Scientific Research Publishing

Advances in Infectious Diseases, 2024, 14, 712-722
https://www.scirp.org/journal/aid
ISSN Online: 2164-2656
ISSN Print: 2164-2648

Outbreak Investigation of Dengue in Byas Municipality, Tanahun, Gandaki Province, Nepal

Ramesh Shrestha[1], Amar Dawadi[1], Gyanu Poudel[1], Neeru Magar[1], Suma Kunwar[1], Uma D.C.[1], Yashoda Poudel[1], Damaru Prasad Paneru[2]

[1]School of Health and Allied Sciences, Pokhara University, Pokhara, Nepal
[2]Faculty of Health Science, School of Health and Allied Sciences, Pokhara University, Pokhara, Nepal
Email: rameshshrestha0826@gmail.com

How to cite this paper: Shrestha, R., Dawadi, A., Poudel, G., Magar, N., Kunwar, S., D.C., U., Poudel, Y. and Paneru, D.P. (2024) Outbreak Investigation of Dengue in Byas Municipality, Tanahun, Gandaki Province, Nepal. *Advances in Infectious Diseases*, **14**, 712-722.
https://doi.org/10.4236/aid.2024.144053

Received: July 12, 2024
Accepted: November 23, 2024
Published: November 26, 2024

Abstract

Introduction: Dengue fever, a viral disease transmitted by Aedes mosquitos, is a major global health issue. Dengue fever has become a major public health concern in Nepal, with recurring epidemics. This study explores the recent Dengue outbreak in Byas Municipality of Tanahun district aiming to identify significant risk factors and make recommendations for prevention and control. **Methods:** A cross-sectional descriptive study was conducted in Byas Municipality of Tanahun district of Nepal. A structured questionnaire was used to collect socio-demographic, clinical, environmental, and behavioral data from 101 confirmed and suspected Dengue cases. The classification of Dengue was done based on World Health Organization (WHO) case definitions. The data were entered into EpiData 3.1 and analyzed using SPSS 25. Approval was obtained from the district-level Health Office, Tanahun, and informed consent was obtained from all the participants. **Results**: The majority of the cases were aged 15 - 44 years (61.4%), with females (58.4%) accounting for more than the counterpart males. Major symptoms reported include fever (100%), followed by lethargy (64.4%) and headache (60.4%). Key risk factors identified include limitation of daytime use of bed nets, close contact with infected individuals, and inadequate use of mosquito repellents. The epidemic curve showed multiple peaks, indicating a propagated outbreak. **Conclusion:** The Dengue outbreak in Byas Municipality shows the complex transmission dynamics with multiple peaks which indicate a propagated outbreak. The findings emphasize the need for targeted public health interventions focusing on education, vector control, and demographic-specific measures to mitigate Dengue transmission in the region.

Keywords

Dengue, Outbreak, Risk Factors, Vector Control

1. Introduction

Dengue is a viral disease caused by the Arbo virus, transmitted by the bite of *Aedes aegypti* and, infrequently, by the bite of *Aedes albopictus* mosquitoes. It poses a threat to people worldwide [1] [2]. All the serotypes (DENV1-4) are closely related but, after exposure, provide lifelong immunity to only one serotype of the virus and give the infected a severe disease on subsequent infection [3]. Antibody-dependent enhancement can exacerbate the severity of a different serotype during subsequent infection [4]. Dengue can spread through blood transfusion, organ donation, from an infected pregnant mother to her fetus, or the bite of an infected mosquito [5]. The majority of cases are mild, but severe symptoms include macular skin rash, high fever, headache, swollen glands, nausea, vomiting, myalgia, joint discomfort, and life-threatening consequences such as multi-organ failure, acute Dengue hemorrhagic fever (DHF), and Dengue shock syndrome (DSS) [6] [7]. Dengue has no specific antiviral treatment, and recovery usually takes 2 - 7 days. The best defense is to avoid mosquito bites. Early detection and treatment of symptoms are critical for preventing complications and virus propagation [3] [8]-[10].

World Health Organization (WHO) reported that Dengue cases have increased eightfold in just over two decades, from roughly half a million in 2000 to more than 4.2 million in 2022 [11]. It is one of the most serious vector-borne diseases in the world, with a high rate of morbidity and mortality. It remains endemic in more than 100 countries, and it is highly prevalent in Southeast Asia [12].

The first case of Dengue fever was reported in Nepal in 2004 by a Japanese traveler. Soon after the emergence of this disease, the illness rapidly evolved into an escalating threat, which produced repetitive epidemics affecting lowland regions and parts of mid-hills. Big outbreaks are on record in 2006, 2010, 2016, 2019, 2022, and 2023 and follow a 2 - 3 year cycle [13] [14].

The Dengue outbreak has spread to Damauli in Byas Municipality, an administrative headquarters for the Tanahun district. There were 1800 cases of Dengue reported as of Tuesday, October 10, 2023. The Tanahun health office reports that since September 19, 2023, three people have died due to Dengue infection [15].

An investigation was launched to better understand the Dengue outbreak in Byas Municipality of Tanahun District of Nepal, which is following an increase in cases. The study aimed to determine the scope of the outbreak by analyzing Dengue cases by time, place, and person. The goal is to determine the scale of the outbreak, to map case distribution over time and place, and to identify relevant risk factors. The purpose was to present recommendations for effective Dengue prevention and control techniques in Byas Municipality of Tanahun.

2. Data and Methods

An outbreak investigation was carried out in Byas municipality of Tanahun district, Nepal, in October 2023. To understand the epidemic situation and risk factors, the cross-sectional descriptive study was conducted by interviewing 101 confirmed and suspected Dengue cases using a structured questionnaire. Socio-demographic, clinical, environmental, and behavioral risk factors information were collected and the World Health Organization (WHO) case definitions were used for suspected and confirmed Dengue cases, to ensure standard classification. Collected data were entered in Epidata 3.1 and analyzed using SPSS 25. Approval was obtained from the district-level Health Office of Tanahun. Informed consent was obtained from all the participants before the study.

3. Results

The research included 101 individuals with confirmed or suspected cases of Dengue. The majority (61.4%) of the participants were 15 - 44 years old, with females outnumbered (58.4%) of their male counterparts. Similarly, the majority (62.4%) of the cases were Janajati and other ethnic groups. In the same way, 33.7% had either basic or secondary-level education. The highest proportion of the cases (30.7%) were students, followed by almost a quarter (23.8%) engaged in business activities, with 21.8% government job holders and others depicted in Table 1.

Table 1. Socio-demographic characteristics of the participants.

Variables	Characteristics	Frequency (n = 101)	Percent (%)
Age	<15 Years	14	13.9
	15 - 44 Years	62	61.4
	>44 Years	25	24.8
Sex	Female	59	58.4
	Male	42	41.6
Ethnicity	Janajati and others (Dalit and Madhesi)	63	62.4
	Brahmin/Chhetri	38	37.6
Educational level	Illiterate	4	4
	Literate	14	13.9
	Basic education (Grades 1 - 8)	34	33.7
	Secondary education (Grades 9 - 12)	34	33.7
	Bachelor and above	15	14.9
Occupation	Students	31	30.7
	Business	24	23.8
	Government job service	22	21.8
	House person	18	17.8
	Private Job	6	5.9

Note: In Nepal, the term "Janajati" typically refers to Indigenous ethnic groups, and "Dalit and Madhesi" refer to marginalized community populations. "Brahmin/Chhetri" refers to the high-caste groups traditionally considered upper caste within the social hierarchy.

Significant trends are apparent in the history of Dengue cases in Byas municipality, Tanahun, spanning from August 22, 2023, to October 8, 2023. The initial case appeared on August 22, with a gradual rise and subsequent fall in the same month. Significantly, there was a peak in the number of cases on September 30, showing a period of intense transmission. A decrease occurred from October 2 to October 3 following the peak. However, there was a second increase in cases from October 4 to October 6. The multiple peaks observed on the epidemic curve suggest a propagated outbreak, highlighting the continuous and complex dynamics of Dengue transmission in the area. (Figure 1)

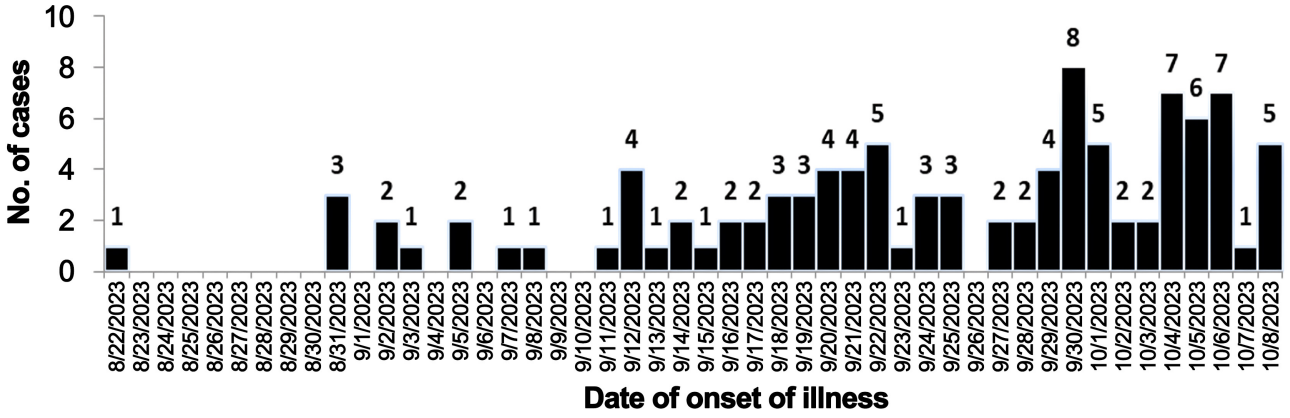

Figure 1. Epidemic curve of Dengue cases outbreak by date of onset.

The clinical manifestations of Dengue among the study participants are summarized in Table 2. The most common symptom reported was fever (100%) followed by lethargy/restlessness (64.4%) and reported headaches (60.4%). Myalgia/arthralgia was noted among 56.4% of the cases. Nearly half of the participants (47.5%) experienced nausea, with almost a quarter of them (23.8%) reported abdominal pain. Likewise, 16.9% of the participants reported rashes. Other reported symptoms include hemorrhagic manifestations, exanthema, and itching skin, as shown in Table 2.

Table 2. Clinical symptoms reported by study participants.

S.N	Categories	Frequency (n = 101)	Percent (%)
1	Fever	101	100
2	Lethargy, restlessness	65	64.4
3	Headache/retro-orbital pain	61	60.4
4	Myalgia/Arthralgia	57	56.4
5	Nausea	48	47.5
6	Abdominal pain	24	23.8
7	Rash or hemorrhagic manifestation/Exanthema/Itching skin	17	16.9

*Multiple Response.

The behavioral and environmental factors related to Dengue among the study participants are outlined in Table 3. A history of previous infection was reported by 8.9% of participants. The majority of them had bed nets available (95%) with them, and more than four out of every five used them in night sleep (83.2%). However, just 7.1% of individuals who utilized bed nets while sleeping at night also used them while sleeping during the day. In 5.9% of households, containers with water were found either open or left unattended, and of these cases, larvae were discovered in 16.7%. Similarly, 25.7% of participants reported having had close contact with people who had a similar illness in the past two weeks. Furthermore, 7.9% of cases reported a history of travel to Dengue-affected areas in the last 14 days. Only a few (5.9%) of the participants reported that they had used mosquito repellent on their skin, whereas only 29.7% were wearing long-sleeved clothing. Likewise, 1% of participants mentioned a garage located within 100 meters of their home or workplace.

Table 3. Environmental and behavioral risk factors for Dengue infection.

S.N	Variables	Frequency (n = 101)	Percent (%)
1	History of the previous infection	9	8.9
2	Bed net available	96	95
3	Bed nets used during nighttime sleeping	84	83.2
4	If Yes, Bed net used during daytime sleeping (n = 84)	6	7.1
5	Water container open or discarded pot or tire containing water	6	5.9
6	If yes, larvae identified (n = 6)	1	16.7
7	Close contact with a similar illness in the last 2 weeks	26	25.7
8	Travel history at Dengue affected area within 14 Days	8	7.9
9	Use of mosquito repellent on the skin	6	5.9
10	Wearing long-sleeved clothes	30	29.7
11	Garage nearby (around 100 meters) home or workplace	1	1

Table 4 illustrates the association between bed net use at night time and other socio-demographic factors. Chi-Square test was used to test the significant differences between the different outcomes by the respective covariates at the significance level <0.05. Participants <40 years used bed nets more frequently (85.3%) than those 40 years and older (78.8%), however, the difference is not statistically significant. Men had a higher tendency to use the bed nets (90.5%) than their counterpart women (78%).

Significantly higher proportion of the Brahmin/Chhetri used the bed nets more frequently (94.7%) than others ($p < 0.01$).

The use of mosquito repellent in the study population was low across all demographic categories. Although a higher proportion of individuals aged 40 years and

above reported repellent use compared to those under 40, this difference was not statistically significant (P = 0.06). Similarly, no significant associations were observed between repellent use and sex (P = 0.66) or ethnicity (P = 0.82). (Table 5)

Table 4. Distribution of bed net use while sleeping at night among participants by age, sex, and ethnicity.

Variables	Characteristics	Bed net use while sleeping at night		Significance level
		Yes	No	
Age	Less than 40 years	58 (85.3%)	10 (14.7%)	P = 0.41
	40 years and above	26 (78.8%)	7 (21.2%)	
Sex	Female	46 (78%)	13 (22%)	P = 0.09
	Male	38 (90.5%)	4 (9.5%)	
Ethnicity	Brahmin/Chhetri	36 (94.7%)	2 (5.3%)	P = 0.01
	Janajati and others (Dalit and Madhesi)	48 (76.2%)	15 (23.8%)	

Table 5. Distribution of mosquito repellent use on the skin among participants by age, sex, and ethnicity.

Variables	Characteristics	Use of mosquito repellent on the skin		Significance level
		Yes	No	
Age	Less than 40 years	2 (2.9%)	66 (97.1%)	P = 0.06
	40 years and above	4 (12.1%)	29 (87.9%)	
Sex	Female	3 (5.1%)	56 (94.9%)	P = 0.66
	Male	3 (7.1%)	39 (92.9%)	
Ethnicity	Brahmin/Chhetri	2 (5.3%)	36 (94.7%)	P = 0.82
	Janajati and others (Dalit and Madhesi)	4 (6.3%)	59 (93.7%)	

Table 6. Distribution of participants wearing long-sleeved vs. short-sleeved clothes by age, sex, and ethnicity.

Variables	Characteristics	Type of clothes wear		Significance level
		Long sleeved	Short sleeved	
Age	Less than 40 years	21 (30.9%)	47 (69.1%)	P = 0.70
	40 years and above	9 (27.3%)	24 (72.7%)	
Sex	Female	14 (23.7%)	45 (76.3%)	P = 0.11
	Male	16 (38.1%)	26 (61.9%)	
Ethnicity	Brahmin/Chhetri	12 (31.6%)	26 (68.4%)	P = 0.74
	Janajati and others (Dalit and Madhesi)	18 (28.6%)	45 (71.4%)	

Table 6 shows the distribution of participants wearing long-sleeved vs. short-

sleeved clothes by age, sex, and ethnicity, among the study participants. The study showed that 30.9% of participants under 40 years and 27.3% aged 40 years and above wore long-sleeved clothing (P = 0.70), indicating no significant age-related difference. Among females, 23.7% and males, 38.1% wore long sleeves (P = 0.11). Ethnic groups exhibited minimal variation, with 31.6% of Brahmin/Chhetri and 28.6% of Janajati participants wearing long sleeves (P = 0.74). No significant associations were observed across demographic factors.

4. Discussion

Nepal has faced a frequent Dengue epidemic during the last two decades since the first Dengue fever case in Nepal was reported in 2004, while the first Dengue outbreak was reported from the lowland areas in 2006. It has been reported that all four serotypes of DENV circulate alternately during different outbreaks [16].

The current study showed that all participants had a fever (100%). This finding is consistent with the investigation conducted in the Somali region, Ethiopia [3], Bihar, Eastern India [9], Dire Dawa city administration, Ethiopia [17], and the University of Malaya Medical Center Kuala Lumpur, Malaysia [18].

Similarly, this study indicated that fever, lethargy, myalgia, and headache were the most prevalent symptoms, which are consistent with earlier studies conducted in India [19], Thailand [20], Vietnam [21], Brazil [22], and Taiwan region [23].

This study showed that the percentage of people who had previously contracted Dengue was low (8.9%), and this finding is in contrast to research conducted in Bangladesh, which found a higher rate of prior infection [1].

Bed nets were widely available (95%), supporting global efforts to encourage their use as a preventive intervention [5]. Despite their availability, only 83.2% reported utilizing bed nets to sleep which is similar to the study conducted in China [24].

Open water containers were reported in 5.9% of participants. This emphasizes the relevance of stagnant water as a breeding habitat for mosquitoes, which is consistent with data from Ethiopia [3].

Close contact with a similar illness in the last two weeks was reported by 25.7% of cases which was half less than the study conducted in Ethiopia [3], highlighting the potential for local transmission clusters. This finding booms the importance of understanding community-level transmission dynamics [12]. Likewise, 7.9% reported having visited Dengue-affected locations within 14 days, emphasizing the importance of mobility in Dengue spread, which is consistent with global travel-associated Dengue cases. This supports existing research, such as studies modeling factors in the emergence of the Dengue outbreak in Sri Lanka and Pakistan, emphasizing the role of mobility in Dengue transmission [25] [26].

This study reveals the low usage of mosquito repellent (5.9%) and is almost similar to the study conducted in Ethiopia [3], but contrasts to studies conducted in Malaysia [12], China [24], and Pakistan [25], where higher utilization was reported.

The analysis of clothing choices found that 70.3% wore short-sleeved attire. This contrasts with the study conducted in Pakistan [25] and closely resembles the study conducted in Ethiopia [3].

Ethnicity emerged as a significant predictor of bed net use, with Brahmin/Chhetri individuals showing higher utilization rates compared to Janajati and others (P = 0.01). However, age and sex did not show significant associations with either bed net usage or clothing types. Additionally, while mosquito repellent usage showed no significant association with age, sex, or ethnicity, it reflects low overall adoption. These results underscore the importance of targeted health education and interventions, particularly focusing on ethnic disparities in preventive practices against mosquito bites.

This study reveals important information about Dengue, which can help design specific measures for its prevention and control. By understanding how the disease spreads and the factors involved, we can develop more effective strategies to stop transmission. This research provides a practical guide for taking action against Dengue in the studied area.

5. Limitation

The study's limitations include a limited sample size, which limits its application. Its singular focus on Byas Municipality may restrict regional generalization. The use of retrospective and self-reported data presents possible biases, and the study lacks in-depth socioeconomic analysis. The cross-sectional methodology makes causal inference difficult, requiring caution in interpreting findings and generating suggestions for future study improvements.

6. Conclusion

The Dengue outbreak in Byas Municipality, Tanahun, has complicated transmission characteristics, including several peaks and a shifting epidemic curve that suggest a propagated outbreak. An analysis of 101 cases showed a demographic skew towards people aged 15 to 44, with a predominance of women. Clinically, fever was present in all cases, along with other usual symptoms. Close contact with people who have similar conditions, wearing short-sleeved clothing, using bed nets less during the day time, and using less insect repellent unkindly have all been recognized as risk factors. To address these demographic disparities, specialized treatments, and prevention approaches are required. This study provides crucial information for focused public health measures to reduce Dengue transmission in the region, with a focus on education, vector control, and demographic-specific treatments.

Acknowledgements

We are grateful to the study participants and Female Community Health Volunteers (FCHVs) for their valuable contributions and cooperation. We also appreciate the collaboration of the Tanahun district Health Office, along with the School

of Health and Allied Sciences at Pokhara University, the Health Sciences Faculty, and our classmates for their encouragement and backing throughout the study. At last, we are heartily thankful to those who have directly or indirectly contributed to our study.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Yesmin, S., Sarmin, S., Ahammad, A.M., Rafi, M.A. and Hasan, M.J. (2023) Epidemiological Investigation of the 2019 Dengue Outbreak in Dhaka, Bangladesh. *Journal of Tropical Medicine*, **2023**, 1-7. https://doi.org/10.1155/2023/8898453

[2] Rijal, K.R., Adhikari, B., Ghimire, B., Dhungel, B., Pyakurel, U.R., Shah, P., *et al.* (2021) Epidemiology of Dengue Virus Infections in Nepal, 2006-2019. *Infectious Diseases of Poverty*, **10**, Article No. 52. https://doi.org/10.1186/s40249-021-00837-0

[3] Mesfin, Z., Ali, A., Abagero, A. and Asefa, Z. (2022) Dengue Fever Outbreak Investigation in Werder Town, Dollo Zone, Somali Region, Ethiopia. *Infection and Drug Resistance*, **15**, 7207-7217. https://doi.org/10.2147/idr.s368562

[4] Malavige, G.N., Fernando, S., Fernando, D.J. and Seneviratne, S.L. (2004) Dengue Viral Infections. *Postgraduate Medical Journal*, **80**, 588-601. https://doi.org/10.1136/pgmj.2004.019638

[5] CDC (2024) Dengue Transmission, Centers for Disease Control and Prevention. https://www.cdc.gov/dengue/transmission/index.html

[6] Laul, A., Laul, P., Merugumala, V., Pathak, R., Miglani, U. and Saxena, P. (2016) Clinical Profiles of Dengue Infection during an Outbreak in Northern India. *Journal of Tropical Medicine*, **2016**, 1-7. https://doi.org/10.1155/2016/5917934

[7] Alejandria, M.M. (2015) Dengue Haemorrhagic Fever or Dengue Shock Syndrome in Children. *BMJ Clinical Evidence*, **2015**, Article 917. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4392842/

[8] Yue, Y., Liu, X., Xu, M., Ren, D. and Liu, Q. (2019) Epidemiological Dynamics of Dengue Fever in Mainland China, 2014-2018. *International Journal of Infectious Diseases*, **86**, 82-93. https://doi.org/10.1016/j.ijid.2019.06.015

[9] Mishra, R. (2016) A Report on Outbreak Investigation of Dengue in Bihar in 2015. *Journal of Medical Science and Clinical Research*, **4**, 13557-13568. https://doi.org/10.18535/jmscr/v4i11.08

[10] Runge-Ranzinger, S. (2016) Technical Handbook for Dengue Surveillance, Dengue Outbreak Prediction/Detection and Outbreak Response (Model Contingency Plan). http://archive.lstmed.ac.uk/6242/

[11] Reliefweb (2023) Dengue Fever: At Least 5 Million Cases and 5500 Deaths in Horror Year. https://reliefweb.int/report/world/dengue-fever-least-5-million-cases-and-5500-deaths-horror-year

[12] Ahmad, R., Suzilah, I., Wan Najdah, W.M.A., Topek, O., Mustafakamal, I. and Lee, H.L. (2018) Factors Determining Dengue Outbreak in Malaysia. *PLOS ONE*, **13**, e0193326. https://doi.org/10.1371/journal.pone.0193326

[13] Dhoubhadel, B.G., Hayashi, Y., Domai, F.M., *et al.* (2023) A Major Dengue Epid

emic in 2022 in Nepal: Need of an Efficient Early-Warning System. https://www.researchgate.net/profile/Bhim-Dhoubhadel/publication/372626230_A_major_dengue_epidemic_in_2022_in_Nepal_need_of_an_efficient_early-warning_system/links/64c09358c41fb852dd9bb8d9/A-major-dengue-epidemic-in-2022-in-Nepal-need-of-an-efficient-early-warning-system.pdf

[14] WHO (2024) Dengue-Nepal. https://www.who.int/emergencies/disease-outbreak-news/item/2022-DON412

[15] The Kathmandu Post (2023) Dengue Infection on the Rise in Tanahun. https://kathmandupost.com/health/2023/09/29/dengue-infection-on-the-rise-in-tanahun

[16] Phuyal, P., Kramer, I.M., Kuch, U., Magdeburg, A., Groneberg, D.A., Lamichhane Dhimal, M., *et al.* (2022) The Knowledge, Attitude and Practice of Community People on Dengue Fever in Central Nepal: A Cross-Sectional Study. *BMC Infectious Diseases*, **22**, Article No. 454.

[17] Biru, M., Geleta, D., Tesfaye, N., Aleyu, M. and Tayachew, A. (2020) Dengue Fever Outbreak Investigation and Response in Dire Dawa City Administration, Ethiopia, 2017. https://www.researchgate.net/profile/Mikias-Alayu/publication/339827057_Dengue_Fever_Outbreak_Investigation_and_Response_in_Dire_Dawa_City_Administration_Ethiopia_2017/links/5e679c6b299bf1744f709fcd/Dengue-Fever-Outbreak-Investigation-and-Response-in-Dire-Dawa-City-Administration-Ethiopia-2017.pdf

[18] Jamaiah, I., *et al.* (2007) Retrospective Study of Dengue Fever (DF) and Dengue Hemorrhagic Fever (DHF) Patients at University Malaya Medical Center, Kuala Lumpur, Malaysia in the Year 2005. *The Southeast Asian Journal of Tropical Medicine and Public Health*, **38**, 224-230.

[19] Deshwal, R., Qureshi, M.I. and Singh, R. (2015) Clinical and Laboratory Profile of Dengue Fever. *Journal of the Association of Physicians of India*, **63**, 30-32.

[20] Thanachartwet, V., Oer-areemitr, N., Chamnanchanunt, S., Sahassananda, D., Jittmittraphap, A., Suwannakudt, P., *et al.* (2015) Identification of Clinical Factors Associated with Severe Dengue among Thai Adults: A Prospective Study. *BMC Infectious Diseases*, **15**, Article No. 420. https://doi.org/10.1186/s12879-015-1150-2

[21] Taylor, W.R., Fox, A., Pham, K.T., Le, H.N.M., Tran, N.T.H., Tran, G.V., *et al.* (2015) Dengue in Adults Admitted to a Referral Hospital in Hanoi, Vietnam. *The American Society of Tropical Medicine and Hygiene*, **92**, 1141-1149. https://doi.org/10.4269/ajtmh.14-0472

[22] Heinen, L.B.D.S., Zuchi, N., Cardoso, B.F., Santos, M.A.M.D., Nogueira, M.L. And Dezengrini-Slhessarenko, R. (2015) Dengue Outbreak in Mato Grosso State, Midwestern Brazil. *Revista do Instituto de Medicina Tropical de São Paulo*, **57**, 489-496. https://doi.org/10.1590/s0036-46652015000600005

[23] Yeh, C., Chen, P., Chuang, K., Shu, Y., Chien, Y., Perng, G.C., *et al.* (2017) Symptoms Associated with Adverse Dengue Fever Prognoses at the Time of Reporting in the 2015 Dengue Outbreak in Taiwan Region. *PLOS Neglected Tropical Diseases*, **11**, e0006091. https://doi.org/10.1371/journal.pntd.0006091

[24] Liu, J., Tian, X., Deng, Y., Du, Z., Liang, T., Hao, Y., *et al.* (2019) Risk Factors Associated with Dengue Virus Infection in Guangdong Province: A Community-Based Case-Control Study. *International Journal of Environmental Research and Public Health*, **16**, Article 617. https://doi.org/10.3390/ijerph16040617

[25] Mehmood, A., Khalid Khan, F., Chaudhry, A., Hussain, Z., Laghari, M.A., Shah, I., *et al.* (2021) Risk Factors Associated with a Dengue Fever Outbreak in Islamabad,

Pakistan: Case-Control Study. *JMIR Public Health and Surveillance*, **7**, e27266. https://doi.org/10.2196/27266

[26] Zhang, Y., Riera, J., Ostrow, K., Siddiqui, S., de Silva, H., Sarkar, S., *et al.* (2020) Modeling the Relative Role of Human Mobility, Land-Use and Climate Factors on Dengue Outbreak Emergence in Sri Lanka. *BMC Infectious Diseases*, **20**, Article No. 649. https://doi.org/10.1186/s12879-020-05369-w