



## Bubonic Plague Alert Based on Flea Index in The Plague Observation Area of Pasuruan District, East Java Year 2023

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### ARTICLE INFO

**Article Type:**  
Research

**Article History:**  
Received: 11 June 2024  
Accepted: 30 June 2024  
Published: 30 June 2024

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### ORIGINAL ARTICLE

#### ABSTRACT

Plague is a very serious health problem and can lead to outbreaks or epidemics caused by the bacterium *Yersinia pestis*. This study aims to determine the alertness of plague based on the flea index in the plague observation area in Pasuruan Regency, East Java. The research method used was exploratory. The research data used secondary data from the Surabaya Public Health Laboratory (BBLabkesmas). The plague observation area included four sub-districts. Tutar, Tosari, Puspo, and Pasrepan. The research variable was the index of fleas found in the observation area. Data were analyzed descriptively and presented in graphical form. The results showed that 2146 rats were caught in 2023, of which 630 were rats with fleas. The majority of rat species found were *Rattus tanezumi* (65.19%), *Rattus exulans* (22.51%), *Hylomys suillus*, shrew (*Suncus murinus*), and other rat species. The flea species found were *Xenopsylla cheopis* (78%) and *Stivalius cognatus* (22%). The two main indicators to measure the risk of plague transmission are the Generalized flea Index and the Specific flea Index. The generalized flea Index measures the density of fleas that are not the main vector of plague, while the Specific flea Index measures the density of *Xenopsylla cheopis* as the main vector of plague. In the Tutar sub-district, the first semester showed Ngaruh hamlet was alert with a specific flea Index of 1.22, but in the second semester, all areas in the Tutar sub-district were declared safe. Pasrepan and Puspo sub-districts were declared safe in both semesters. In the Tosari sub-district, first-semester Tosari Hamlet and second-semester Sedaeng Hamlet were declared alert with a specific flea Index of 1.06 and 1.04 respectively.

**Keywords:** Bubonic Plague, Rat Species, Flea Species, Flea Index

#### ABSTRAK

Pes merupakan masalah kesehatan yang sangat serius dan dapat menimbulkan wabah atau epidemi yang disebabkan oleh bakteri *Yersinia pestis*. Penelitian ini bertujuan untuk mengetahui kewaspadaan penyakit pes berdasarkan indeks pinjal pada daerah pengamatan pes di Kabupaten Pasuruan, Jawa Timur. Metode penelitian yang digunakan adalah eksploratif. Data penelitian menggunakan data sekunder dari Balai Besar Laboratorium Kesehatan Masyarakat (BBLabkesmas) Surabaya. Wilayah pengamatan wabah meliputi empat kecamatan. Variabel penelitian adalah indeks pinjal yang ditemukan di wilayah pengamatan. Data dianalisis secara deskriptif dan disajikan dalam bentuk grafik. Hasil penelitian menunjukkan bahwa sebanyak 2146 ekor tikus tertangkap pada tahun 2023, dimana 630 ekor diantaranya adalah tikus berpinjal. Mayoritas spesies tikus yang ditemukan adalah *Rattus tanezumi* (65,19%), *Rattus exulans* (22,51%), *Hylomys suillus*, curut *Suncus murinus*, dan spesies tikus lainnya. Spesies pinjal yang ditemukan adalah *Xenopsylla cheopis* (78%) dan *Stivalius cognatus* (22%). Dua indikator utama untuk mengukur risiko penularan pes adalah Indeks Pinjal Umum dan Indeks Pinjal Spesifik. Indeks pinjal umum mengukur kepadatan pinjal yang bukan merupakan vektor utama pes, sedangkan Indeks pinjal khusus mengukur kepadatan *Xenopsylla cheopis* sebagai vektor utama pes. Di Kecamatan Tutar, pada semester pertama menunjukkan Dusun Ngaruh dalam kondisi waspada dengan Indeks Pinjal Spesifik sebesar 1,22, sedangkan pada semester kedua seluruh wilayah di Kecamatan Tutar dinyatakan aman. Kelurahan Pasrepan dan Puspo dinyatakan aman pada kedua semester tersebut. Di Kecamatan Tosari, Dusun Tosari pada semester pertama dan Dusun Sedaeng pada semester kedua dinyatakan waspada dengan indeks pinjal masing-masing 1,06 dan 1,04.

**Kata Kunci:** Pes, Spesies Tikus, Spesies Pinjal, Indeks Pinjal

## INTRODUCTION

Bubonic plague is an acute illness that transmits from animals to humans and is caused by the bacterium *Yersinia pestis*. The disease is transmitted through the bite of rat or other rodent fleas that can bite and spread the infection to other animals or humans. Bubonic plague is included in the International Health Regulation (IHR), regulated by the Quarantine Act No. 1 & 2 of 1962 and the Plague Act No. 4 of 1984. As per the law, the management of this disease falls under the authority of the Center (DG PPM and PL) and requires routine control of pests. Bubonic plague, also known as Black death during World War II, causes a very high mortality rate. Known as "sampar", it is a highly lethal disease with symptoms such as bacterial infection, high fever, shock, decreased blood pressure, rapid and irregular pulse, mental disorders, weakness, anxiety, and coma (Direktur Jenderal Pencegahan dan Pengendalian Penyakit, 2017).

The vector of transmission of bubonic plague is the flea in rats which has a role as a reservoir. They are part of the Order siphonaptera which includes small flightless insect species that live as external parasites of mammals and birds, (Koehler & Oi in Mubarak et al., (2022). It has a small size of between 1.504 mm, flat on the side (Dorso lateral). The species known as bubonic plague vectors includes *Xenopsylla cheopis*, *Neopsylla sondaica*, *Stivalius cognatus* (Direktur Jenderal Pengendalian Penyakit dan Penyehatan Lingkungan, 2015). Reservoirs are hosts that are resistant to infestation with *Yersinia pestis* bacteria such as *Rattus exulans* which can be a source of transmission to humans and other animals. Susceptible hosts are hosts that are sensitive to infestation of bubonic plague bacteria such as Asian house rats (*Rattus tanezumi*), sewer rats (*Rattus norvegicus*) and others, (Direktur Jenderal Pengendalian Penyakit dan Penyehatan Lingkungan, 2014).

Bubonic plague originally entered Indonesia through the Port of Surabaya in 1910, carried by rats and its flea from the Port of Rangoon (Myanmar). The disease then spread to Central Java, Yogyakarta and West Java. From 1910 to 1960, 245,375 people died from bubonic plague, with 17.6% of cases occurring in East Java, 51.5% in Central Java and 30.9% in West Java. The disease continued to appear and disappear at intervals. In 1968 and 1970 it was again reported in Boyolali District, in 1986 in Pasuruan District it was found In 1987, there was a case of death with symptoms of fever of unclear cause, so active surveillance was carried out which found 224 suspected cases of bubonic plague and 1 death. Bubonic plague cases were still detected in 2004-2007 in Pasuruan Regency. Since the first outbreak occurred until now, surveillance or monitoring of bubonic plague continues to be carried out to prevent the return of the outbreak (Direktur Jenderal Pengendalian Penyakit dan Penyehatan Lingkungan, 2014).

The presence of the Bubonic Plague in Indonesia gives special attention to preventing the outbreak of the Bubonic Plague. The importance of giving attention by conducting continuous observation of the disease both actively and passively in humans and animals. Until 2013 in Indonesia there are 3 areas that still actively conducting surveillance of bubonic plague, namely Pasuruan District, East Java; Boyolali District, Central Java; and Sleman District, Yogyakarta, (Direktur Jenderal Pengendalian Penyakit dan Penyehatan Lingkungan, 2014). Surveillance activities are carried out in the form of surveillance of rats and flea and surveillance in humans. Rat and flea surveillance is an observation conducted by catching rats using live traps, identifying rats, and collecting blood serum and rat flea. Human surveillance is conducted by actively visiting villages and passively by observing patient data at health centers or other health facilities (Sinulingga, Gunawan, & Yanti, 2022).

Observations are conducted as a form of early alert system to detect the transmission of bubonic plague from rodents to other animals (such as cats, rabbits, guinea pigs, dogs, etc.) and to humans in bubonic plague Endemic areas. Risk factors for bubonic plague are important variables that must be considered to diagnose the possibility of bubonic plague transmission in an area. General variables include the condition of villages, hamlets, or neighborhoods experiencing famine or after a bumper harvest, rat habitat disruption, forest fires, volcanic eruptions, and earthquakes, as well as Ratfall and increased house rat populations. Technical variables include generalized pinjal index  $\geq 2$ , *X. cheopis*-specific pinjal index  $\geq 1$ , and positive serology results in rodents and humans (Direktur Jenderal Pencegahan dan Pengendalian Penyakit, 2017).

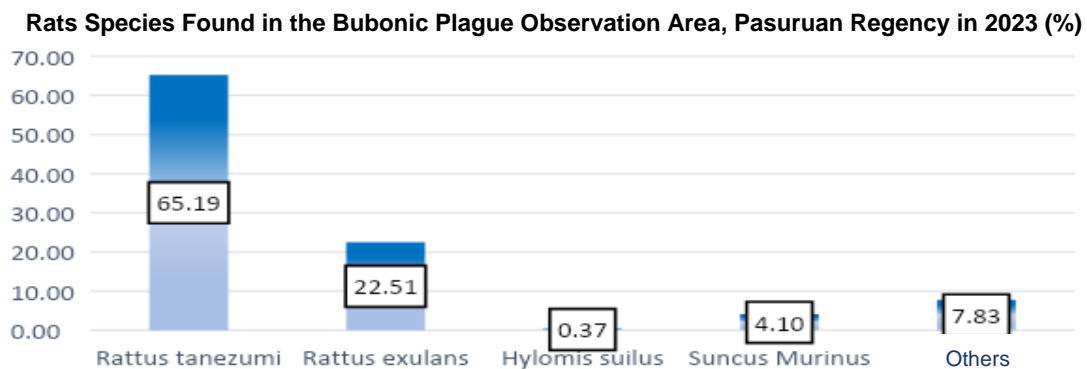
The specific flea index was calculated by dividing the number of *Xenopsylla cheopis* fleas by the number of rats caught and examined. The generalized flea index was calculated by dividing the total number of all flea species by the number of rats caught and examined. Increased alertness is required if one common variable or more than one technical variable is found. Alertness can be done by increasing surveillance of humans, animals, and the environment and its follow-up. This study aims to determine the alertness of bubonic plague based on the flea index in bubonic plague observation areas in Pasuruan District, East Java.

## METHODS

This research uses exploratory method, which is research conducted to identify the causes of a phenomenon (Abubakar, 2021). This study used secondary data from the Surabaya Public Health Laboratory (BBLabkesmas Surabaya), Vector and Disease Carrier Laboratory. The data used is Rodent and Flea Surveillance data in the Bubonic Plague Observation Area of Pasuruan Regency in 2023. The Bubonic Plague Observation Area is located in four sub-districts, namely Tukur Sub-district, Tosari Sub-district, Puspo Sub-district, and Pasrepan Sub-district. The variable in this study was the index of flea found in each observation area. The research was conducted in May 2024 in Pasuruan. The analysis was conducted every semester in 2023 by presenting the general flea index and specific flea index. Data were analyzed univariately and presented through graphs.

## RESULTS

Based on the data obtained from BBLabkesmas Surabaya in the observation area in 2023, the number of rats captured was 2146 with 630 rats manifested by fleas. The types of rats found are as follows:

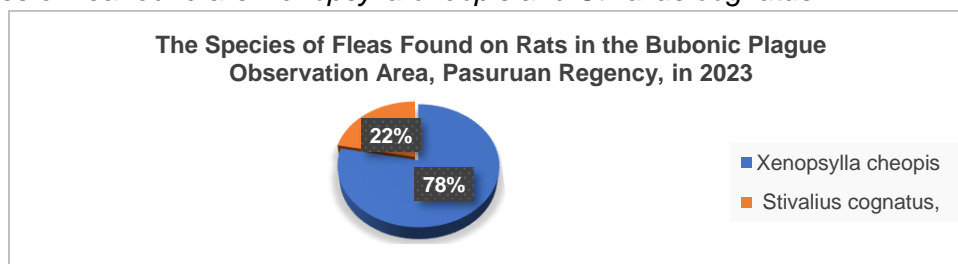


Source: BBLabkesmas Surabaya, 2023

**Graph 1.** Rats Species Found in the Bubonic Plague Observation Area of Pasuruan Regency in 2023

Based on Graph 1 above, it is known that the species of rats found are mostly *Rattus tanezumi*, which is 65.19%, followed by *Rattus exulans* at 22.51%, *Hylomys suillus*, shrew (*Suncus murinus*) and other.

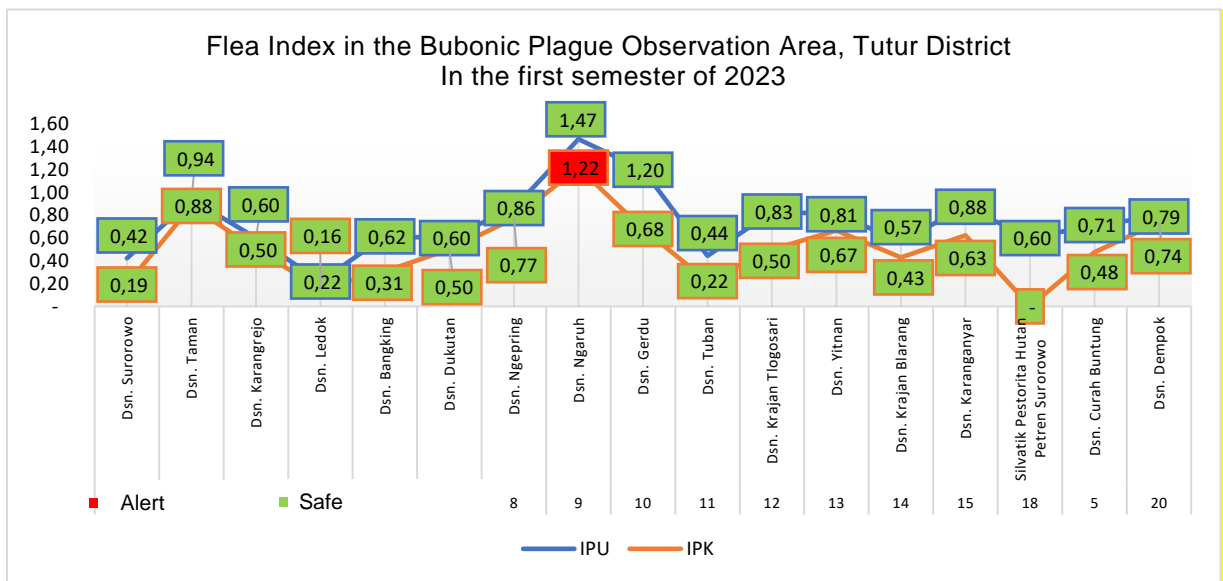
The species of flea found are *Xenopsylla cheopis* and *Stivalius cognatus*.



Source: BBLabkesmas Surabaya, 2023

**Figure 1.** The Species of Fleas Found on Rats in the Bubonic Plague Observation Area, Pasuruan Regency, in 2023

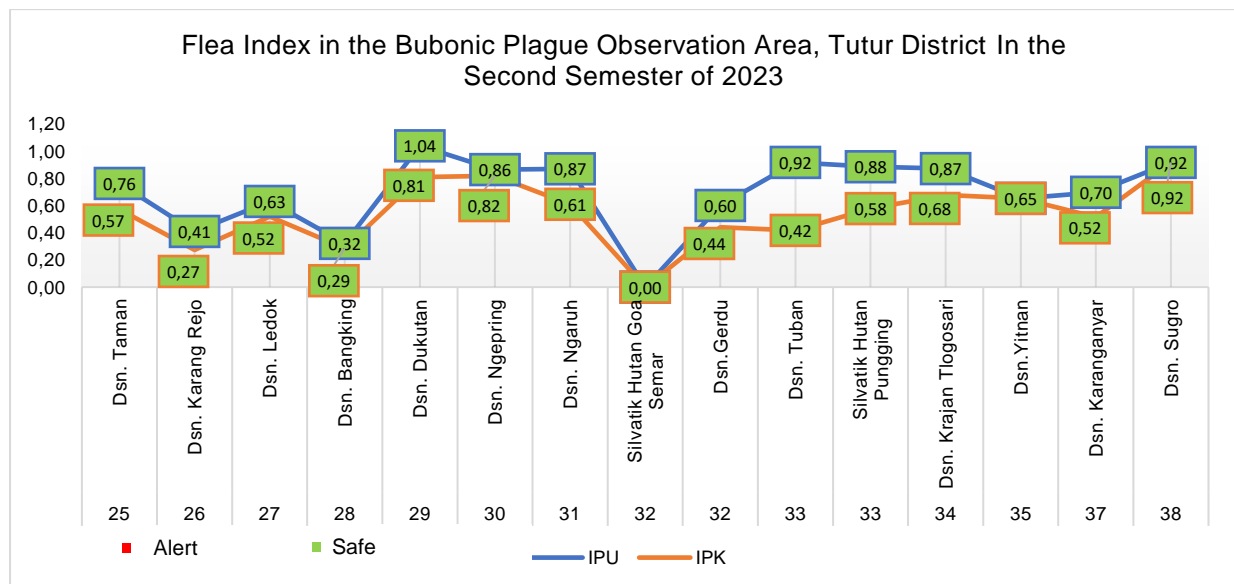
Based on figure 1 above, it is known that most of the flea species found in the Bubonic Plague Observation Area of Pasuruan Regency are *Xenopsylla cheopis*, which amounted to 78% in 2023. In addition, *Stivalius cognatus* was also found at 22%.



Source: BBLabkesmas Surabaya, 2023

**Graph 2.** Flea Index in the Bubonic Plague Observation Area, Tutar District In the first semester of 2023

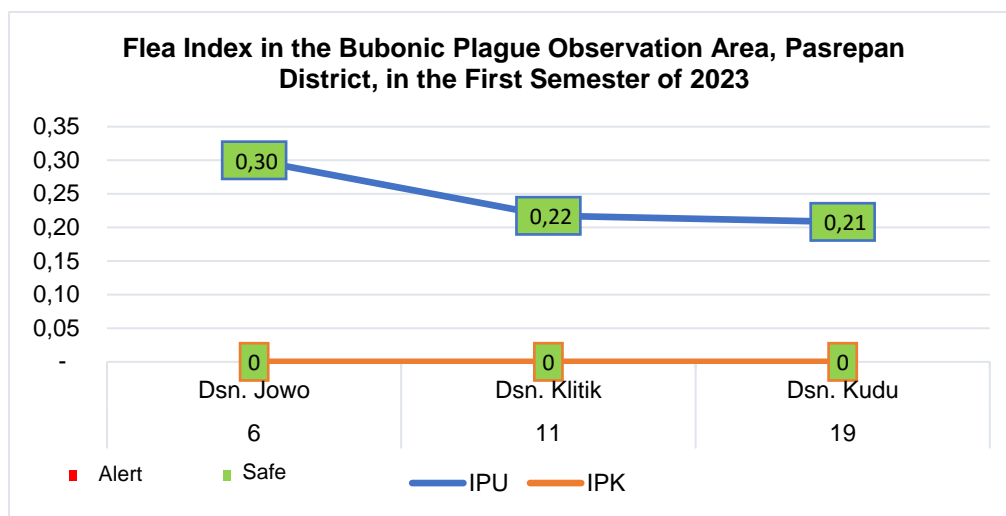
Based on graph 2 above, it is known that the general flea index or IPU and specific flea index or IPK in the 17 observation areas in the first semester in Tutar Subdistrict are highest in Ngaruh, namely IPU of 1.47, and IPK of 1.22. This shows that the Ngaruh Hamlet area can be declared alert based on the flea Index because of specific flea index or IPK > 1. Other hamlets that were observed in the first semester in Tutar Subdistrict can be declared safe, based on the flea index because IPK < 1 and IPU < 2.



Source: BBLabkesmas Surabaya, 2023

**Graph 3.** Flea Index in the Bubonic Plague Observation Area, Tutar District In the Second Semester of 2023

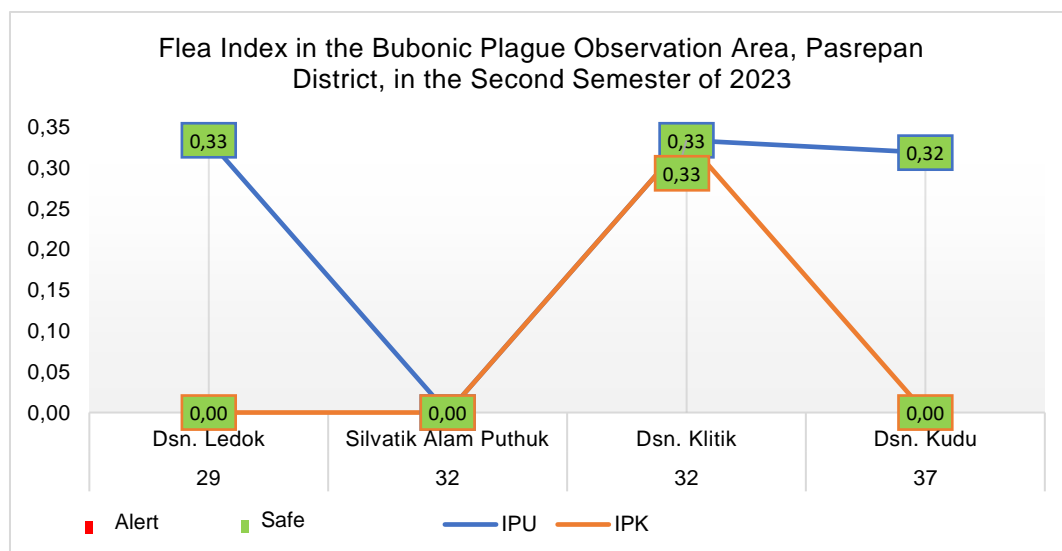
Based on the graph 3 above, it is known that the general flea index in the fifteen (15) second-semester observation areas in Tutur Subdistrict is highest in Dukutan Hamlet at 1.04. Meanwhile, the highest of specific flea index was in Sugro Hamlet, which amounted to 0.92. This shows that all areas observed in the second semester in Tutur Sub-district can be declared safe, based on the Flea Index because specific flea index or IPK < 1 and general flea index or IPU < 2.



Source: BBLabkesmas Surabaya, 2023

**Graph 4.** Flea Index in the Bubonic Plague Observation Area, Pasrepan District, in the First Semester of 2023

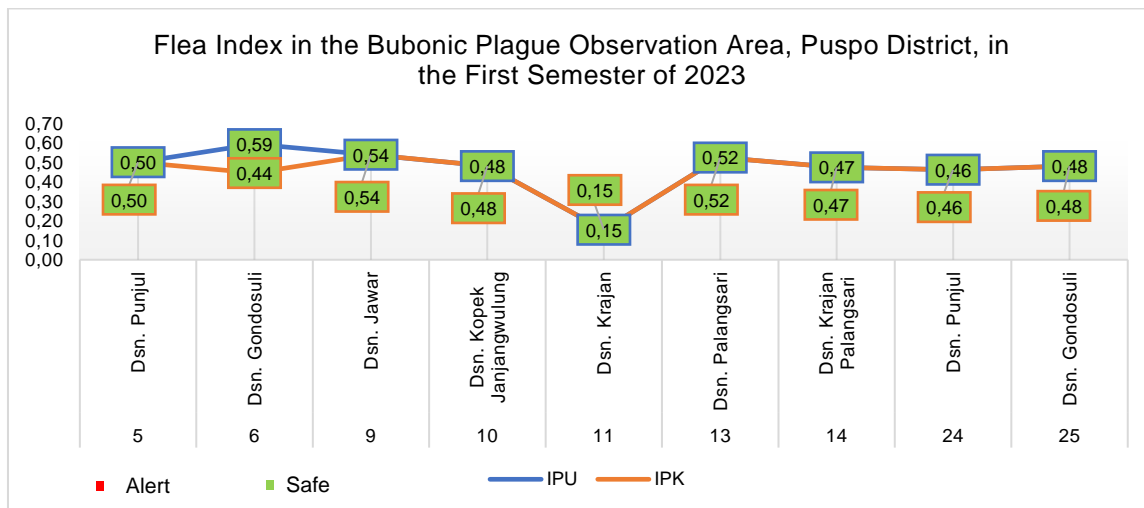
Based on graph 4 above, it is known that the general flea index in the 3 observation areas in the first semester is the highest in Pasrepan District, namely in Jowo Hamlet at 0.30. As for the specific flea index are 0 in all observation areas in Pasrepan sub-district. This shows that all bubonic plague observation areas in Pasrepan District in the first semester can be declared safe based on the Flea Index because specific flea index or IPK < 1 and general flea index or IPU < 2.



Source: BBLabkesmas Surabaya, 2023

**Graph 5.** Flea Index in the Bubonic Plague Observation Area, Pasrepan District, in the Second Semester of 2023

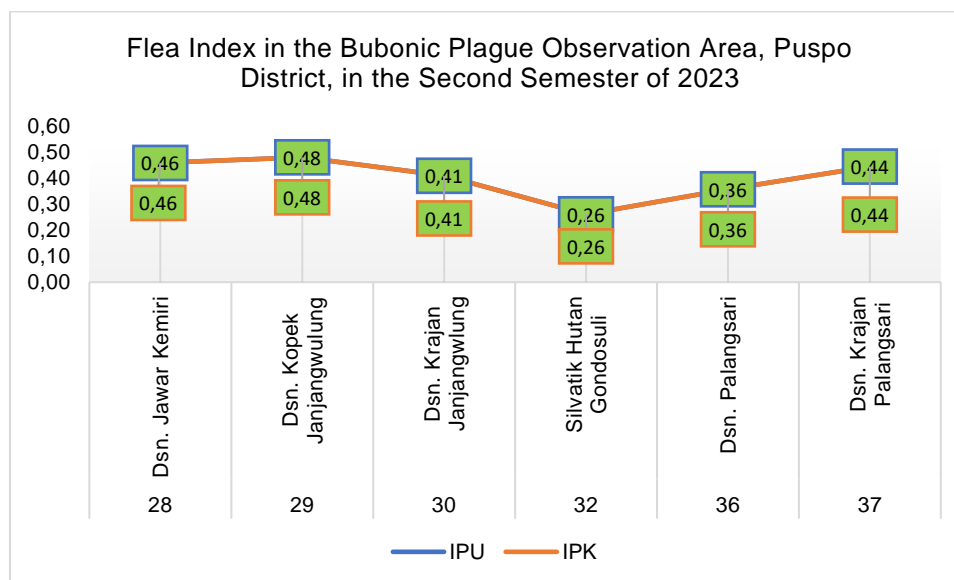
Based on graph 5 above, it is known that the general flea index in the 4 observation areas in the second semester is the highest in Pasrepan Subdistrict, located in Ledok Hamlet and Klitik Hamlet, which is 0.33. Meanwhile, the highest specific flea index was in Klitik Hamlet, which amounted to 0.33. This shows that all bubonic plague observation areas in Pasrepan Subdistrict in the second semester can be declared safe based on the Flea Index because specific flea index or IPK < 1 and general flea index or IPU < 2.



Source: BBLabkesmas Surabaya, 2023

**Graph 6.** Flea Index in the Bubonic Plague Observation Area, Puspo District, in the First Semester of 2023

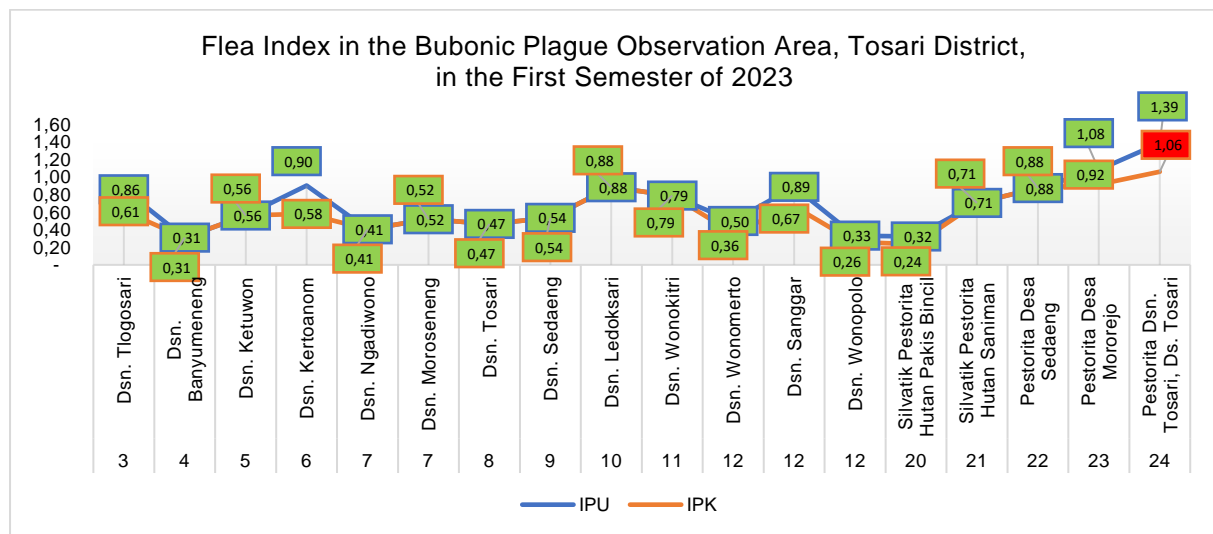
Based on graph 6 above, it is known that the general flea index in the 9 observation areas in the first semester is highest in Puspo District, namely in Gondosuli Hamlet at 0.59. While the highest specific flea index is in Jawar Hamlet, which is 0.54. This shows that all bubonic plague observation areas in Puspo sub-district can be declared safe based on the flea index because specific flea index or IPK < 1 and general flea index or IPU < 2.



Source: BBLabkesmas Surabaya, 2023

**Graph 7.** Flea Index in the Bubonic Plague Observation Area, Puspo District, in the Second Semester of 2023

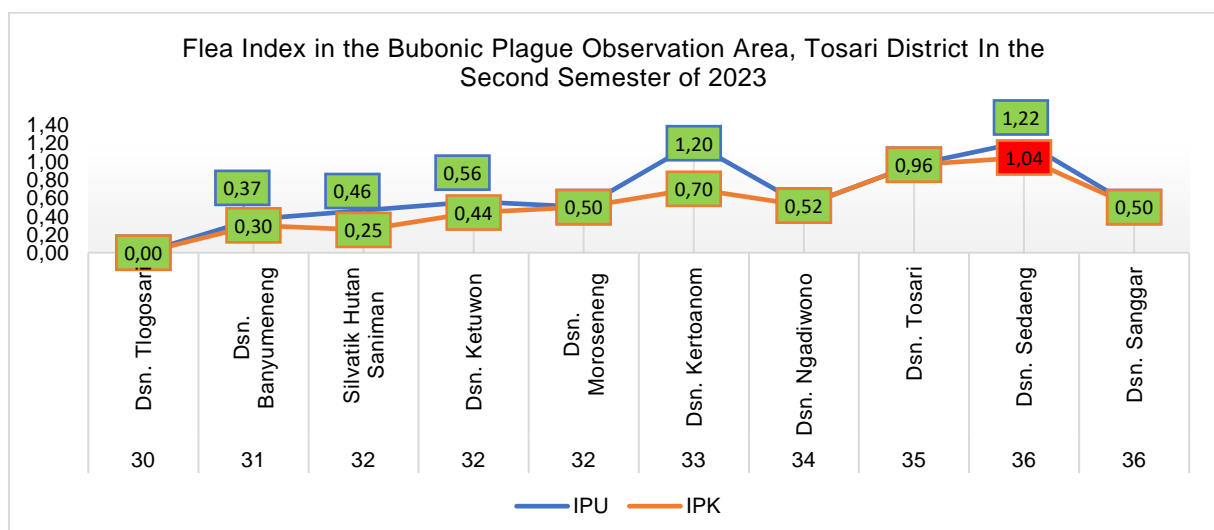
Based on graph 7 above, it is known that the highest general flea index and specific flea index in the second semester found in the 6 observation areas of Puspo Subdistrict is in Kopek Hamlet, Janjangwulung, which is 0.48. This shows that all bubonic plague observation areas in Puspo sub-district in the second semester can be declared safe based on the Flea Index because specific flea index or IPK < 1 and general flea index or IPU < 2.



Source : BBLabkesmas Surabaya, 2023

**Graph 8.** Flea Index in the Bubonic Plague Observation Area, Tosari District, in the First Semester of 2023

Based on graph 8 above, it is known that the highest general flea index in the 18 observation areas of the first semester is in Tosari Hamlet in Week 24, which is 1.39. While the highest specific flea index is also in the Tosari Hamlet area in Week 24, which is 1.06. This shows that Tosari Hamlet can be declared alert based on the Flea Index because specific flea index > 1. While the other first-semester observation areas in the Tosari Sub-district can be declared safe based on the Flea Index because specific flea index or IPK < 1 and general flea index or IPU < 2.



Source: BBLabkesmas Surabaya, 2023

**Graph 9.** Flea Index in the Bubonic Plague Observation Area, Tosari District In the Second Semester of 2023

Based on graph 9 above, it is known that the general flea index in the 10 highest second-semester observation areas in Tosari Subdistrict is in Sedaeng Hamlet, which is 1.22. While the highest specific flea index is also in the Sedaeng Hamlet area, which is 1.04. This shows that Sedaeng Hamlet can be declared alert based on the Flea Index because specific flea index or  $IPK > 1$ . While the other second-semester observation areas in the Tosari Subdistrict can be declared safe based on the Flea Index because specific flea index or  $IPK < 1$  and general flea index or  $IPU < 2$ .

## DISCUSSION

Rodent and Flea observations were conducted starting in the second week of 2023 until the 36th week of 2023. Data obtained from BBLabkesmas Surabaya is the result of observations from 82 observation areas and silvatic. In 82 areas, 2146 rats were observed, of which 630 rats with fleas (TDF). Rodent and flea observations were conducted in homes, gardens, and forests.

The species of rats found in the observation area were mostly *Rattus tanezumi* or house rats. This rat is known as a domestic rat which is found in many areas of the house such as roofs, rooms, kitchens, and storeroom, and sometimes also found in the garden around the house. (Direktur Jenderal Pengendalian Penyakit dan Penyehatan Lingkungan, 2014). Research by Hilal, Ngadiono, & Koemiasari, (2019) says that the most common type of rat found in the focus area of Pasuruan Regency is *Rattus tanezumi*. The species rat found is by the implementation of observations made in the area of the residents' homes.

The species rats found were *Rattus exulans* at 22.51%, *Hylomys suillus*, shrew (*Suncus murinus*), and other types of rats. *Rattus exulans* is a peridomestic rat that is mostly found in outdoor areas. This rat is also known as a field mouse. *Rattus exulans* were found in many observations in garden and forest areas. Other species found are silvatic area rats such as *Rattus tiommanicus* and *Rattus Niviventer* which are commonly found in forest areas. Silvatic areas are rat habitats far from human settlements that consume wild plants, live in forests, and have infrequent interactions with humans, (Direktur Jenderal Pengendalian Penyakit dan Penyehatan Lingkungan, 2014).

The species fleas found in the Bubonic Plague Observation Area of Pasuruan Regency in 2023 were *Xenopsylla cheopis* and *Stivalius cognatus*. The most common species found was *Xenopsylla cheopis* at 78%, while *Stivalius cognatus* was found at 22%. This indicates that the disease will be more easily transmitted through the bite of this type of flea, resulting in a higher risk of transmission of bubonic plague. This statement is by research conducted Riyanto, (2019) who said that the species flea found in the observation area of the incidence of Bubonic Plague in Nongkojajar, Pasuruan Regency were *Xenopsylla cheopis* and *Stivalius cognatus*, with *Xenopsylla cheopis* as the most dominant species. *Xenopsylla cheopis* is the most common species of flea found on the bodies of rats, especially in the tropics. The *Xenopsylla cheopis* species is the indicator of the specific flea index that is the main cause of the bubonic plague in Indonesia, (Kementerian Kesehatan Republik Indonesia, 2017).

According to WHO in Plague Manual Epidemiology, distribution, surveillance, and control, *Xenopsylla cheopis* is a species confirmed as a vector of bubonic plague (Ro'in, 2024). It is a cosmopolitan or *synanthropic* murine rodent. It is known as *synanthropic* because it lives in human settlements and is found in many home environments and is closely related to humans so it will greatly facilitate the transmission of bubonic plague such as *R. Tanezumi*, *Riol rats* or *Rattus norvegicus* and *Mus musculus*, (Direktur Jenderal Pengendalian Penyakit dan Penyehatan Lingkungan, 2014.)

According to Andyani, (2023) said that in the Bubonic Plague enzootic area in Surorowo Hamlet, one of the bubonic plague focus areas of Pasuruan Regency, the distribution of *Xenopsylla cheopis* flea was mostly found in domestic habitats. This statement is by the research of Hilal et al., (2019) who said that the species of *Xenopsylla cheopis* flea was most commonly found in the reservoir species of *Rattus tanezumi*. The most common species of flea found matched the most common type of reservoir rats.

*Stivalius cognatus* is the dominant flea in the mountainous areas of Java, Direktur Jenderal Pengendalian Penyakit dan Penyehatan Lingkungan, (2014). The observation area of Pasuruan Regency is a mountainous area with a height range of 500-1000 and <1000 meters above sea

level, so many fleas of this species are found. Kecamatan Tukur and Kecamatan Tosari are located at an altitude of >1000 meters above sea level, while Kecamatan Puspo and Pasrepan are located at an altitude of 500-1000 meters above sea level (Badan Pusat Statistik Kabupaten Pasuruan, 2023).

*Stivalius cognatus* flea are found in the main reservoir of peridomestic rats. Peridomestic rats mostly live outside the house and its surroundings, but sometimes they are also found inside the house. This type of rat is commonly found in plantations, rice fields, and home yards. Peridomestic rats include field rats *R. exulans*, rice field rats *R. argentiventer*, wirok rats *bandicota indica*, and field rats *M. cervicolor*, (Direktur Jenderal Pengendalian Penyakit dan Penyehatan Lingkungan, 2014). In the Bubonic plague enzootic area in Surorowo Hamlet, one of the bubonic plague focus areas in Pasuruan Regency, the distribution of *Stivalius cognatus* flea was found in silvatic habitats, (Andyani, 2023).

Based on graphs 1 and 2, it is known that Tukur sub-district was observed in 17 areas, namely 15 areas from the Nongkojajar Health Center and 2 from the Sumberpitu Health Center area. The general flea index and specific flea index in 17 hamlets in the first semester in Tukur sub-district were highest in Ngaruh hamlet, Nongkojajar health center, namely general flea index or IPU at 1.47, and specific flea index or IPK at 1.22. This indicates that Ngaruh Hamlet can be declared alert based on the Flea Index because specific flea index > 1. The results of observations in 16 other observation areas conducted in the first semester and 15 observation areas in the second semester in Tukur Sub-district can be declared safe, based on the Flea Index because IPK < 1 and IPU < 2.

The results of observations in the Pasrepan subdistrict based on graph 3 and graph 4 show that in 3 observation areas in the first semester and 4 observation areas in the second semester have specific flea index < 1 and general pinjal index < 2. The results of observations in the Puspo subdistrict based on graph 5 and graph 6 show that in 9 observation areas in the first semester and 6 observation areas in the second semester have special pinjal index < 1 and general pinjal index < 2.

Based on graph 7 and graph 8, it is known that the general flea index in the 18 observation areas of the first semester is highest in Tosari Subdistrict in Tosari Hamlet in Week 24, which is 1.39. While the highest specific flea index is also in the Tosari Hamlet area in Week 24, which is 1.06. The highest second semester observation results found in Tosari Subdistrict are in Sedaeng Hamlet, which is 1.22. While the highest specific flea index is also in the Sedaeng Hamlet area, which is 1.04.

This shows that Tosari Hamlet and Sedaeng Hamlet can be declared alert based on the Flea Index because the specific flea index > 1. The results of observations in 17 other observation areas conducted in the first semester and 9 observation areas in the second semester in the Tosari Sub-district can be declared safe, based on the Flea Index because specific flea index or IPK < 1 and general flea index or IPU < 2.

Based on the Regulation of the Minister of Health of the Republic of Indonesia 50 Year 2017, IPU has a threshold value of <2 and IPK <1. The observation results show that in 2023 there are observation areas that have a flea index that exceeds the threshold, namely Ngaruh Hamlet in Tukur Subdistrict and Tosari Hamlet and Sedaeng Hamlet in Tosari Subdistrict. This condition can cause a high potential for disease transmission, one of which is bubonic plague. This is confirmed by Ristiyanto in Nur Fadillatur Ro'in, (2024) that there is a potential for bubonic plague transmission if the specific pinjal index number shows > 1. According to Ristiyanto et al., (2020) there is also a significant relationship between the occurrence of bubonic plague cases and the flea index, especially in garden areas.

Factors that can support an increase in the flea index are the entry of forest rats carrying infective flea into settlements, causing them to attack domestic rats, or contact between rats and/or their fleas with bubonic plague sources in forest areas (Direktur Jenderal Pengendalian Penyakit dan Penyehatan Lingkungan, 2014). The influx of forest rats with effective flea and contact with domestic rats is due to land use changes that result in disruption of rat habitat and loss of food sources, so the rats move into settlements. This can transmit bubonic plague to house rats which can potentially infect humans. On the other hand, contact of rats and/or their flea with sources of bubonic plague in sylvatic areas may occur because these areas have forest

areas covered by bamboo and large trees that serve as breeding sites for rats near humans, allowing contact of rats and/or their flea with rats in residential areas.

The high number of flea index can also be influenced by the number of hosts or reservoirs of flea, namely rats. The observation area of Pasuruan Regency is a mountainous area with many agricultural lands that produce foodstuffs such as potatoes, chilies, and various kinds of vegetables. This can be an attractive place for rats to visit due to the availability of sufficient food as a source of life for rats. In addition, this observation area has an environment that supports the life of rats such as one of the observation areas of Surorowo Hamlet in the Tengger Bromo Semeru mountain range has a cold temperature with dry air that is favored by rats, (Ilmi et al., 2021).

Some other factors that can affect the flea index include temperature and rainfall, as well as increased rat density due to poor sanitation, such as increased waste volume without proper management, thus providing a place for rats to nest (Aanisah & Yudhastuti, 2022). In addition, physical environmental factors that affect the flea index are the type of walls of the house, the presence of windows, the presence of ceilings, and the temperature of the house (Ilmi et al., 2021).

Based on the Guidelines for the Investigation and Management of Extraordinary Events of Communicable Diseases and Food Poisoning (Guidelines for Disease Epidemiology), it states that alertness if one general variable and one or more technical variables are found. General variables include the condition of villages, hamlets, or neighborhoods experiencing famine or after a bumper harvest, disruption of rat habitat, forest fires, volcanic eruptions, earthquakes, the discovery of Ratfall, and an increase in the house rat population. Technical variables include general flea index or IPU  $\geq 2$ , specific flea index of *X. Cheopis*  $\geq 1$ , and positive serology results in rodents and humans, (Direktur Jenderal Pencegahan dan Pengendalian Penyakit, 2017). Observation areas that exceed the threshold of the flea index can be categorized as alert so that it is necessary to increase surveillance of humans, animals and the environment and follow-up.

## CONCLUSION

The number of rats found in the bubonic plague observation area in 2023 was 2146 rats, 630 of which were rats with flea. The species rat found was mostly *Rattus tanezumi* at 65.19%, followed by *Rattus exulans* at 22.51%, *Hylomys suillus*, shrew (*Suncus murinus*), and other species. The species flea found were *Xenopsylla cheopis* (78%) and *Stivalius cognatus* (22%). Bubonic plague alertness in Tukur Subdistrict, the first semester showed that the observation area of Ngaruh Hamlet was declared alert based on the fulfillment of one of the technical variables, namely IPK $>1$ , which was 1.22. In Pasrepan Subdistrict, all areas were declared safe in the first and second semester. In Kecamatan Puspo, all observation areas were also declared safe in the first and second semester. In Tosari Subdistrict, there are 2 observation areas that are declared alert, namely Tosari Hamlet and Sedaeng Hamlet because the specific flea index  $>1$  are 1.06 and 1.04 in the first and second semester respectively. This shows that the observation area of bubonic plague in Pasuruan Regency still needs to be aware of the transmission of bubonic plague. Therefore, it is important to maintain early awareness by monitoring the local area both through surveillance of rodents and fleas and surveillance in humans, as well as conducting prevention and control and other follow-up.

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