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'Prevalence and Risk Factors of Lymphatic Filariasis in Urban and Rural Communities of Sindewahi tehsil, Chandrapur district, Maharashtra.

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Abstract
About 304 million people live in areas where filariasis is known to be prevalent, putting them at risk of getting it. An estimated 22 million people have microfilaria in their blood, while 16 million people have clinical symptoms. The purpose of the study was to determine the prevalence of lymphatic filariasis in a tribal population in the Chandrapur district's Sindewahi tehsil. Community-focused cross-sectional research was carried out. Blood smears were obtained at night between 9:00 and 11:30 p.m. using the finger prick technique. The normal staining procedure was performed and thick smears were created. Diethyl carbamazine (DEC) was used in a provocative test the next day. 100 mg of DEC was taken orally, and an hour later, a blood sample was taken in accordance with normal protocols. Despite all efforts to ensure compliance, DEC could only be distributed to 300 individuals. Overall MFR in urban Sindewahi is 1.38% (1.52% in men, 1.25% in women), DR is 1.05% (0.97% in men, 1.13% in women), and ER is 2.44% (2.49% in men, 2.39% in women). The rural population has a much higher overall MFR of 2.23% (2.08% for males and 2.39% for females), while the overall MD averages 2.17 (1.80 for males and 2.54 for females). The overall DR was 1.41% (1.69% for men and 1.13% for women), and the overall ER was 3.64% (3.77% for men and 3.52% for women). The overall MD in rural areas is higher at 2.79, reflecting heavier infections (2.89 in males, 2.70 in females). Elephantitis and Hydrocele was the commonest clinical manifestation.
Keywords: *Prevalence, Lymphatic Filariasis, insect, mosquito-borne disease*

Introduction

Aedes, Culex, and Anopheles mosquitoes are among the many mosquito species that transmit lymphatic filariasis (LF), a neglected tropical disease (NTD) caused by three filarial worm species: Wuchereria bancrofti, Brugia malayi, and B. timori (WHO, 2018). Once a mosquito injects LF larvae into a new host's circulation, the worms enter the lymphatic system. They mature, procreate, and discharge microfilariae (Mf) there (Taylor et al., 2010) [27]. Adult worms can live for five to seven years and emit millions of Mf.

Although most infected individuals show no symptoms, some may have lymphatic malfunction, which can result in scrotal hydrocele in men and severe lymphoedema (elephantiasis), especially in the lower limbs (WHO, 2020). People with these long-term effects often experience social embarrassment, mental health issues, and negative economic effects in addition to being disfigured and crippled. Recent estimates indicate that LF affects around 120 million people globally, mostly in 72 countries in Africa, Asia, the Western Pacific, and a tiny part of the Americas (Ramaiah and Ottesen, 2014) [19].

This chronic sickness sign is still present in at least 3.6 crore people. In 17 nations and 6 union territories, lymphatic filariasis is common and poses a risk to around 552 million people (WHO, 2004). Twenty Indian states have reported native cases of lymphatic filariasis, putting more than 600 million people at danger. It has been shown that filariasis is endemic in 250 districts (Programme NVBDCP, 2014). The World Health Organisation (WHO) established the Global Programme to Eliminate Lymphatic Filariasis (GPELF) in 1997 (Ottesen EA 2000) [18].

Its two primary objectives are to: i) treat populations in endemic areas on a wide scale utilising

mass drug administration (MDA) to limit the spread of the disease and ii) treat people with chronic problems to reduce their suffering. Initially, MDA was treated with two-drug regimens of either diethylcarbamazine and albendazole (for other locations) or ivermectin and albendazole (for areas where LF co-endemic with onchocerciasis). The locals were found to know very little about the origin of the sickness. It was recommended that a significant focus be placed on public awareness in order to raise public awareness (Dudhmal et al., 2015a) [7].
The painful and severely deformative apparent chronic manifestations of morbidity in LF include hydrocele and lymph scrotum, which are male urogenital illnesses, and acute dermatolymphoceleadenitis (ADLA) and elephantiasis, which are obvious chronic symptoms of lymphoedema. Severe pain and fever are hallmarks of ADLA bacterial infection phases. Rheumatoid arthritis, breast lymphoedema, and vulva swelling are some less frequently reported clinical symptoms (Melrose, 2002) [14].
The disease known as lymphatic filariasis is endemic in 17 districts of Maharashtra: Gadchiroli, Chandrapur, Gondia, Bhandara, Wardha, Nagpur, Amravati, Akola, Yawatmal, Jalgaon, Nandurbar, Nanded, Latur, Osmanabad, Solapur, Sindhudurg, Thane. Specifically, nine of these seventeen districts are solely found in the Vidarbha region of Maharashtra (Mahakalkar et al., 2017) [13]. Through mass drug administration (MDA), which includes the age-appropriate dosage of 100 mg of DEC or Ivermectin and the oral administration of a single dose of 400 mg of albendazole to control filarial warm infestation, the Indian government has been working to eradicate this infection (NVBDCP Programme 2014).
Six Filarial Survey Units, sixteen Filaria Control Units, ten Filaria Night Clinics, and one Filaria Training Centre are responsible for implementing the National Filariasis Control Program, which was founded in Maharashtra in 1957. The conclusions of a one-man panel report served as its foundation. In order to support the GPELF's progress with regard to the morbidity pillar, this study aimed to ascertain the incidence of lymphatic filariasis in a rural Sindewahi tehsil in the Chandrapur district.

Materials and method

From January 2022 to December 2022, the Tehsil Sindewahi was the site of the current study. Sindewahi is a tehsil in the Chandrapur district, and it is 260 meters above sea level. The total population of Sindewahi Tehsil is 1, 10,440. There are 54656 women and 55784 men. In contrast to rural areas, which are abundant in domestic animals (e.g., cows, buffalo, goats, dogs, chickens, and birds), urban areas have a far lesser quantity of domestic animals and flowers. In rural places, modern sanitary amenities like septic tanks and drainage are uncommon.
Following Gubler's protocol, a finger prick was performed between 1900 and 2300 hours to obtain a blood sample (20µl). (Gubler and others, 1973) [10] Random sampling was used by humans to choose a protected zone (Zar, 2010) [28], which comprised roughly 10% to 15% of the population in the chosen observe region. After being obtained, blood samples are spread out on glass slides and brought into the lab. To check for the presence of microfilaria, blood smeared slides were examined under a microscope after being dried in distilled water and stained with Leishman's stain. The filarial parasites (microfilaria), if any, were counted and documented for every patient with microfilaria (Simonsen, 2003). [25]
The age, gender, medical history, and financial and socioeconomic circumstances of each challenge have been revealed. Age groups were used to segment the whole survey: 0–4 years, 5–14 years, 15–39 years, and everyone beyond 40.

Observation

In **urban Sindewahi,** the **microfilarial rate (MFR) is 1.38%** (1.52% in males, 1.25% in females), the **disease rate (DR)** is **1.05%** (0.97% in males, 1.13% in females), and the **endemicity rate (ER)** is **2.44%** (2.49% in males, 2.39% in females). The average **microfilarial density (MD)** is **2.17** (1.80 in males, 2.54 in females). In contrast, **rural Sindewahi** exhibits significantly higher values, with **MFR at 2.23%** (2.08% in males, 2.39%

in females), **DR at 1.41%** (1.69% in males, 1.13% in females), and **ER at 3.64%** (3.77% in males, 3.52% in females). The **MD** is also higher at **2.79** (2.89 in males, 2.70 in females), indicating a heavier infection burden.

Among different age groups**, children aged 0–4 years** showed no infections in both urban and rural areas, suggesting limited exposure to the disease. In the **5–14 years age group,** infections were present but no clinical disease was observed. The **urban MFR** was **0.94%,** while the **rural MFR** was **2.23%,** indicating a higher risk of infection in rural areas. In the **15–39 years age group**, both infection rates and disease progression were more pronounced. The **urban MFR was 1.56%,** while the **rural MFR was 2.55%.** The **disease rate** was also higher in rural areas **(1.84% vs. 1.20% urban),** leading to a greater **endemicity rate (4.40% rural vs. 2.77% urban).** This reflects the impact of prolonged exposure to infected vectors in rural settings. The **40+ years age group** showed the highest prevalence in urban areas, with **MFR at 1.77%, DR at 1.62%,** and **ER at 3.40%.** However, rural Sindewahi had even higher values, reinforcing the cumulative impact of long-term exposure. Notably, hydrocele prevalence was **1.48% in older rural males,** whereas elephantiasis was **1.0% in younger males.** Urban hydrocele prevalence was **0.59%,** with elephantiasis at **0.38%.** Overall, rural Sindewahi experiences a significantly heavier burden of lymphatic filariasis, with higher transmission rates, increased microfilarial density, and greater disease progression, particularly in adults.

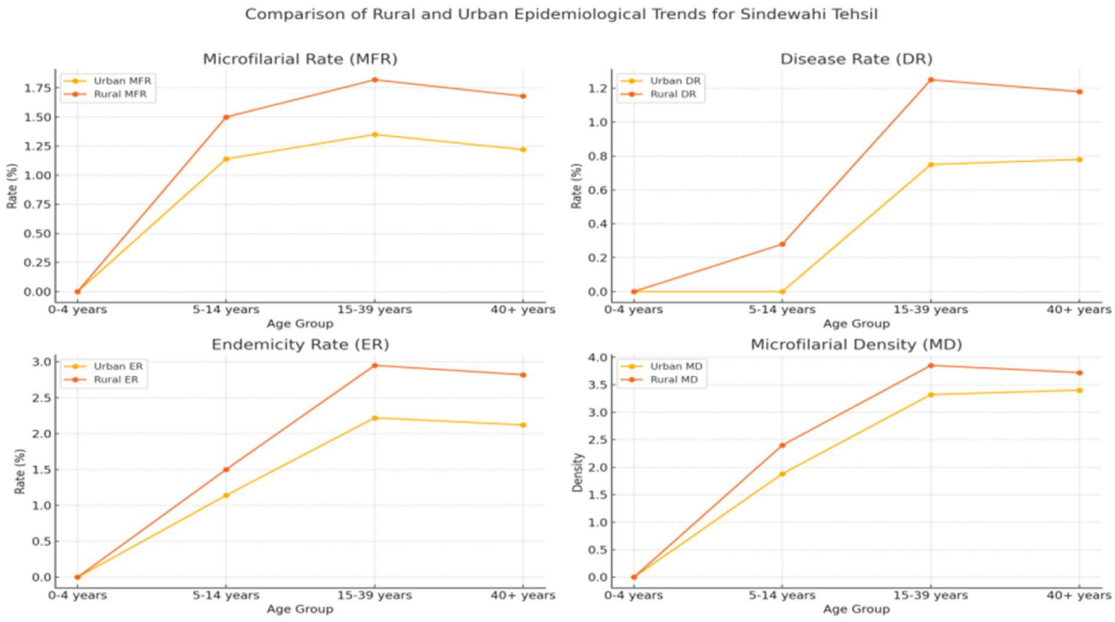

Table: 1. Microfilarial rate, Disease rate, Endemicity rate and Average microfilarial density to the sex and age group among the urban population of Sindewahi, tehsil Chandrapur District.

Age Group in year	Sample Collection			Microfilarial Rate(%)			Disease Rate (%)			Endmicity Rate (%)			Average Microfilaria Density		
	M	F	Total	M	F	O	M	F	O	M	F	O	M	F	O
0-4	232	238	470	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5-14	423	427	850	1.18	0.70	0.94	0.0	0.0	0.0	1.18	0.70	0.94	1.60	1.66	1.63
15-39	700	705	1405	1.71	1.41	1.56	1.42	0.99	1.20	3.14	2.41	2.77	1.75	3.2	2.47
40- A.	1010	1014	2024	1.88	1.67	1.77	1.28	1.97	1.62	3.16	3.64	3.4	2.05	2.76	2.40
Total	2365	2384	4749	1.52	1.25	1.38	0.97	1.13	1.05	2.49	2.39	2.44	1.8	2.54	2.17

M = male, F = female, O = overall

Table: 2. Microfilarial rate, Disease rate, Endemicity rate and Average microfilarial density to the sex and age group among the rural population of Sindewahi, tehsil Chandrapur District.

Age Group in year	Sample Collection			Microfilarial Rate(%)			Disease Rate (%)			Endmicity Rate (%)			Average Microfilaria Density		
	M	F	Total	M	F	O	M	F	O	M	F	O	M	F	O
0-4	232	238	470	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5-14	423	427	850	2.83	1.63	2.23	0.0	0.0	0.0	2.83	1.63	2.23	2.08	2.14	2.11
15-39	700	705	1405	1.85	3.26	2.55	2.42	1.27	1.84	4.28	4.53	4.40	3.61	2.56	3.08
40- A.	1010	1014	2024	2.37	2.66	2.51	2.27	2.76	2.02	4.65	4.43	4.54	3.0	3.40	3.2
Total	2365	2384	4749	2.08	2.39	2.23	1.69	1.13	1.41	3.77	3.52	3.64	2.89	2.7	2.79

M = male, F = female, O = overall

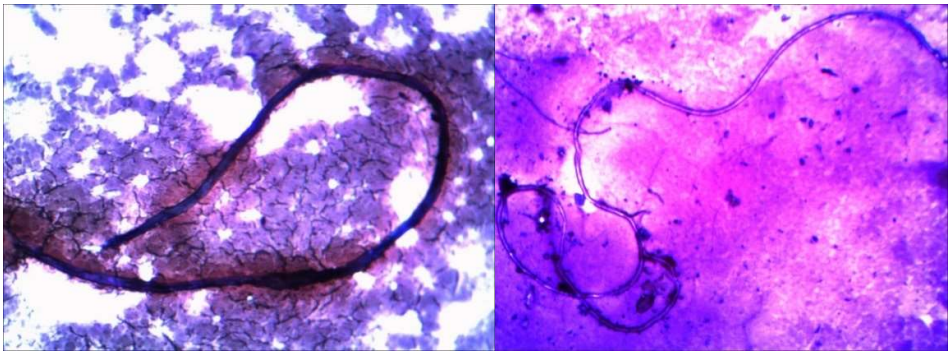

Fig: *Wuchereria bancrofti* observed from blood sample

Results and discussion

The overall DR in urban Sindewahi is 1.05% (0.97% in men, 1.13% in females), whereas the overall MFR is 1.38% (1.52% in males, 1.25% in females). As well as an overall ER of 2.44% (2.39% for females, 2.49% for men). The average MD is 2.17 overall (1.80 for men and 2.54 for women). The total MFR of 2.23% (2.08% for men and 2.39% for women) is much higher among the rural population. DR of 1.41% overall (1.13% for females, 1.69% for men) and 3.64% total ER (3.52% in females, 3.77% in men). Due to higher infection rates (2.89 in men and 2.70 in females), the total MD in rural regions is higher at 2.79.

Males outperformed females in this research region in every metric ($p<0.05$, statistically significant difference). K. D. Ramaiah et al. (1997) noted a similar discovery in a rural area in south India. This discrepancy represents a higher risk of LF exposure in rural areas, which is probably brought on by environmental factors such standing water, poor sanitation, and

restricted access to healthcare. In separate studies carried out in Howarth and Calcutta, Bhattacharya et al. (1964) found that the mf rates were 7.8% and 13.6%, respectively. Previous reports (WHO 2002); Hawking F, Denham DA. (1977); Chandra G. et al. (2007) in the coastal regions of Digha, West Bengal, India. Tropical Disease Bulletin, Parts I, II, and III; Paul E. Simonsen et al., 2012; Rao CK. (1982).According to Chandra G. et al. (2013), who studied the population of rural and urban areas in West Bengal, India, the prevalence of filariasis is lower in rural areas than in urban areas. This is because of better conditions for infection transmission in rural areas, such as high population density, increased population migration and travel, an increase in slum areas, and an ineffective vector. Kamal Narain and Vaishali Gupta (2018) discovered that the population under study had same endemicity in both urban and rural locations.

Overall, according to the gender distribution, males had greater levels of MR, MMD, DR, and ER than females in both locations (differences are statistically not significant, $p>0.05$), which is also what some other research have shown. Rudra SK, Chandra G (2000), Chandra G (1996 & 1998), Paramanik M, Chandra G (2009) in Susania, West Bengal; Mishra A, Bhadoriya RS (2009) in district Datia M.P.; Koroma JB et al. (2012). This can be explained by the fact that, in both research sites, males were more likely than females to be bitten by mosquitoes.

According to the age group distribution, MR, DR, and ER were typically greater among younger to middle-aged individuals (15–39) in both research locations, which is relatively comparable to some other places. Chandra G et al. (2007) West Bengal; Paramanik M, Chandra G (2009) in Susunia, West Bengal. Sasa, M. (1976). The age group (40 and up) had a greater MMD, which is comparable to some other locations but inconsistent with the results of many other places. Bankura District, West Bengal (2000) Rudra SK, Chandra G.

Males were more likely than females to have microfilaremia in our research of both urban and rural populations. Rudra and Chandra (1998 & 2000) in Bankura, Pani SP et al. (1991 & 1994), and Lunge VR (2019) in Maharashtra all came to identical conclusions. Adam M. Fimbo (2020) in the north-eastern Tanzanian rural region of Mkinga district,which is extremely endemic Males aged 40 years and older had the highest microfilaria rate (1.88%) among the urban population in the current research region. Females aged 15–39 years had the highest microfilaria rate (3.26%) among the rural population in the current research region. Male and female microfilaraemia rates did not differ significantly ($p>0.05$).

The rural population of Chandrapur district had a 1.41% filarial illness rate, which was substantially higher than the urban population's 1.05% (statistically significant difference, $p<0.05$). According to reports by Jain et al. (1989), Srividya et al. (1991), Prasad et al. (1993), Dutta et al. (1995), Albuqerque et al. (1995), Chandra (1998), and Rudra and Chandra (2000), the illness rate was greater in females than in men in both locations. Females aged 40 and above had the greatest illness rate in Sindewahi's urban population (1.97%), whereas females in the same age group in the rural population (2.76%).

These results corroborate Michael et al.'s (1996) observation that filariasis mostly affects adults and older age groups and seems to affect men more often. Age had an impact on acute episodic lymphangitis in both sexes of the research area's urban and rural populations. (Shrivastava et al., 1969) found no illness in the 0–10 age range, followed by an increased trend with age that is comparable to the results of the current research.

There was a statistically significant difference ($p<0.05$) between the urban population's filarial endemicity rate of 2.44% and the rural population's rate of 3.64% in Chandrapur district. Males are more affected than females ($p>0.05$, statistically not significant differences). According to Kar et al. (1993) in an endemic village in Orissa, Kumar et al. (1994) in Puri district, Orissa, Dutta et al. (1995) in upper Assam, Pani et al. (1991) in Pondicherry, Chandra (1998) in Purulia district, West Bengal, Estamble et al. (1994) in Kwale district, Kenya, Meyrowitsch et al. (1995) in North Eastern Tanzania, and Rudra & Chandra (1998 & 2000) in Bankura District,

West Bengal, the endemicity rate of the present uraban area was lower than that of the endemic areas. The endemicity rate of rural area studied was higher than that in Memari, West Bengal as reported by Chandra and Hati (1996).

The Chandrapur district's rural population had a greater mean microfilarial density (2.79) than the urban population (2.17), ($p>0.05$). The mean microfilarial density in females was greater than that in men in the current research locations, both in urban and rural populations, as reported by Dutta et al. (1995), Albuquereque et al. (1995), Chandra et al. (1996), and Rudra and Chandra (1998 & 2000).

The current analysis suggests that filarial issue control is a problem in a number of Sindewahi tehsil locations. MDA applications need to be effectively implemented and enhanced in order to meet the objectives of GPELF. More research is needed to detect infected persons, and more reliable and effective diagnostic techniques such as immunochromatographic (ICT) cards are needed.

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Reference

1. Bhattacharya, B., Das Dalal, A. K., & Sukul, N. C. (1988). Infection of *Culex quinquefasciatus* with *Wuchereria bancrofti* larvae in a natural population in a filarial endemic village of West Bengal, India. *Environment and Ecology, 6*, 377–380.
2. Chandra, G. (1996). Filariasis survey in a rural area of West Bengal. *Journal of Communicable Diseases, 28*(3), 206–208.
3. Chandra, G., Banerjee, A., & Hati, A. K. (1993). Seasonal prevalence of *Culex quinquefasciatus* in urban and rural areas of West Bengal. *Bulletin of Calcutta School of Tropical Medicine, 41*, 10–11.
4. Chandra, G., Majumder, G., & Hati, A. K. (1998). Studies on transmission dynamics of lymphatic filariasis in rural areas of West Bengal. *Proceedings of the Zoological Society of Calcutta, 51*(2), 116–128.
5. Dutta, P., Gogoi, B. K., Chelleng, P. K., Bhattacharya, D. R., Khan, S. A., Goswami, B. K., & Mahanta, J. (1995). Filariasis in the labor population of a tea estate in Upper Assam. *Indian Journal of Medical Research, 101*, 245–246.
6. Estambale, B. B. A., Simonsen, P. E., Knight, R., & Bwayo, J. J. (1994). Bancroftian filariasis in Kwale district of Kenya: Clinical and parasitological survey in an endemic community. *Annals of Tropical Medicine and Parasitology, 88*(2), 145–151.
7. Michael, E., Bundy, D. A. P., & Grenfell, B. T. (1996). Reassessing the global prevalence and distribution of lymphatic filariasis. *Parasitology, 112*(4), 409–428.
8. Meyrowitsch, D. W., Simonsen, P. E., & Makunde, W. H. (1995). Bancroftian filariasis: Analysis of infection and disease in five endemic communities of North-Eastern Tanzania. *Annals of Tropical Medicine and Parasitology, 89*(6), 653–663.
9. Pani, S. P., Vanamail, P., & Das, P. K. (1994). Microscale variation in filarial disease and risk of developing disease associated with microfilariaemia in urban situations. *Asian Journal of Tropical Medicine and Public Health, 25*(4), 719–723.
10. Prasad, R. N., Das, M. K., Sharma, T., & Dutta, G. D. P. (1993). Prevalence of filariasis in rural areas of Shahjahanpur district, Uttar Pradesh. *Indian Journal of Medical Research (A), 97*, 112–114.
11. Rudra, S. K., & Chandra, G. (2000). A comparative epidemiological study on lymphatic filariasis between tribal and non-tribal populations of Bankura district, West Bengal, India. *Annals of Tropical Medicine and Parasitology, 94*(4), 365–372.

12. Srividya, A., Pani, S. P., Rajagopalan, P. K., Bundy, D. A. P., & Grenfell, B. T. (1991). Clinical epidemiology of bancroftian filariasis: Effect of age and gender. *Transactions of the Royal Society of Tropical Medicine and Hygiene, 85*(2), 260–264.
13. WHO. (2002). *Lymphatic filariasis: The disease and its control.* WHO Technical Report Series, No. 821. Geneva: World Health Organization.
14. Bhattacharya, N. C. (1964). Tropical diseases. *Bulletin*, *2*(171), 171.
15. Chandra, G., Chatterjee, S. N., & Das, S. (2007). Lymphatic filariasis in the coastal areas of Digha, West Bengal, India. *Tropical Doctor, 37*(2), 136–139.
16. Chandra, G., & Hati, A. K. (1996). Filariasis survey in a rural area of West Bengal. *Journal of Communicable Diseases, 28*(3), 206–208.
17. Chandra, G. (1998). Studies on transmission dynamics of lymphatic filariasis in rural areas of West Bengal. *Proceedings of the Zoological Society of Calcutta, 51*(2), 116–128.
18. Chandra, S. (1979). Observations in filariasis in some villages around Lucknow. *Indian Journal of Medical Research, 61*, 1127.
19. Dogara, M. M., Nock, H. I., Agbede, R. I. S., Ndams, S., & Joseph, K. (2012). Prevalence of lymphatic filariasis in three villages in Kano State, Nigeria. *Internet Journal of Tropical Medicine, 8*(1).
20. Dudhmal, D., Chavan, S., & Walke, D. (2015). Filaria and its vector management practices: A case study in a filaria-endemic village of Maharashtra State, India. *International Journal of Current Research and Review, 3*(6), 179–185.
21. Dudhmal, D. H., & Chavan, S. P. (2021). Problems against filaria health workers in a filaria-endemic region: A practical study. *International Journal of Advanced Biotechnology and Research, 12*(2), 23–26.
22. Gawda, B. (1961). Filariasis in Mysore State, Bharkal Town: Facts and figures. *Bulletin of Malaria and Other Communicable Diseases, 4*, 137.
23. Gubler, D. J., Inui, T. S., Black, H. R., & Bhattacharya, N. C. (1973). Comparisons of microfilaria density in blood sampled by finger-prick, venipuncture, and ingestion by mosquitoes. *American Journal of Tropical Medicine and Hygiene, 22*(2), 174–178.
24. Koroma, J. B., Bangura, M. M., Hodges, M. H., Bah, M. S., & Zhang, Y. (2012). Lymphatic filariasis mapping by immunochromatographic test cards and baseline microfilaria survey prior to mass drug administration in Sierra Leone. *Parasites & Vectors, 5*, 10–17.
25. Lunge, V. R. (2019). Lymphatic filariasis challenges and strategies. *International Journal of Community Medicine and Public Health, 6*(2), 30–30.
26. Mahakalkar, A. L., Sapkal, H. P., & Baig, M. M. (2017). High genetic diversity of filarial worm, *Wuchereria bancrofti* in endemic regions of Maharashtra. *Helminthologia, 54*(4), 292–297.
27. Melrose, W. D. (2002). Lymphatic filariasis: New insights into an old disease. *International Journal for Parasitology, 32*(8), 947–960.
28. Mishra, A., & Bhadoriya, R. S. (2009). An epidemiological study of filariasis in a village of district Datia, MP. *Indian Journal of Community Medicine, 34*, 202–205.
29. Mishra, S. S. (1979). An epidemiological study of filariasis in Reva Town, MP. *Indian Journal of Public Health, 1*, 7–16.
30. NVBDCP. (2017). National Vector Borne Disease Control Programme.
31. Ottesen, E. A. (2000). The global programme to eliminate lymphatic filariasis. *Tropical Medicine & International Health, 5*(9), 591–594.
32. Paramanik, M., & Chandra, G. (2009). Lymphatic filariasis in the foothill areas around Susunia of West Bengal in India. *Asian Pacific Journal of Tropical Medicine, 2*, 20–25.
33. Ramaiah, K. D., & Ottesen, E. A. (2014). Progress and impact of 13 years of the global programme to eliminate lymphatic filariasis. *PLoS Neglected Tropical Diseases, 8*(e3319).

34. Rudra, S. K., & Chandra, G. (1998). Bancroftian filariasis in tribal population of Bankura district, West Bengal, India. *Japanese Journal of Tropical Medicine and Hygiene, 26*, 109–112.
35. Shrivastava, B. V. (1973). Human filariasis in slums of Bengal Ore Corporation. *Indian Journal of Medical Research, 15*, 589.
36. Shrivastava, R. M., & Prasad, B. C. (1969). Epidemiology of bancroftian filariasis. *Indian Journal of Medical Research, 3*, 57.
37. Simonsen, P. E. (2003). Filariasis. In G. C. Cook & A. Zumla (Eds.), *Manson's Tropical Diseases* (21st ed.). London: W.B. Saunders.
38. Singh, S., Bora, D., Dhariwal, A. C., Singh, R., & Lal, S. (2006). Lymphatic filariasis in rural areas of Patna district, Bihar: A challenge ahead. *Journal of Communicable Diseases, 38*(2), 160.
39. Taylor, M. J., Hoerauf, A., & Bockarie, M. (2010). Lymphatic filariasis and onchocerciasis. *The Lancet, 376*(9747), 1175–1185.
40. Zar, J. H. (2010). *Biostatistical analysis* (5th ed.). Upper Saddle River, NJ: Pearson Prentice-Hall.