality, preventive actions should be carried out throughout the year and intensified during the months of higher incidences. The risk of sting may be reduced by the mapping and removal of hives, as well by the development of educational campaigns to inform the general population about this issue, as well as beekeepers and specialized health workers on preventive measures against envenomation. Regarding the beekeepers, specific training on the installation and management of hives is also important.

The findings showing that cases involved mainly men indicate a differential risk between genders in the studied region. This is in accordance with studies performed in *Santa Catarina*[16] and *Paraiba*[14], which are states located in the South and Northeast of Brazil, respectively. The high number of victims in the age range of 20 to 39 years indicates that the economically active population is more likely to be stung by honey bees. Importantly, our results showed that the number of cases involving children and adolescents is also significant, approximately 30%. This may be explained by the fact that younger people, mainly children, are more frequently involved in outdoor activities. Furthermore, because of their inherent curiosity, as well as their ignorance of the danger and decreased ability to flee if attacked, children may be at higher risk of being stung[17].

There are two common behaviors which may contribute to the spread of AHBs in the environment[12]. The first one is the swarming, which occurs during periods of food abundance, when the colony population grows and a new queen emerges, thus making the bees leave the hive with the original queen to search for a new hive site. The second behavior is absconding, which occurs when food sources are scarce and weather conditions are unfavorable for the survival of swarms, thus leading to their migration to another site. Since swarming and absconding are inherent to AHBs, and because of anthropomorphic changes of the environment (agriculture, livestock, reforestation, and the building of cities), the number of swarms that migrate to and are established in urban areas has increased annually[11,18]. Urban areas provide not only numerous sites for the installation of colonies (houses, walls, trees), but also many resources necessary for their survival, such as nectar, pollen, water and resin[13]. As a result, the number of honeybee envenomation cases has increased mainly in urban areas[14,16]. Accordingly, the finding that the highest number of cases occurred in urban areas may be a result of swarming and absconding, as well as of anthropomorphic changes to the environment, numerous sites for the installation of colonies, and floral and water resources available to the development of colonies[18,19].

The part of the body most frequently bitten was the head. This result is consistent with the literature[14] and may be a result of the fact that flying insects usually fly at the height of the human head. The predominance of victims assisted within three hours after sting is in accordance with what was reported by other studies carried out in Brazil[5,14]. This finding may indicate that the population is well informed about the importance of receiving medical care in cases of honey bee envenomation. Typically, honeybee sting is manifested by localized pain and edema, without a systemic reaction. These symptoms are present, to some degree, in all the stung individuals and are caused by vasoactive components of bee venom rather than by allergic mechanisms. In this study, local symptoms (90.80%) were more frequent than systemic ones (12.30%). The most frequent local manifestations were pain (92.16%) and swelling (81.46%). Other common local symptoms, such as ecchymosis (8.90%), erythema (2.40%), itching (2.20%) and hyperemia (1.98%), were less frequent. Vagal (34.16%) and neuro-paralytic manifestations (19.87%), headache (16.10%), dyspnea (7.45%), fever (7.45%) and dizziness (6.21%) were the most frequent systemic manifestations. These symptoms were the same described in other clinical and epidemiological studies[2,5,14]. The majority of honeybee sting cases was classified as mild and progressed to healing, suggesting that cases were caused by a single or a few stings. This finding is in agreement with epidemiological studies performed in other Brazilian regions[14,16].

Although we have identified four deaths in the studied period, the data from the Brazilian Health Ministry report only three cases in the same period, thus suggesting underreporting in the recording systems. AHBs envenomation may be due to single sting or massive attacks. The lethality of AHBs is related to their aggressiveness and propensity to poke the victim massively. It is important to highlight that the medical data provided by the Brazilian Health Ministry do not discriminate whether envenoming was caused by a single or multiple stings. This information should be included in the records so as to provide more accurate clinical data. This action might improve the treatment of honeybee sting victims. Since epidemiological data is fundamental to improve knowledge on honeybee envenomation at regional levels, the enhancement of data collection procedures seems to be urgent. Accordingly, a better

understanding of cases in the studied region seems to require a more specialized training of health workers and more accurate protocols for recording the victims' information. Without basic infrastructure and training, it will be difficult to gather precise epidemiological information about health problems related to honeybee sting cases in the Brazilian Northeast. It is important to highlight that the current study was based on a secondary epidemiological data source recorded by different health professionals, thus allowing various interpretations of the medical records, affecting the accuracy of information. Despite that, the information regarding both the incidence of honeybee envenomation according to the region and the epidemiological features of the cases are important to evaluate the problem and to develop public policies aimed at reducing the number of cases and improving the victims' medical assistance. In this sense, the current study may contribute to a better comprehension of honeybee sting cases in the state of *Ceará*, thus representing a useful tool for identifying the conditions that have raised the risk of honeybee stings in the Northeastern Brazil. In conclusion, the current study showed that the honeybee sting cases are frequent in *Ceará*, with wide distribution of cases in several municipalities of the state. Cases occurred mainly in urban areas with higher frequencies in the rainy months (July to October). Victims were predominantly economically active young man, and were mostly stung on the head. Most victims reported local pain and swelling at the site of the sting, with no systemic manifestations. Therefore, honeybee sting cases were in general mild and with low lethality. Campaigns for removing swarms from urban areas and preventing honeybee stings may lead to a significant decrease in the incidence of such condition, thus reducing the demand for health services and improving the population safety and welfare. Further training of health professionals seems to be necessary to improve their skills in recording epidemiological information.

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