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Epidemiological study of the bee stings in the state of Bahia, northeastern Brazil, from 2010 to 2019

Estudo epidemiológico dos acidentes por picada de abelha no estado da Bahia, nordeste do Brasil, de 2010 a 2019

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Abstract
Introduction: *envenomation and deaths by bee stings have increased in all regions of Brazil. However, there are few epidemiological studies on them, especially in the states of northeastern Brazil.* ***Objective****: to determine the epidemiological characteristics of bee stings in the state of Bahia, Northeastern Brazil, from 2010 to 2019.* ***Methodology****: this is a descriptive and analytical epidemiological study conducted through a retrospective survey of secondary data provided by the database of the Notifiable Diseases Information System of the Ministry of Health.* ***Results****: between 2010 and 2019, a total of 7,979 cases were analyzed. Incidents were distributed in 356 municipalities, with the highest frequency in the regions of Agreste and Sertão da Bahia. Cases occurred in all months of the investigated years, with a greater occurrence in urban areas, affecting mainly adult men. The anatomical region of the body most affected by the sting was the head and most cases received medical care within 3 hours after the incident. Local manifestations were more frequent than systemic ones. The injuries were predominantly classified as mild and progressed to cure.* ***Conclusions****: the high number of cases and their extensive spatial distribution reveal that bee stings may be considered an emerging and neglected public health problem in the state of Bahia.*
Keywords: *Bee Venoms. Envenomation. Public Health. Epidemiology*.

Resumo
Introdução: os acidentes e os óbitos causados por picada de abelha têm aumentado em todas as regiões do Brasil. Contudo, existem poucos estudos epidemiológicos sobre acidentes com abelha, principalmente nos estados do Nordeste do Brasil. **Objetivo:** determinar as características epidemiológicas do acidente por picada de abelha no estado da Bahia, Nordeste do Brasil, de 2010 a 2019. **Metodologia:** trata-se de um estudo epidemiológico descritivo e analítico realizado por meio de uma pesquisa retrospectiva de dados secundários disponibilizados pelo banco de dados do Sistema de Informação de Agravos de Notificação do Ministério da Saúde. **Resultados:** entre 2010 e 2019, um total de 7.979 casos foi analisado. Os acidentes foram distribuídos em 356 municípios, com a maior frequência nas regiões do Agreste e do Sertão da Bahia. Os casos ocorreram em todos os meses dos anos investigados, com maior ocorrência em áreas urbanas, afetando principalmente homens adultos. A região anatômica do corpo mais atingida pela picada foi a cabeça e a maioria dos casos recebeu assistência médica até 3 horas após o incidente. As manifestações locais foram mais frequentes do que as sistêmicas. Os agravos foram predominantemente classificados como leve e progrediram para a cura. **Conclusões:** o elevado número de casos e a sua extensa distribuição espacial revelam que o acidente causado por picada de abelha pode ser considerado um emergente negligenciado problema de saúde pública no estado da Bahia.
Palavras-chave: Abelhas. Envenenamento. Saúde Pública. Epidemiologia.

INTRODUCTION

Bees of European origin were brought to Brazil during the colonial period for honey production, namely Apis mellifera mellifera, Apis mellifera caucasica, Apis mellifera carnica and Apis mellifera ligustica. In 1956, for scientific purposes, queen bees of African origin (Apis mellifera scutellata) were introduced in Brazil. Some of them escaped to the environment and started successive mating with European bees, generating a hybrid species that was called the Africanized bee[1]. This hybrid bee easily adapted to the flora, fauna, and climate of the Americas, allowing it to conquer this territory at a rate of 250 to 300 km per year. Between 1966 and 1970, they reached Paraguay, Bolivia, Argentina, and Uruguay. Later, between 1977 and 1985, their presence in Venezuela, Colombia, and Ecuador was registered. In less than 5 years, they had crossed Central America, and in 1985 arrived in Mexico and the United States of America in 1990 (FERREIRA et al., 2012).

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The Africanized bee has a very intense defensive behavior, with a high capacity for reproduction, adaptation, and migration (FERREIRA et al., 2012; MEDEIROS; FRANÇA, 2009). These characteristics and anthropogenic environmental changes, in rural and urban areas, possibly contributed to the increased incidence of bee stings in Brazil and other countries in the Americas (FERREIRA et al., 2012; MEDEIROS; FRANÇA, 2009; PEREIRA et al., 2010; CHIPPAUX, 2015). Cases have increased in all regions of Brazil, becoming an emerging and neglected environmental public health problem (COSTA et al., 2018; DE OLIVEIRA et al., 2019). According to the Ministry of Health of Brazil, in the year 2000 they amounted to 1,440 cases, and 3 deaths were registered. In 2018, these numbers increased to 20,725 cases and 58 deaths (BRASIL. MINISTÉRIO DA SAÚDE, 2020).

The clinical manifestations after a bee sting depend on the affected site and on its number, as well as on the sensitivity of the victim to the venom. The severity of cases can vary from mild local inflammation to a severe systemic allergic reaction which, not rarely, can result in anaphylactic shock and death. In envenomation caused by multiple stings, severe envenoming can occur and eventually lead to death (ALMEIDA et al., 2011; MEDEIROS; FRANÇA, 2009).

In the case of one or a few stings, local symptoms such as acute pain, edema, itching, and erythema quickly manifest. In the case of multiple stings, systemic manifestations may occur, due to the large amount of inoculated venom. In this scenario, symptoms are itching, redness, increased body temperature, hypotension, tachycardia, headache, nausea and/or vomiting, abdominal cramping, and bronchospasm. In more severe cases, shock, acute respiratory failure, rhabdomyolysis, and acute renal failure may also occur. Local allergic manifestations are characterized by edema and pruritus that persist for a few days. The most frequent systemic allergic reactions are generalized hives, bronchospasm, hypotension, urinary incontinence, laryngeal edema, cyanosis, loss of consciousness, and anaphylactic shock (ALMEIDA et al., 2011; MEDEIROS; FRANÇA, 2009).

In Brazil, from 2010 to 2018, 115,833 cases and 328 deaths by bee stings were reported. In 2018, the Northeast region recorded the highest incidence of accidents and deaths from bee stings in Brazil. Bahia is the second state in the Northeast with the highest number of cases and the first in deaths (BRASIL. MINISTÉRIO DA SAÚDE, 2020). However, there is little regional and/or local epidemiological information on the most affected populations and in which circumstances, regions, and/or municipalities incidents occur most frequently. In addition, social and environmental changes that have taken place in this region in recent decades must have their impact on the subject further investigated. In this sense, this study aimed at describing and analyzing the epidemiological characteristics of bee sting accidents in the state of Bahia, Northeastern Brazil, from 2010 to 2019.

METHODOLOGY

Study Design

This is a retrospective descriptive and analytical epidemiological study of bee stings in the state of Bahia, from 2010 to 2019. The epidemiological variables used were: year, month, sex, age group, zone of occurrence of the incident, anatomical location of the sting, time elapsed from the sting to medical care, local and systemic symptoms, severity, and evolution. All variables were analyzed to avoid duplicate entries into the system. This information was collected from the database of the Informatics Department of the Brazilian Unified Health System.

Measures of absolute and relative distribution were used to describe the results. The normal distribution of data was determined using the Kolmogorov-Smirnov test. The statistical analysis to verify the growth trend in the number of incidents was initially measured by Chi-square and later by simple linear regression. The other statistical analyzes were performed using the Chi-square test to verify the relationship between epidemiological variables and the risk of death. In addition, the Odds Ratio and its confidence interval (95%) were calculated using death as the dependent variable. Multivariate logistic regression for deaths was also performed, with backward and forward estimation. Variables associated with death with a significance level of $p < 0.05$ in the univariate analysis were included in the multivariate analysis. The model was adjusted using the Hosmer-Lemeshow test. Furthermore, the CA test (correspondence analysis) was performed for local and systemic symptoms. Data were analyzed using SPSS version 20.0 for Windows (SPSS Inc. Chicago, IL, USA).

The spatial distribution of cases was determined with the ArcGIS 10.5 software (ESRI, USA) using incidence estimates by municipality. The incidence rate was obtained through the proportion of cases by the population of the 417 municipalities in the state of Bahia, estimated for every 100,000 inhabitants. The spatial interpolation of the incidence of cases of bee stings was performed using the inverse distance weighting method (MITAS; MITASOVA, 1999). For this analysis, the power value used was 2, the search neighborhood was defined with a radius of 30.15, and smoothing of 0.2 was used. It was not necessary to use barriers. Population and demographic information were collected from the database of the Brazilian Institute of Geography and Statistics.

This study was developed following the rules of Resolution 466/2012 from the National Council of Ethics in Research (CONEP), which outlines that research involving only secondary data in the public domain, without identifying the participants, do not require approval by the Committee System of Ethics in Research of CONEP.

Study Area

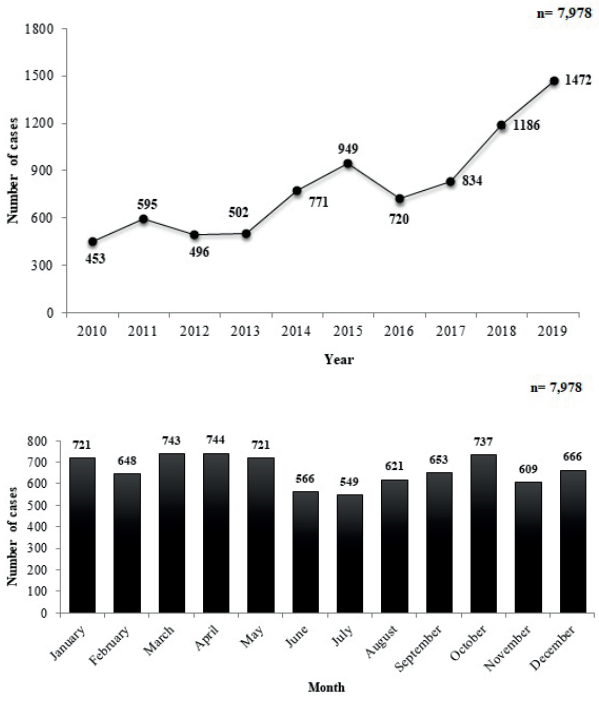
Bahia is the largest state in the Northeast of Brazil, occupying an area of 564,760,427 km², with a population

of 14,930,634 inhabitants and a population density of 24.82 inhabitants/km². Its population is distributed in 417 municipalities, with about 80% of its citizens residing in urban areas and 20% in rural ones (IBGE, 2021). The territory is covered by vegetation from the Caatinga, Cerrado, and Tropical Humid Forest biomes. Temperatures are high but can vary due to the influence of air masses, relief and vegetation. In the coastal areas, the humid tropical climate prevails, with temperatures that can vary between 24 °C and 32 °C. On the coast, rainfall is irregular and lasts almost all the year, with a yearly average that can exceed 1,500mm. However, in the inland part of the state, the semi-arid climate prevails, characterized by low humidity and temperatures between 27 ºC and 31 ºC, which can reach up to 40 ºC in long periods of drought. Rains are sparse and irregular, with an average rainfall inferior to 500 millimeters per year (MODESTO, 2020).

RESULTS

In the state of Bahia, from 2010 to 2019, bee stings increased from 453 to 1,472, reaching a total of 7,979 cases (Figure 1A), with an average of 798 incidents per year. The mean annual incidence was 5.36 cases/100,000 inhabitants. Bee stings were distributed over all months between 2010 and 2019 (Figure 1B), with an average of 665 cases per month. The months of April (n=744; 9.32%) and March (n=743; 9.31%) registered the highest numbers of cases, while the lowest numbers were registered in June (n=566; 7.09%) and July (n=549; 6.88%).

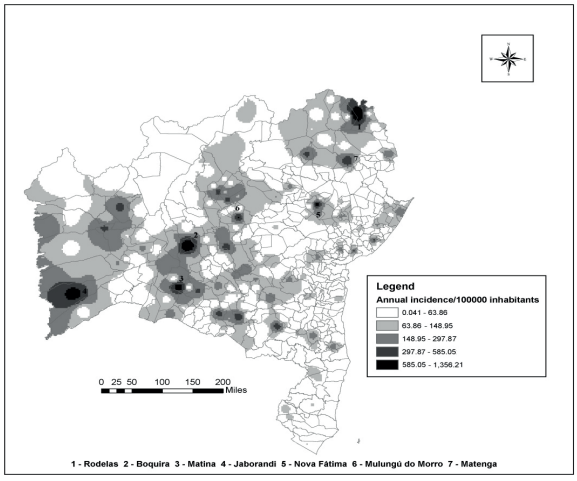
Figure 1 – (A and B) *Temporal distribution of the bee stings in the Bahia, from 2010 to 2019*



Source: Research data, 2021.

Regarding the spatial distribution, cases were distributed in 353 municipalities, with incidence values between 0 and 1,356,20459 cases/100,000 inhabitants (Figure 2). The most significant incidences were in the region of Agreste and Sertão da Bahia. The municipalities with the highest incidence of cases per 100,000 inhabitants were Rodelas (1382,488479), Boquira (1214,376653), Matina (885,173346), Jaborandi (787.119857), Nova Fátima (780,849974), Mulungu do Morro (606,16264), Euclides da Cunha (544,68928) and Maetinga (537.804492) (Figure 2).

Figure 2 – *Spatial distribution of bee stings cases in Bahia, from 2010 a 2019.*



Source: Research data, 2021.

Table 1 shows the distribution of bee stings in Bahia, from 2010 to 2019, according to sex, age, zone of occurrence, the time elapsed from the sting to medical care, anatomical region of the sting, local symptoms and systems, severity, and evolution. Cases were more frequent with men (n=5,050; 63.30%) than with women (n=2,922; 36.63%) and predominantly affected individuals aged 20 to 39 years (n=1,633; 20.47%). Incidents occurred more frequently in urban areas (n=3,903; 50.53%) than in rural ones (n=2,979; 38.57%). The individuals mostly received medical assistance within 1 hour after the sting (n=2,727; 34.18%), followed by cases that received treatment between 1 and 3 hours after the sting (n=1,517; 19.20%). The stings affected mainly the head (n=2,731; 34.23%), hands (n=1,133; 14.20%) and arms (n=1,024; 12.83%). Local clinical manifestations were observed in 7,083 cases (88.78%) and systemic manifestations in 554 cases (7.15%). Regarding severity, the accidents were classified as mild (n=6,477; 88.02%), moderate (n=815; 11.08%) and severe (n=66; 0.90%). The incidents progressed more frequently to cure (n=7,119; 99.47%) and 38 cases to death, resulting in a lethality rate of 0.004% (Table 1).

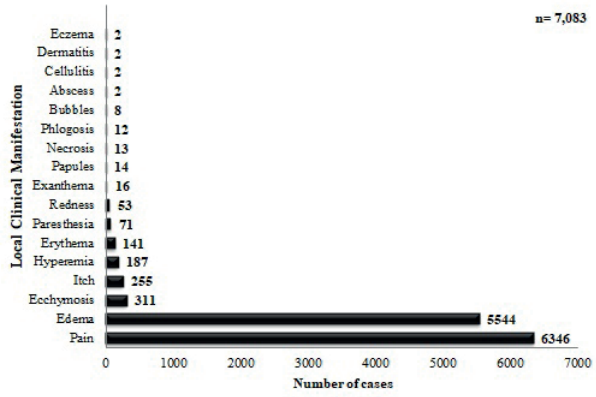
Table 1 – *Distribution of the bee stings in the Bahia, from 2010 to 2019, according to the gender, victims age, occurrence zone, time from sting until medical care, anatomic region of the sting, severity and outcome*

Variables	*(n)*	*%*
Gender		
Female	*2,922*	*36.65*
Male	*5,050*	*63.35*
Total	*7,972*	*100*
Victims Age (Years)		
0-9	*1,495*	*18.74*
10-19	*1,284*	*16.09*
20-29	*1,633*	*20.47*
30-39	*1,302*	*16.32*
40-49	*949*	*11.9*
50-59	*621*	*7.78*
60-69	*352*	*4.41*
70-79	*206*	*2.58*
> 80	*136*	*1.71*
Total	*7,978*	*100*
Occurrence Zone		
Urban	*3,903*	*56.07*
Rural	*2,979*	*42.80*
Periurban	*79*	*1.13*
Total	*6,961*	*100*
Time from sting until medical care		
0-1h	*2,727*	*45.10*
1-3h	*1,517*	*25.07*
3-6h	*446*	*7.38*
6-12h	*208*	*3.44*
12-24h	*490*	*8.11*
>24h	*659*	*10.9*
Total	*6,047*	*100*
Anatomic Site of the sting		
Head	*2,731*	*41.88*
Arm	*1,024*	*15.70*
Hand	*1,133*	*17.37*
Trunk	*726*	*11.13*
Leg	*379*	*5.81*
Foot	*529*	*8.11*
Total	*6,522*	*100*
Severity		
Mild	*6,477*	*88.02*
Moderate	*815*	*11.08*
Severe	*66*	*0.90*
Total	*7,358*	*100*
Outcome		
Cure	*7,119*	*99.47*
Death	*38*	*0.53*
Total	*7,157*	*100*

Source: Research data, 2021.

Among the 7,979 cases, 7,083 manifested local symptoms and 554 systemic symptoms. The most frequent local clinical manifestations were pain (n=6,346; 89.59%), edema (n=5,544; 78.56%), ecchymosis (n=311; 4.39%), pruritus (n=255; 3.60%), hyperemia (n=187; 2.64%) and erythema (n=141; 1.99%) (Figure 3).

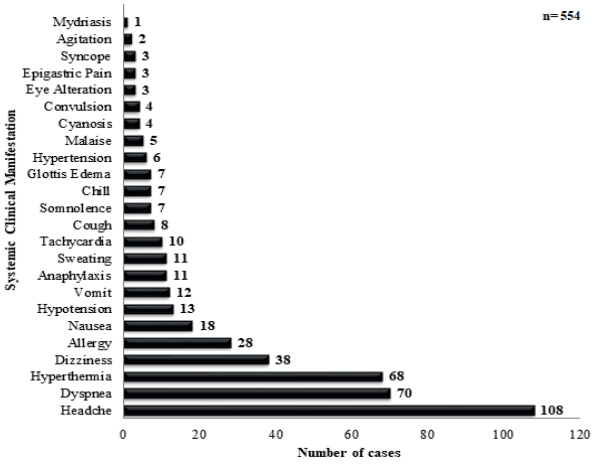
Figure 3 – *Distribution of the bee stings in the Bahia, from 2010 to 2019, according to the local clinical manifestations*



Source: Research data, 2021.

The most frequent systemic manifestations were headache (n=108; 19.49%), dyspnea (n=70; 12.63%), hyperthermia (n=68; 12.27%) and dizziness (n=38; 6.80%) (Figure 4).

Figure 4 – *Distribution of the bee stings in the Bahia, from 2010 to 2019, according to the systemic clinical manifestations*



Source: Research data, 2021.

DISCUSSION

The present study shows the increase in bee stings in the state of Bahia, with a growing trend (R^2=0.779) mainly from 2016 to 2019. These data reveal the improvement of the system for notifying injuries by poisonous animals, possibly due to the expansion of the Health Strategy for the Family and the decentralization of health surveillance actions (SOUSA et al., 2015). Cases occurred every month, with a low variation in frequency, demonstrating that the cases were not seasonal. This fact can be par-

tially attributed to the stable climatic conditions of the region, described by the high average temperature, low precipitation rate, and high luminosity. Furthermore, the temperature in this region varies little between summer and winter, especially when compared to the South and Southeast regions of Brazil.

The occurrence of incidents in 353 municipalities demonstrates the extensive spatial distribution. The most significant envenomation was reported in the regions of Agreste and Sertão da Bahia, suggesting that they may form an area of risk of bee stings. The municipalities with the highest incidence of cases are located in a semi-arid region of the Northeast, where the hot and dry climate prevails for about 7 to 8 months. Under these conditions, bees are more active and can look for better survival conditions, in which the distance from predators and the availability of food and water are more suitable. The greater movement of bees may favor their contact with humans, increasing incidents.

The significant difference in cases between male (63.35%) and female (36.65%) individuals showed that men are more exposed to bee stings. This may be due to the work activities performed mainly by men, namely, civil construction, transportation, agriculture, and tending to livestock. Our results also show that the cases mainly involve adult individuals (20 to 60 years old), indicating that the highest proportion of cases is among the economically active population. The high proportion of children (18.74%) and adolescents (16.09%) involved in the envenomation may be partially explained by the active behavior of people in these age groups. The age group from 0 to 9 years old causes great concern, as they are children, who do not know how to defend themselves and therefore may be subject to being stung. Another worrying factor is the low body weight of the children, suggesting that they may tolerate fewer stings.

Cases decreased in individuals aged over 60 years, but the risk of death was higher in the age groups over 80 years (OR 20,770; CI 11,505 – 37,527; p < 0.01) and from 70 to 79 (OR 4,599; CI 2,074 – 10,194; p < 0.01) when compared to other age groups. This situation may occur because individuals over 60 years of age are in the process of declining metabolism, their physiological functions are reduced, loss of muscle mass and resistance to physical and chemical injuries is limited (BORTZ, 2002; LALLY; CROME, 2007; KULMINSKI et al., 2007). Such characteristics indicate that this portion of the population has a higher risk of death. On the other hand, in the state of Rio Grande do Norte, Marques et al. (2020) reported that injuries by bee stings with children and adolescents are at greater risk of progressing to severe severity and/or death (MARQUES et al., 2020). Taken together, these observations indicate that the groups at greatest risk of death are children, adolescents, and individuals over the age of 70 years.

Despite the predominance of bee stings in urban areas (56.07%), the risk of death was higher in rural zone (OR 1,679; CI 1,019 – 2,766; p < 0.05). The greater risk of death in the latter may be related to the difficulty of the population in municipalities in having access to health services, as they are far from large urban centers. The higher frequency of cases in urban areas may be due to the higher number of inhabitants, and the ability of bees to adapt to anthropogenic environmental changes (SOUSA et al., 2015). Furthermore, social and environmental changes in rural areas reduce the quality and availability of habitats for bees. Consequently, urban areas often become a refuge and/or shelter for them, in addition to being a place with a great source of food and water (BAUM et al., 2012; PEREIRA et al., 2010).

The anatomical region of the body most affected by the stings was the head (41.88%), followed by the hands (17.37%), arms (15.70%), and trunk (11.13%). However, the risk of death was higher in cases where the sting reached the trunk (OR 4,663; CI 2,677 – 8,122; p<0.05). The proximity of the bite site to vital organs can increase the severity of cases. The trunk has vital organs such as the heart and lungs, in addition to large vessels that contribute to the rapid and wide distribution of the venom in the human body. When the sting reaches the head, the clinical manifestations are severe because, in addition to local edema, edema of the glottis can occur, with blockage of the upper airways.

Medical care was provided in 70.17% of cases within 3 hours after the sting, suggesting that the population is aware of the importance of quickly seeking it in the case of an envenoming. Furthermore, the instantaneous onset of acute pain at the sting site has been an essential factor in the quick search for medical care. The immediate search for medical care may also be due to fact that the bee stings are predominantly urban, where they are quickly provided by health services (CHIPPAUX, 2015; MARQUES et al., 2020).

Despite the favorable prognosis, the occurrence of monthly cases indicates the need for preventive actions. The bee stings raise concern, as it can often be a medical emergency and there is still no specific antivenom for its treatment (ALMEIDA et al.., 2011; FERREIRA et al., 2012; MEDEIROS; FRANÇA, 2009). Of the total cases, 88.84% showed local symptoms, while 6.94% also exhibited systemic symptoms. Cases in which necrosis was reported (OR 19,436; CI 2,458 – 153,663; p < 0.05) and/or ecchymosis (OR 6,281; CI 2,722 – 14,493; p < 0.05) have a higher risk of death compared to other local symptoms. Among the systemic manifestations, hypertension (OR 120,273; CI 21,291 – 679,414; p<0.05), sleepiness (OR 38,902; CI 4,560 – 331,849; p<0.05), laryngeal edema (OR 38,902; CI 4,560 – 331.849; p<0.05), anaphylactic shock (OR 23,329; CI 2,906 – 187,304; p<0.05), hypotension (OR 23,329; CI 2,906 – 187,304; p<0.05) and dyspnea (OR 11,019; CI 3,294 – 36,865; p<0.05) have a higher risk of death when compared to other systemic manifestations.

CONCLUSIONS

The epidemiological profile of bee stings in the state of Bahia is similar to that of other states in the Northeast of Brazil (LINARD et al., 2014; MARQUES et al., 2020; SOUSA et al., 2015) The cases have extensive spatial distribution and occur in all months of the year, especially in the regions of Agreste and Sertão. These data suggest that these regions may form an extensive risk area for this type of envenomation. The cases mainly affect adult men, who are preferentially stung on the head. Most individuals receive medical care within 3 hours of the incident and more frequently manifest local symptoms and, to a lesser extent, systemic symptoms. The prognosis is often favorable and the lethality rate is low. However, the monthly average of cases is high and urgently requires actions to prevent, control, and/or reduce its number. These sanitary actions must be implemented and disseminated to the entire population and consist of avoiding exposure to risk locations and/or with a history of bee stings. If necessary to visit these locations, it is recommended the use of appropriate clothing consisting of pants, a long-sleeved shirt and shoes with socks. It is important to emphasize that health education actions are an useful instrument used by professionals, because in this way the population may act assertively, in order to reduce exposure to the risks of bee envenomation and carry out the early search for health services in situations in which that the stings occur. The information reported here, on the spatial and temporal distribution of cases, may be used by public health agents in the state of Bahia to develop sanitary actions at a local and/or regional level, aiming at preventively controlling cases and improving the care of victims. In addition, the budget can be managed with greater security, reducing and/or avoiding losses. Finally, this study also provides information that may be used for comparison with the epidemiological profile of studies conducted in other regions of Brazil, enabling the exchange of detailed and updated information.

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