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Research article

Factors affecting the transmission of dengue fever in Haikou city in 2019

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Abstract: In this study, due to multiple cases of dengue fever in two locations in Haikou, Hainan, several factors affecting the transmission of dengue fever in Haikou in 2019 were analyzed. It was found that dengue fever spread from two sites: a construction site, which was an epidemic site in Haikou, and the university, where only four confirmed cases were reported. Comparative analysis revealed that the important factors affecting the spread of dengue fever in Haikou were environmental hygiene status, knowledge popularization of dengue fever, educational background, medical insurance coverage and free treatment policy knowledge and active response by the government.

Keywords: dengue fever; nonlinear regression model; descriptive statistics; control measures

1. Introduction

Dengue fever is an acute infectious disease caused by the dengue virus, transmitted by *Aedes* mosquitoes, which are mainly distributed in tropical and subtropical regions [1]. In the past half century, the incidence of dengue fever has increased more than 30 fold, becoming the most serious mosquito-borne disease in the world [2]. There were more than 3.9 billion people in approximately 129 countries living in dengue-endemic areas, and approximately 390 million people worldwide were infected with dengue fever [3−5]. According to data released by the World Health Organization, the number of dengue fever cases increased from 505,430 in 2000 to more than 2.4 million in 2010 and 4.2 million in 2019; the number of reported deaths increased from 960 to 4032 from 2000 to 2015 [3]. With the rapid increase in the incidence, the spread of dengue fever has become a severe public health problem [3].

Hainan Province was once an endemic area for dengue fever. Dengue outbreaks occurred in Hainan in the 1980s and 1990s, with more than 600,000 reported cases [6]. Subsequently, Hainan did not report a local case of dengue fever for a long time. Hainan experienced local transmission caused by imported cases for two consecutive years in 2018 and 2019, and an epidemic occurred in September 2019. Between September 5th to 8 o'clock on September 13th, 105 cases were reported in the province, resulting in a severe situation. On September 7th, Hainan Province initiated a level III emergency response to the dengue fever epidemic, held a provincial dengue prevention and control deployment meeting and organized a province-wide patriotic health campaign to reduce the density of mosquito vectors. The epidemic response was upgraded to a level II response on September 9th. A treatment expert group was established to implement fixed-point treatment centers for patients, and a joint prevention and control group was established to strengthen prevention measures and control the dengue fever epidemic [7]. By the end of 2019, the epidemic had been controlled.

Currently, the main factors that affect dengue fever epidemics are the density of mosquito vectors, the infection rate and the susceptibility of the population. Prevention and control methods mainly include managing the source of infection, interrupting the transmission route and protecting the susceptible population [8]. In recent years, research on dengue fever epidemic characteristics, its influencing factors and prevention and treatment methods has been conducted [9−15]. However, the local outbreak in Hainan over two consecutive years suggests that not all influencing factors of dengue fever epidemics have been thoroughly and systematically studied, potentially resulting in local outbreaks and incomplete prevention and control measures.

In this study, two dengue epidemic sites in Haikou, Hainan, in 2019 were selected (one was a construction site and the other was a university) to study the influencing factors of dengue transmission, with the goal of providing a scientific basis for dengue prevention and control.

2. Methods

2.1. Research sites

Two dengue fever outbreak sites in Haikou, Hainan, were selected in this study. One was a construction site on the west coast of northwestern Haikou city and is referred to as the construction epidemic site (the same below); the other was a university located in the middle of Haikou city and is referred to as the university epidemic site (the same below).

2.2. Data sources

The research data were mainly divided into two groups: the first was the data from local dengue fever cases in Haikou, Hainan, in 2019, and the second was the return visit data of dengue fever patients at the epidemic site studied. Dengue fever case data were provided by the local health and disease control agency. The data included basic information about dengue fever patients in Haikou in 2019, such as sex, age, occupation, case classification, dengue NS1 antigen detection, local or imported case, current address, onset time, confirmed diagnosis time, test results (virus type), discharge time, etc.

2.3. Telephone follow-up

We conducted case investigations and follow-up by telephone; additional data included the family's annual income level and the patient's educational background, medical insurance coverage, and awareness of dengue fever treatment policies. We obtained informed consent from the participants.

2.4. Data analysis

This study comparatively analyzed the data of typical dengue fever cases and control measures in Haikou, as well as the return visit data of cases. With Excel, R and other software, descriptive statistics were calculated, and nonlinear regression analyses were performed to identify the influencing factors of dengue fever transmission in Haikou.

2.5. News information collection

We collected news information related to dengue fever in Haikou from June 2019 to October 2019, including weather conditions during these five months, various dengue epidemic prevention and control documents issued by the Haikou municipal government and articles from various newspapers on methods citizens used to help control the epidemic.

3. Results

3.1. Situation of dengue fever in the construction epidemic site

According to the data of local cases of dengue fever in Haikou in 2019 provided by the Hainan Provincial Department of Health and Disease Control, a dengue fever epidemic occurred at the construction site in 2019, with a total of 65 clinically confirmed cases. The dates of onset for the first and last patients are September 1 and 16, and the dates of the first and last confirmed cases are September 5 and 16, respectively. The statistics of specific cases are shown in Table 1.

3.2. Situation of dengue fever at the university epidemic site

There was also an outbreak of dengue fever at a university during the same period, with 4 cumulative clinically confirmed cases. The dates of onset of the first and last cases were September 12 and 16, and the dates of the first and last confirmed cases were September 15 and 17, respectively. The statistics of specific cases are shown in Table 2. All four infected patients had a history of travel to Southeast Asia or the west coast of Haikou, and epidemiological investigations showed that they were all infected while traveling; all cases were considered imported cases, and transmission did not occur within or around the university epidemic site.

Table 1. Dengue fever infection at the construction epidemic site in September 2019.

Case number	Date of onset	Date of confirmed diagnosis	Number of new cases
1	September 1	September 8	1
2	September 2	September 7	6
3−7	September 2	September 8	6
8	September 3	September 8	1
9−10	September 4	September 7	6
11−14	September 4	September 8	6
15	September 5	September 5	10
16−23	September 5	September 8	10
24	September 5	September 10	10
25	September 6	September 7	4
26−27	September 6	September 8	4
28	September 6	September 10	4
29−37	September 7	September 8	10
38	September 7	September 9	10
39−44	September 8	September 8	6
45	September 9	September 9	4
46−48	September 9	September 10	4
49−50	September 10	September 10	3
51	September 10	September 11	3
52	September 11	September 11	1
53−59	September 12	September 12	7
60	September 13	September 13	3
61	September 13	September 14	3
62	September 13	September 17	3
63	September 14	September 14	1
64	September 15	September 16	1
65	September 16	September 16	1

Table 2. Dengue fever infection at the university epidemic site in September 2019.

Case number	Date of onset	Date of confirmed diagnosis	Number of new cases
1	September 12	September 15	1
2	September 14	September 15	1
3	September 15	September 15	1
4	September 16	September 17	1

3.3. Comparison of dengue infection data at the two epidemic sites

We compared the cumulative numbers of cases (symptoms) at the two epidemic sites from September 1 to 18, as shown in Figure 1. According to the regression analysis, the cumulative number of cases at the construction site was in accordance with the quadratic polynomial

$$y = -0.235x^2 + 8.5627x - 11.6961,$$

where y represents the cumulative number of cases, and x values represent the date from September 1 to 18, as detailed in the yellow dotted line in Figure 1. The corresponding p-value is $2.6467 \times 10^{-15} < \alpha$ at the significance level $\alpha = 0.05$, the regression equation is significant, and thus the regression model holds.

Figure 2 shows the comparison of the cumulative numbers of confirmed cases between the two sites from 5 to 18 September. Regression analysis revealed that the number of diagnosed cases at the construction epidemic site was larger than the number of cases at the university epidemic spot, in accordance with the logistic function

$$y = \frac{65}{1+e^{0.0505301x^2-1.35171x+5.05697}},$$

where y represents the cumulative number of diagnosed cases, and x represents the date from September 5 to 18, as detailed in the yellow dotted line in Figure 2. Here, the effect of the polynomial regression model is not ideal. According to the characteristics of the actual data, we choose the common logistic model of population dynamics for fitting. The corresponding p-value is $2.46 \times 10^{-10} < \alpha$ at the significance level $\alpha = 0.05$, the regression equation is significant, and thus the regression model holds.

It is obvious from Figures 1 and 2 that dengue fever spread from the construction epidemic site, and the number of infections and confirmed cases continually increased until control was achieved on the 16th. According to the epidemiological survey conducted by our project team, the cases from the university epidemic site were all imported, and no transmission occurred. According to the regression model, there was a large difference between the number of patients with onset and the number of confirmed cases at the construction epidemic site, which suggests that there were different distribution characteristics.

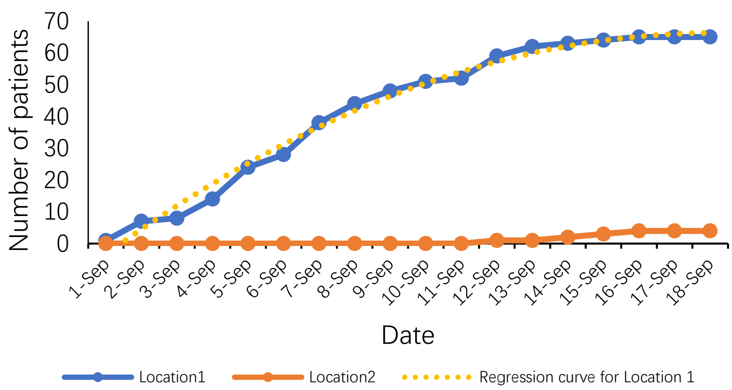

Figure 1. Cumulative numbers of dengue fever patients at the construction epidemic site (Location 1) and the university epidemic site (Location 2) from September 1 to 18, 2019.

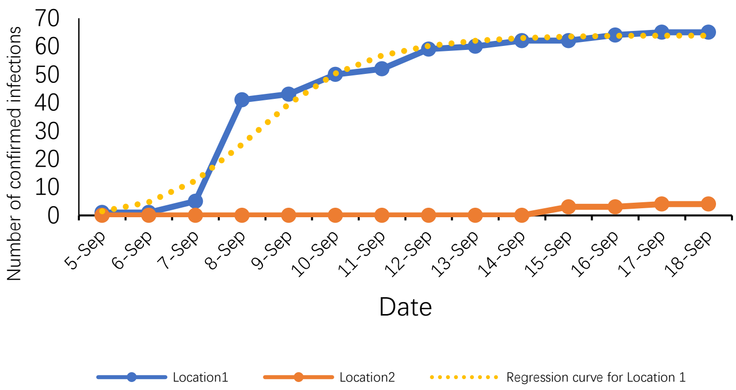

Figure 2. Cumulative numbers of confirmed cases of dengue fever at the construction epidemic site (Location 1) and the university epidemic site (Location 2) from September 5 to 18, 2019.

3.4. Time of confirmed diagnosis

We counted the average time interval between symptom onset and confirmed diagnosis at the construction and university epidemic sites (see Figure 3). The abscissa in the figure shows the dates of onset, and the ordinate corresponds to the average numbers of days until diagnosis for all those with symptoms on that date. Figure 3 shows that when dengue fever occurred at the construction site on September 1, the interval from symptom onset to confirmed diagnosis was long. The first patient with symptom onset on September 1 was not confirmed until 7 days later. For those with symptom onset on September 2, it took an average of 5.8 days to receive a confirmed diagnosis, and the patient who became ill on September 3 received a confirmed diagnosis 5 days later. Subsequently, with the strengthening of publicity regarding the prevention and treatment of dengue fever, the interval between onset and confirmed diagnosis gradually decreased, and beginning on September 7, cases were mostly confirmed in approximately 1 day, with an average of 0.57 days. On the other hand, the average time from symptom onset to confirmed diagnosis in the 4 patients at the university epidemic site was 1.25 days, which was much shorter than the average diagnosis time of 3.29 days at the construction epidemic site before September 6.

We carried out a regression analysis of the average diagnosis time of the patients at the construction epidemic site and observed a decreasing exponential trend:

$$y = \frac{4.68621}{e^{0.265064x - 0.729322}},$$

where y represents the average time interval between symptom onset and confirmed diagnosis, and x represents the date from September 1 to 16, as shown by the yellow dotted line in Figure 3. The corresponding p-value is $1.52 \times 10^{-10} < \alpha$ at the significance level $\alpha = 0.05$, the regression equation is significant, and thus the regression model holds. The time of confirmed diagnosis decreased gradually and exponentially.

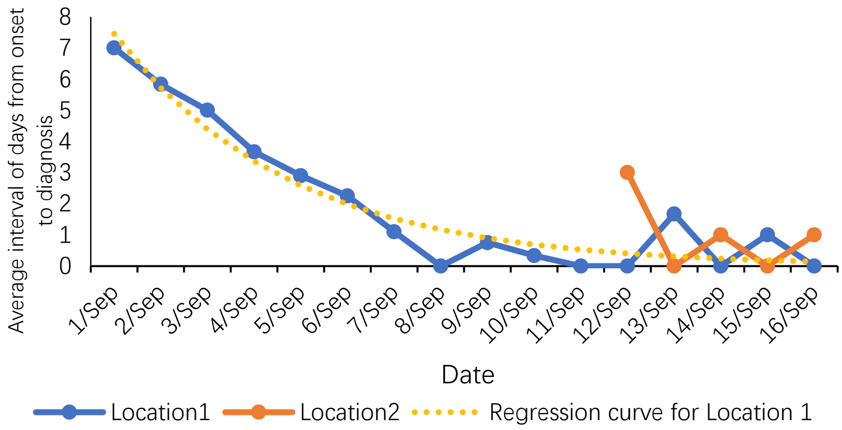

Figure 3. Average time intervals between the onset of dengue and confirmed diagnosis of dengue at the construction epidemic site (Location 1) and the university epidemic site (Location 2) from September 1 to 16, 2019.

3.5. Incidence tendency at the construction epidemic site

To further study the incidence tendency of cases at the construction epidemic site, statistics were calculated according to the number of cumulative cases over 3 days (Figure 4). The incidence was the highest from September 5 to 7, with 24 cases, and then steeply declined over the subsequent 3 days, and it finally stabilized at approximately 11 cases. From September 13−15, the number of cases decreased sharply again.

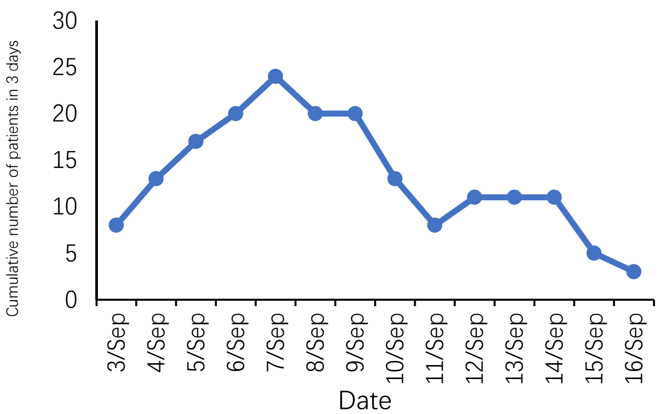

Figure 4. Cumulative number of cases over 3 days at the construction epidemic site.

3.6. Sex and age of the patients

The ages of the 4 patients at the university epidemic site, including 2 males and 2 females, were 24, 43, 53 and 63 years old, and there was no obvious tendency in terms of age or sex. The sex and age distributions of the population infected at the construction epidemic site are shown in Figure 5. As seen in the figure, the number of males infected at the epidemic spot was significantly larger than that of females. In terms of age distribution, the patients infected at the construction epidemic site were mostly in the range of 21−50 years old, accounting for 83.1%, among whom the number of patients aged 41−50 years old was the largest, reaching 44.6%.

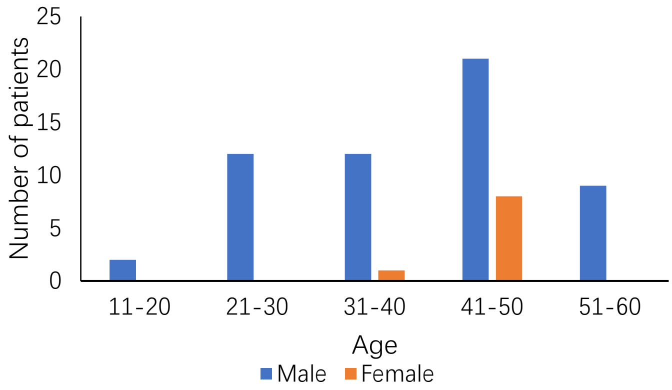

Figure 5. Sex and age distributions of patients infected at the construction epidemic site.

3.7. Occupational distribution of cases

According to the case records, among the 65 people infected at the construction epidemic site, 63 people were workers, accounting for 97% of the total. 1 person had missing records, and 1 person had a different occupation. Among the 4 people at the university epidemic spot, one was a retired teacher, one was an undergraduate student, and two were employed workers at the university. The occupational distribution at the university was different from the occupational distribution at the construction epidemic site.

3.8. Case follow-up information

According to the method in Section 2.2, we conducted telephone follow-ups for the people infected with dengue fever at the construction epidemic sites and the university epidemic site. Among the people infected at the construction epidemic site, 9 people were willing to participate in the follow-up and provided data. All 4 people infected at the university epidemic site participated in the follow-up. We made a telephone return visit to all infected people at the construction site, but only a small number of them were willing to be followed up with. Most of them had some resistance to the disease and were not willing to be interviewed. A small number of samples would have a certain impact on our follow-up analysis, but it just shows that the public's understanding of dengue disease will greatly affect its transmission, as discussed in the following sections.

3.9. Patient income levels

Among the followed patients from the construction epidemic site, 3 people had an annual family income of RMB 10,000−40,000, accounting for 33% of the total, 2 people had an income of RMB 40,000−80,000, accounting for 22.2%, 1 person had an income of RMB 80,000−100,000, accounting for 11.1%, and 3 people had incomes of more than RMB 100,000, accounting for 33.3%.

Among the 4 people infected at the university epidemic site, 1 person had an annual family income of more than RMB 100,000, one had an income of RMB 80,000−100,000, one had an income of RMB 40,000−80,000, and one had an income of RMB 10,000−40,000, each accounting for 25%. There was no obvious difference in the income distribution between the two sites.

3.10. Educational background

Among the patients that completed follow-up from the construction site, 6 people had an educational level of junior high school or below, 2 people had an educational level of senior high school, and 1 person had an educational level of university. Thus, only 11% were highly educated. Among those infected at the college, 2 people had an education level of university, and 2 people had an educational level of junior middle school or below, which shows that 50% had achieved higher education. The people infected at the university had a higher level of education than those infected at the construction site.

3.11. Health insurance coverage

Among the patients who completed follow-up from the construction site, 6 people had medical insurance, and 3 people had no medical insurance. The proportion with medical insurance accounted for 66.7%. One hundred percent of the people infected at the university had medical insurance.

3.12. Knowledge of dengue treatment reimbursement policy before the visit

Among the patients who completed follow-up from the construction site, 7 people were unaware of the reimbursement policy, and 2 people were aware of the policy, accounting for only 22.2%. It is particularly noteworthy that the two people who knew about the reimbursement policy did not have health insurance. None of the people infected at the university knew about the reimbursement policy.

3.13. Access to information about dengue fever treatment

Among the patients who completed follow-up from the construction site, 2 people obtained information about dengue treatment from community workers, and 7 people obtained information from hospitals. Among the 4 people infected at the university, 2 people obtained dengue fever information from school and community publicity campaigns, and 2 people obtained information from hospitals. The university epidemic site had a higher proportion of patients who accessed dengue treatment information from non-hospital sources.

4. Discussion

The two epidemic sites in Haikou are approximately 23 kilometers apart, and it is unlikely that mosquitoes traveled between the two sites. Therefore, the dispersion and transmission of dengue fever in the two selected regions had a certain degree of independence. It is worth pointing out that the total number of 4 cases of dengue infection in the university area is relatively small, but this is precisely due to the population characteristics of the region that lead to the lack of dengue spread.

Correspondingly, in another area, the number of infections in the early stage is also small, but the subsequent spread of dengue fever has a larger overall number of infected samples. The spread of dengue fever in the two regions is in sharp contrast, so the relevant discussion is instructive.

4.1. Sanitation

The China Meteorological Administration [16] reported that the weather in Haikou had been hot and humid since June 2019, which was not only conducive to mosquito breeding but also increased the need for prevention and control measures for mosquito-borne diseases. After the outbreak of dengue fever, the Haikou Social Civilization Operation Headquarters [17] proposed to reduce mosquito density and the dispersion and transmission of dengue fever Haikou city. On September 14, the city began conducting mosquito control, with three rounds: the first concentrated mosquito control period was September 14−18, the second period was September 19−24, and the third period was September 25−30. Chengyong Hu [18], a reporter from the Nanguo Metropolis Daily, pointed out that at the same time of direct elimination of mosquitoes, the Haikou Municipal Government called on all people to participate in "clean courtyard" activities, which involved eliminating mosquito breeding locations, which is the most fundamental and effective measure for mosquito prevention and control. All street communities actively responded to the government's call to carry out antimosquito and hygiene campaigns. They used seven methods to mitigate mosquito breeding. First, idle containers containing standing water were dumped and inverted. Second, rubbish, such as plastic films and disposable plastic containers, was removed, placed on corners and thoroughly cleaned. Third, lids were placed on drinking water containers and functional water containers, and the water was changed every 5−7 days. If the water was not changed, mosquito fish were added. Fourth, water in vases and tanks with aquatic plants was changed every 5−7 days. The inner walls of the containers were thoroughly cleaned, and if the water was not changed, mosquito fish were added. Fifth, bamboo trunks and tree holes were filled with sand in parks and other attractions to avoid pooling. Sixth, tires were placed in rainproof locations or covered with rainproof cloth to avoid pooling; if there was pooling, waste tires were perforated or treated with mosquito repellent. Last, ponds that could not be drained were treated with long-term mosquito repellent [19]. All the methods mentioned above are conventional and can effectively control the breeding of mosquitoes to achieve mosquito control in a city. According to Figures 1 and 4, dengue fever was well controlled and did not rebound after the large-scale antimosquito campaign at the Haikou construction site in mid-September. Dengue fever in the university epidemic site was imported mainly during the period of mosquito control, which is an important reason why dengue fever did not spread at the university epidemic site. Thus, killing the *Aedes* mosquito vector that transmits dengue fever is an effective way to prevent the spread of dengue fever.

4.2. Popularization of disease knowledge

Among patients infected in the early stage of the epidemic at the construction site, there was a long time interval from symptom onset to confirmed diagnosis. For example, some workers at the construction site had been ill since September 1, but infection was not confirmed until the 8th. Among the six patients who fell ill on the 2nd, one received a confirmed diagnosis in the hospital on the 7th, and the remaining five received confirmation on the 8th. In contrast, the confirmed diagnosis time of patients infected at the university epidemic site was relatively short (Figure 3). According to the results in Section 3, on September 7, the diagnosis time of patients infected at the construction epidemic site decreased to approximately 1 day, and at this time, the cumulative number of cases over 3 days at the construction epidemic site also peaked and continued to decline after that. Thus, for the epidemics of dengue fever, early diagnosis played an important role in preventing the rapid spread of the disease at the university epidemic spot. There were many reasons for the prolonged time to confirmed diagnosis. According to the follow-up data, the main reason was the general lack of knowledge about the prevention and control of dengue fever among the people at the construction epidemic site. The initial symptoms of dengue are similar to those of a common cold. In the absence of relevant knowledge, patients mistook their symptoms for a cold, and they practiced moderate rest for self-observation or bought over-the-counter cold drugs from pharmacies for conservative treatment. Only after a few days, when the symptoms persisted or became more serious, did they consider going to the hospital. In the early stage of the construction site epidemic, the time from symptom onset to confirmed diagnosis was more than 5 days, during which the patients were not quarantined, leading to the rapid spread of the disease in the early stage of the outbreak. As shown in Figure 3, with the improvement in publicity on the prevention and treatment of dengue fever, starting on the 7th, the time from onset to confirmed diagnosis was reduced to an average of 0.57 days. Subsequently, on the basis of the popularization of disease knowledge, many patients who suspected they were infected with dengue went to the hospital and were isolated on the day of onset, resulting in control of the spread of dengue. Figure 4 also shows that since the 7th, the cumulative number of cases in the three days no longer increased, and the trend of disease spread was contained. Finally, the spread of dengue at the construction epidemic site was controlled. In contrast, the university and the surrounding community carried out large-scale publicity campaigns on the prevention and control of dengue fever during the middle of the outbreak of dengue fever. Therefore, it was recorded at follow-up that the persons infected at the university epidemic site had a better understanding of dengue fever. Therefore, after they traveled back from Southeast Asia or returned from the west coast of Haikou, they visited the hospital at the onset of symptoms and discomfort associated with dengue. Quarantine and treatment were administered within an average of 1.25 days, and there was no further spread of dengue in the region. The longer the interval between the onset of the disease and the confirmed diagnosis was, the greater the risk of disease spread. In addition, during the telephone follow-up, all four follow-up personnel in the university area had a high awareness of the importance of dengue fever prevention and control. As a result, all individuals actively cooperated with the follow-up, hoping to contribute their cases to the prevention and control of dengue fever. In contrast, many infected individuals at the construction site had insufficient knowledge about dengue fever prevention and control and a limited understanding of its importance. Consequently, many of them believed that providing their personal dengue fever case information to research institutions would be of little significance and refused to be interviewed. The above discussion suggests that knowledge popularization of dengue is an important factor affecting transmission, and it is necessary to strengthen scientific publicity on the prevention and treatment of dengue so that the public has a certain degree of understanding of the symptoms, characteristics and treatment and will seek medical treatment early when related symptoms occur. This will effectively control the spread of dengue fever.

4.3. Educational level

According to the follow-up results, the proportion of people with a higher education level who were infected at the university epidemic site was higher than that of those who were infected at the construction site. During follow-up, it was also found that people with a higher education level were more likely to report seeing popular scientific public information about dengue epidemic prevention, such as billboards and media clips; were better able to judge suspected infection when symptoms appeared; and were more actively involved in medical examinations and treatment than those with a lower educational level. Considering this and the discussion in the previous section, it is believed that a higher level of education is beneficial to the prevention and treatment of dengue fever.

4.4. Health insurance coverage and free treatment policy knowledge

According to the follow-up data, 66.7% of the people infected at the construction epidemic site had medical insurance, while 100% of the patients infected at the university epidemic site had medical insurance. Through follow-up calls, it was found that health insurance coverage also had an important impact on early medical treatment seeking at the time of onset. Generally, people with health insurance are more willing to go to the hospital early than those without health insurance, which is another important factor leading to the obvious difference in confirmed diagnosis time between the two sites (Figure 3). As those infected at the university epidemic site were fully covered by medical insurance, they had a higher willingness to go to the hospital early, and the time until confirmed diagnosis was relatively short. In addition, isolation treatment of dengue fever incurs higher costs. Although the Hainan Provincial Government has a policy to provide free treatment for dengue fever, the follow-up data revealed that the rate of awareness of this policy was very low, at only 22.2% among those infected at the construction epidemic site. This is another reason for the longer time between symptom onset and early diagnosis in those infected at the construction epidemic site. As shown in Figure 3, the interval between symptom onset and confirmed diagnosis at the construction site continued to shorten exponentially, which was largely due to increased public understanding of the free treatment policy after increased publicity, especially in the later stage, during which infection was confirmed on the same day as onset. Without worries about medical expenses, people were able to see a doctor in time and receive treatment as soon as possible. Moreover, although the four patients infected at the university epidemic site were not aware of the free medical policy in advance, they visited the hospital for treatment in a relatively short period of time because they all had medical insurance. This is another reason why the disease at the university epidemic spot did not spread beyond the four imported cases.

4.5. The Government's positive response

In 2019, the epidemic of dengue fever in Hainan in both the local transmission area and the imported area was finally well controlled. Some important factors influencing dengue control were as follows: The local government departments conducted positive responses; appropriately abandoned the interests of tourism, entertainment and other industries; and focused on implementing a variety of measures. The Leading Group (enlarged) Meeting of Haikou City Dengue Prevention and Control and Social Civilization Operation [20] put forward the following proposals: First, they resolutely shouldered the responsibility and earnestly safeguarded the health of the people. Second, they strengthened joint prevention and control measures, and mosquito prevention and control measures were carried out in all locations without restrictions. Third, based on multiparty coordination, the measures formulated by the headquarters were fully ensured and implemented and were carried out in an effective manner. Fourth, the accountability of supervision and management was strengthened, the implementation of mitigation strategies was urged, and those who were ineffective in their work were held accountable. Fifth, the publicity of prevention and control knowledge was strengthened, and a positive atmosphere in which everyone could take action to prevent disease transmission and achieve control was created. Through the above measures taken by the government, the dengue fever outbreak in Hainan Province in 2019 was quickly controlled.

5. Conclusions

In view of the different transmission characteristics of dengue fever in two locations in Haikou, we analyzed some factors affecting the transmission of dengue fever in Haikou in 2019. Based on the comparative analysis of the characteristics of the dengue fever outbreaks at the Haikou construction site and at the university epidemic site, several important factors affecting the spread of dengue fever in Haikou were identified.

5.1. Environmental hygiene

With the implementation of mosquito control measures in Haikou, the dengue fever epidemic was rapidly controlled, and eliminating the transmission vector was a very effective control method.

5.2. Popularization of disease knowledge

The initial symptoms of dengue fever are similar to those of a common cold, which indicates that we need to strengthen the publicity of dengue fever prevention and treatment so that the public has a certain understanding of symptoms, characteristics and treatment. Consequently, cases can be identified, and isolation and treatment can be carried out in a timely manner.

5.3. Educational background

People with a higher education level are more likely to accept popular scientific propaganda on dengue epidemic prevention, such as billboards and media; they can better judge suspected infection and participate in medical treatment of symptoms.

5.4. Health insurance coverage and free treatment policy knowledge

Treatment of dengue fever can incur higher costs. If the government increases health insurance coverage or provides free medical care, people will be able to see a doctor in a timely manner and receive treatment as soon as possible, providing opportunities to control the spread of dengue fever. At the same time, the government should publicize the free treatment policy to increase awareness of this policy among residents.

5.5. Positive response of the government

The government conducted a positive response; appropriately abandoned the interests of tourism, entertainment and other industries; and concentrated its efforts on implementing a variety of measures to strengthen responsibility, joint prevention and control, and multiparty coordination, which was an important aspect of rapid control after the outbreak of dengue fever in Hainan in 2019.

Use of AI tools declaration

The authors declare they have not used Artificial Intelligence (AI) tools in the creation of this article.

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Conflict of interest

The authors declare no competing interests.

Data sharing

With the permission of the corresponding authors, we can provide participant data without names and identifiers but not the study protocol, statistical analysis plan or informed consent form. Data can be provided after the Article is published. Once the data can be made public, the research team will provide an email address for communication. The corresponding authors have the right to decide whether to share the data or not based on the research objectives and plan provided.

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