Original Research Article

Trends in water borne diseases in Kerala: an analysis of directorate of health services portal data

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Received: 05 June 2021
Revised: 05 July 2021
Accepted: 06 July 2021

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ABSTRACT

Background: Kerala faces high mortality-morbidity rates from water borne diseases. For the timely management of communicable diseases, understanding trends, pattern and seasonality of disease was important. The aim was to find out the trend, pattern and seasonal variation of water borne diseases in Kerala.

Methods: Retrospective record based descriptive study was done to find out the trend and pattern of water borne diseases and to find out its seasonal variation in Kerala. Data from the DHS (directorate of health services) portal during 2011 to 2019 were collected and analyzed.

Results: More than 97 percent of water borne diseases are due to diarrheal diseases but no death reported. A rising trend in diarrheal disease is observed. Typhoid, hepatitis A and cholera showed decreasing trend. Leptospirosis shared only 0.2 to 0.4 percent, but death rate was high. Malapuram tends to report most number of cases but percentage share was highest from Kozhikode in 2011. Palakkad reported highest number and Kottayam lowest among central districts. Among southern districts, Thiruvananthapuram reported highest number of cases and Pathanamthitta lowest. Malappuram showed declining trend among northern districts while least number of cases were reported from Wayand district. Seasonal variability was observed in 2011-2013 and 2018.

Conclusions: Seasonal variation in occurrence of water borne diseases in rainy season is statistically significant when compared to winter season. Data on water borne disease other than diarrheal diseases is a matter of concern.

Keywords: Water borne disease, Diarrheal diseases Kerala, Seasonality, Trend and pattern

INTRODUCTION

According to WHO, diarrheal diseases contribute to as many as 4 million cases and 1.8 million deaths annually.1 Water borne illnesses are the second cause of death among children under the age of 5 years.2 Approximately 5000 people die every day from waterborne diarrheal illnesses.3 Epidemiologic transition from infectious diseases to non-communicable diseases is a reality in Kerala where health indicators are assumed to be the best among Indian states and compared with developed countries. But it is reported to have the highest rates of morbidity among the Indian states. Research on various water borne diseases like diarrhea, acute jaundice, hepatitis A, leptospirosis in the state is evident from many studies.4-11 Another concern is seasonality of disease incidence which can turn into epidemics if proper management does not exist. Seasonality of water quality and diarrheal disease counts in urban and rural settings in South India was studied.12 Hyderabad based hospital study during 2011-2013 confirmed seasonality of diarrheal diseases.13 A hospital based study in Kerala...
noted higher number of ADD cases during summer. Hence it was important to study the trends and pattern in diseases and its seasonality for early diagnosis and timely management.

**Objectives**

The objectives of the study were to analyse the trend and pattern in water borne diseases in Kerala and its districts and to study the seasonality of water borne diseases.

**METHODS**

This retrospective descriptive multi-year analytical study used data from DHS Kerala portal which provided communicable disease data. Month wise and district wise water borne disease data during 2011 to 2019 years were analysed from the communicable disease data. Surveillance data from all tertiary level hospitals, district hospitals, sub divisional hospitals, community health centers, primary health centers, urban primary health centers and private hospitals in the 14 districts of the state were reported in the office of the DHS in Thiruvananthapuram on weekly basis and from which it compiled and uploaded monthly in the portal as communicable diseases. Water borne diseases from communicable diseases (which include vector borne diseases and airborne diseases) data were separated and used for this study. Since it was a publically available data no ethical issue was involved. Month wise and district wise water borne disease data were analysed using percent distribution and average per year to find out the trend and seasonal variations. Districts were classified as south (Thiruvananthapuram, Kollam, Pathanamthitta, Alappuzha and Idukki), central (Kottayam, Ernakulam, Thrissur and Palakkad) and north (Malappuram, Kozhikode, Wayanad, Kannur and Kasaragode) to find out the comparisons in the distribution of diseases.

Seasons were classified as summer (March-May), rainy (June-October) and winter (November-February). Mean differences in frequency between two sample proportions (between seasons) were tested using ANOVA test. \( P<0.05 \) was fixed as a significant level. If there is significant variability in mean values within groups, then multiple comparisons through Tukey post hoc test was conducted for the seasons.

**RESULTS**

Table 1 reveals that among communicable diseases water borne diseases holds more than 97 percent and hence water borne diseases are studied in the paper.

Trend analysis shows that a huge hike in number of water borne diseases in 2012 and there is steady increase during 2013 to 2016, a small reduction in 2017 and a steady increase after that (Figure 1).

Thiruvananthapuram reports 7.8 percent and Kollam reports 4.4 percent of the cases of WBD on an average per year during 2011-2019 (Table 3). Pathanamthitta is the district reported lowest percent of WBD cases followed by Kottayam and Idukki as depicted in Figure 3. Ernakulam contributes on an average 7 percent of the WBD in the state. Thrissur holds more than 10 percent of the cases except in 2019 (9.2 percent). In all years Palakkad contributes more than 10 percent except in 2019. District is high among the central districts with regard to WBD. Kottayam provides the lowest contribution but when percentage change is considering it is highest among central part of Kerala. A large number of WBD is contributing by Malappuram in all years and is more than 20 percent in 2013 and 2014. Kozhikode contributes 7.3 percent in 2011 to 12.5 percent in 2019 WBD. Among the districts Malappuram contributes the highest and Wayanad is the lowest among northern districts (Table 3) (Figure 5). Only 2.7 percent (each in 2013 and 2015) to 4.1 percent (2019) of the WBD is contributed by Wayanad. Kannur contributes on an average 9 percent of WBD cases during these years. Percent change of water borne disease over 2011 in 2019. District is high among the central districts with regard to WBD. Kottayam provides the lowest contribution but when percentage change is considering it is highest among central part of Kerala. A large number of WBD is contributing by Malappuram in all years and is more than 20 percent in 2013 and 2014. Kozhikode contributes 7.3 percent in 2011 to 12.5 percent in 2019 WBD. Among the districts Malappuram contributes the highest and Wayanad is the lowest among northern districts (Table 3) (Figure 5). Only 2.7 percent (each in 2013 and 2015) to 4.1 percent (2019) of the WBD is contributed by Wayanad. Kannur contributes on an average 9 percent of WBD cases during these years. Percent change of water borne disease over 2011 in 2019. District is high among the central districts with regard to WBD. Kottayam provides the lowest contribution but when percentage change is considering it is highest among central part of Kerala. A large number of WBD is contributing by Malappuram in all years and is more than 20 percent in 2013 and 2014. Kozhikode contributes 7.3 percent in 2011 to 12.5 percent in 2019 WBD. Among the districts Malappuram contributes the highest and Wayanad is the lowest among northern districts (Table 3) (Figure 5). Only 2.7 percent (each in 2013 and 2015) to 4.1 percent (2019) of the WBD is contributed by Wayanad. Kannur contributes on an average 9 percent of WBD cases during these years. Percent change of water borne disease over 2011 in 2019. District is high among the central districts with regard to WBD. Kottayam provides the lowest contribution but when percentage change is considering it is highest among central part of Kerala. A large number of WBD is contributing by Malappuram in all years and is more than 20 percent in 2013 and 2014. Kozhikode contributes 7.3 percent in 2011 to 12.5 percent in 2019 WBD. Among the districts Malappuram contributes the highest and Wayanad is the lowest among northern districts (Table 3) (Figure 5). Only 2.7 percent (each in 2013 and 2015) to 4.1 percent (2019) of the WBD is contributed by Wayanad. Kannur contributes on an average 9 percent of WBD cases during these years. Percent change of water borne disease over 2011 in 2019.

Trend of districts shows that Alappuzha and Kollam shows a declining trend and Pathanamthitta which was lowest reported in earlier years now began to increase in reporting number of cases (Figure 3). Thiruvananthapuram has a jump in water borne diseases from 2015 and remain high during recent years. Among the central
Table 1: Trend in communicable diseases in Kerala, 2011-2019.

| Diseases             | 2011        | 2012        | 2013        | 2014        | 2015        | 2016        | 2017        | 2018        | 2019        | Average     |
|----------------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Vector borne         | 3517 (1.2)  | 6237 (0.9)  | 9940 (2.3)  | 5008 (1.1)  | 6993 (1.5)  | 9334 (1.8)  | 23587 (4.8) | 5504 (1.1)  | 6612 (1.1)  | 8526 (1.7)  |
| Water borne          | 269014 (95.2) | 724424 (99.1) | 421749 (97.6) | 447966 (98.9) | 471952 (98.5) | 498712 (98.1) | 466086 (95.1) | 545139 (98.8) | 546894 (93.7) | 487993 (97.3) |
| Air borne            | 10194 (3.6) | 115 (0)     | 256 (0.1)   | 43 (0)      | 176 (0)     | 215 (0)     | 408 (0.1)   | 1063 (0.2)  | 30468 (5.2) | 4771 (1)    |
| Total                | 282725 (100) | 730776 (100) | 431945 (100) | 453017 (100) | 479121 (100) | 508261 (100) | 490081 (100) | 551706 (100) | 583974 (100) | 501289 (100) |

Figures in brackets show percent.

Table 2: Trend and mortality in major water borne diseases during 2011-2019.

| Water borne diseases | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | % change over 2011 |
|----------------------|------|------|------|------|------|------|------|------|------|-------------------|
| Leptospirosis number (%) | 944 (0.4) | 736 (0.2) | 814 (0.2) | 1075 (0.2) | 1098 (0.2) | 1710 (0.3) | 1408 (0.3) | 2079 (0.4) | 1211 (0.2) | 28.3 |
| Death (death rate)    | 70 (7.4) | 18 (2.5) | 34 (4.2) | 43 (4.0) | 43 (3.9) | 35 (2.1) | 80 (5.7) | 99 (4.8) | 57 (4.7) | - |
| Hepatitis A number (%) | 4583 (1.7) | 6305 (1.7) | 6166 (1.5) | 2831 (0.6) | 1980 (0.4) | 1351 (0.3) | 988 (0.2) | 1369 (0.3) | 1620 (0.3) | -64.6 |
| Death (death rate)    | 10 (0.2) | 8 (0.1) | 8 (0.1) | 6 (0.2) | 10 (0.5) | 10 (0.7) | 24 (2.4) | 5 (0.4) | 57 (0.4) | - |
| Cholera number (%)    | 18 (0) | 30 (0) | 20 (0) | 13 (0) | 1 (0) | 10 (0) | 8 (0) | 9 (0) | 9 (0) | -50.0 |
| Death (death rate)    | 1 (5.6) | 2 (6.7) | 0 | 0 | 0 | 0 | 1 (12.5) | 0 | 0 | - |
| Typhoid number (%)    | 2291 (0.9) | 2849 (0.8) | 2930 (0.7) | 1956 (0.4) | 1772 (0.4) | 1668 (0.3) | 314 (0.1) | 109 (0) | 27 (0) | -98.8 |
| Death (death rate)    | 2 (0.09) | 1 (0.04) | 0 | 0 | 0 | 2 (1.2) | 1 (3.2) | 0 | 0 | - |
| ADD number (%)        | 261178 (97.1) | 357252 (97.3) | 411819 (97.6) | 442104 (98.7) | 467102 (99.0) | 493973 (99.0) | 463398 (99.4) | 540814 (99.3) | 544027 (99.5) | 108.3 |
| Death (death rate)    | 4 (0) | 8 (0) | 2 (0) | 5 (0) | 0 (0) | 14 (0) | 8 (0) | 12 (0) | 6 (0) | - |
| Total number          | 269014 | 367172 | 421749 | 447979 | 471953 | 498712 | 466116 | 544380 | 546894 | 103.3 |
| Total deaths          | 87 | 37 | 44 | 54 | 53 | 61 | 114 | 116 | 70 | - |
### Table 3: Trend and pattern in water borne diseases in districts from 2011-2019.

| Districts          | 2011    | 2012    | 2013    | 2014    | 2015    | 2016    | 2017    | 2018    | 2019    | Average | % change 2011-2019 |
|--------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|-------------------|
| Thrissur hapuram   | 18986   | 21474   | 26921   | 26301   | 36530   | 46695   | 44934   | 50195   | 47530   | 35507   | 150.3             |
| Kollam             | 11652   | 12491   | 19232   | 23835   | 23348   | 25099   | 19439   | 23211   | 21072   | 19931   | 80.84             |
| Pathanamthitta     | 5893    | 6101    | 6555    | 6451    | 8501    | 8946    | 9521    | 14542   | 16030   | 9161    | 172               |
| Idukki             | 9891    | 10165   | 11039   | 12148   | 12835   | 13259   | 13853   | 13566   | 12975   | 12192   | 31.18             |
| Kottayam           | 7253    | 8495    | 11339   | 10327   | 9269    | 10011   | 10384   | 14369   | 17966   | 11045   | 147.7             |
| Alappuzha          | 15456   | 21676   | 22128   | 22581   | 21523   | 23238   | 18632   | 20002   | 20403   | 20626   | 32.01             |
| Ernakulam          | 19712   | 24797   | 28516   | 29995   | 31232   | 31231   | 33133   | 38444   | 44365   | 31269   | 125.1             |
| Thrissur           | 30324   | 39973   | 47570   | 48326   | 52036   | 53186   | 48613   | 56665   | 50390   | 47454   | 66.17             |
| Palakkad           | 36450   | 46117   | 50501   | 54915   | 57429   | 52701   | 47557   | 55591   | 49133   | 49994   | 34.8              |
| Malappuram         | 41302   | 71237   | 87923   | 91081   | 98490   | 87503   | 84255   | 10455   | 86356   | 82633   | 109.1             |
| Kozhikode          | 19699   | 37064   | 37270   | 44648   | 52010   | 59046   | 50625   | 52845   | 68174   | 46820   | 246.1             |
| Wayanad            | 9504    | 10513   | 11540   | 13863   | 12945   | 14448   | 16542   | 19900   | 22286   | 14616   | 134.5             |
| Kannur             | 30110   | 34753   | 37012   | 36542   | 36780   | 42074   | 39158   | 48569   | 55515   | 40057   | 84.37             |
| Kasaragod          | 12782   | 22316   | 24652   | 26961   | 28035   | 31275   | 29441   | 32015   | 34699   | 26908   | 171.5             |
| Total              | 26901   | 367172  | 421748  | 44797   | 471953  | 498712  | 466087  | 54438   | 546894  | 44821   | 103.3             |

### Table 4: Seasonal variation in water borne diseases.

| Year    | N   | Mean  | F    | P    | Groups  | Difference | P   |
|---------|-----|-------|------|------|---------|------------|-----|
| 2011    |     |       |      |      | Winter Vs Summer | 8996.58 | 0.046 |
| Winter  | 4   | 21639.25 | 14.598 | 0.001 |         |            |     |
| Summer  | 3   | 12642.67 | 14.598 | 0.001 | Winter Vs Summer | 7266.55 | 0.065 |
| Rainy   | 5   | 28905.80 | 14.598 | 0.001 | Winter Vs Rainy | 16263.13 | 0.001 |
| 2012    |     |       |      |      | Winter Vs Summer | 4877.00 | 0.884 |
| Winter  | 4   | 50342.0 | 3.058 | 0.097 | Winter Vs Rainy | 21137.80 | 0.099 |
| Summer  | 3   | 55219.0 | 3.058 | 0.097 | Winter Vs Rainy | 16260.80 | 0.271 |
| Rainy   | 5   | 71479.80 | 3.058 | 0.097 | Winter Vs Rainy | 24086.25 | 0.031 |
| 2013    |     |       |      |      | Winter Vs Summer | 3228.25 | 0.930 |
| Winter  | 4   | 26802.75 | 5.664 | 0.026 | Winter Vs Summer | 20858.0 | 0.083 |
| Summer  | 3   | 30031.0 | 5.664 | 0.026 | Winter Vs Rainy | 24086.25 | 0.031 |
| Rainy   | 5   | 50889.0 | 5.664 | 0.026 | Winter Vs Rainy | 20858.0 | 0.083 |
| 2014    |     |       |      |      | Winter Vs Summer | 309.25 | 0.998 |
| Winter  | 4   | 34000.25 | 1.989 | 0.193 | Winter Vs Rainy | 8178.15 | 0.253 |
| Summer  | 3   | 33691.0 | 1.989 | 0.193 | Winter Vs Rainy | 8487.4 | 0.282 |
| Rainy   | 5   | 42178.40 | 1.989 | 0.193 | Winter Vs Rainy | 1774.5 | 0.962 |
| 2015    |     |       |      |      | Winter Vs Summer | 7262.90 | 0.462 |
| Winter  | 4   | 35859.5 | 0.842 | 0.462 | Winter Vs Rainy | 5488.4 | 0.677 |
| Summer  | 3   | 37634.0 | 0.842 | 0.462 | Winter Vs Rainy | 265.5 | 1.000 |
| Rainy   | 5   | 43122.4 | 0.842 | 0.462 | Winter Vs Rainy | 23415.1 | 0.196 |
| 2016    |     |       |      |      | Winter Vs Summer | 23680.6 | 0.237 |
| Winter  | 4   | 31869.5 | 2.378 | 0.148 | Winter Vs Rainy | 23680.6 | 0.237 |
| Summer  | 3   | 31604.0 | 2.378 | 0.148 | Winter Vs Rainy | 23680.6 | 0.237 |
| Rainy   | 5   | 55284.60 | 2.378 | 0.148 | Winter Vs Rainy | 23680.6 | 0.237 |

Continued.
| Year | N   | Mean     | F    | P    | Groups               | Difference | P    |
|------|-----|----------|------|------|----------------------|------------|------|
| 2017 | Winter | 4 | 32173.75 | 1.980 | 0.194 | Winter Vs Summer | 3206.25 | 0.925 |
|      | Summer | 3 | 35380.0  |      |      | Winter Vs Rainy    | 14076.45 | 0.197 |
|      | Rainy  | 5 | 46250.2  |      |      | Summer Vs Rainy    | 10870.2  | 0.410 |
| 2018 | Winter | 4 | 36726.75 | 3.998 | 0.057 | Winter Vs Summer   | 3888.92  | 0.875 |
|      | Summer | 3 | 40615.67 |      |      | Winter Vs Rainy    | 18398.45 | 0.060 |
|      | Rainy  | 5 | 55125.20 |      |      | Summer Vs Rainy    | 14509.53 | 0.184 |
| 2019 | Winter | 4 | 39288.0  | 2.397 | 0.146 | Winter Vs Summer   | 1973.0   | 0.966 |
|      | Summer | 3 | 41261.0  |      |      | Winter Vs Rainy    | 13903.0  | 0.163 |
|      | Rainy  | 5 | 53191.8  |      |      | Summer Vs Rainy    | 11930.8  | 0.297 |

Figure 1: Trend in water borne diseases.

Figure 2: Trend in major water borne diseases; (A) leptospirosis; (B) hepatitis A; (C) cholera; (D) typhoid; (E) ADD (diarrhoea).
**Seasonal variation in water borne diseases**

Seasonal variation in infectious disease transmission plays an important role in determining when epidemics happen.\(^{15}\)

Seasonal variation in WBD is evident in years 2011, 2012, 2013 and in 2018 (Table 4). Mean number of diseases in three seasons has variability (F=14.6 and p=0.001) in 2011. Hence, we go for the multiple comparisons through Tukey post hoc test. Significant variability in winter versus summer (p=0.05), winter versus rainy (p=0.06) and summer versus rainy (p=0.001). The difference in the occurrence of WBD in rainy season with respect to winter is statistically significant at 10% level in 2012. In 2013, rainy season with respect to winter and summer has an influence in the
concurrency of WBD. In 2018 number of cases is significantly varied according to the rainy seasons compared to winter.

DISCUSSION

Although the state had been successful in controlling a number of communicable diseases earlier, the emergence of water borne diseases in recent years has led to considerable increase in morbidity and mortality. Information about trends and pattern in disease is necessary for planning the infrastructure and human resources to combat with the health needs.

During the reference period, more than 98 percent of the communicable diseases were due to water borne diseases. Data from government of Kerala suggested that the water borne diseases were now emerging in the state. More than 97 percent of the water borne disease were due to diarrhea but no death was reported in the reference period. Increasing trend of diarrhea was observed. Typhoid, hepatitis A and cholera showed a decreasing trend. Leptospirosis shared only 0.2 to 0.4 percent of the water borne diseases in Kerala. But death rate was high for the disease as highest as 7.4. Water borne diseases (WBD) was mostly reported by Malappuram but percent share over 2011 was highest in Kozhikode. Among central districts reported cases of WBD was highest in Palakkad (but showed a declining trend after 2016) and lowest in Kottayam (but showed an increasing trend in recent years), whereas among southern districts Thiruvananthapuram reported the highest number of cases and Pathanamthitta the lowest (but now it showed an increasing trend). Malappuram which was reporting highest number of cases and now showed a declining trend among northern districts and Wayanad was the least reported WBD district. Seasonal variability in water borne disease was also observed in 2011-2013 and in 2018. The difference in the occurrence of WBD in rainy season with respect to winter was statistically significant.

Analysis of the DHS portal data showed that 97 percent of the waterborne diseases were due to diarrheal diseases and it was very high from other studies. Prevalence of water borne diseases among communicable disease was reported by 14.6% in a tertiary level hospital and was based on inpatient data.\textsuperscript{14} Our study used DHS portal data which included outpatient data of primary level to tertiary level. In India, a case fatality rate of 5.0 per 1000 cases were reported.\textsuperscript{16} Our study pointed out 0.2 to 0.4 percent share of leptospirosis and 0.2 to 1.7 percent these diseases among waterborne diseases. Admissions due to water borne diseases in the hospital increased during rainy season with respect to summer and winter was also proved in Kerala.\textsuperscript{14} Occurrence of acute diarrheal diseases is more in monsoon season is proved in India and in states.\textsuperscript{16,17} This was consistent with our study that mean number of cases increased during rainy seasons significantly. It may be due to the contamination of open wells. Spatial analysis study of open wells in urban Trivandrum reported that dug wells were a major source of drinking water and 73% of the wells contaminated with coliform organisms. The reasons for the coliform contamination are the close proximity of septic tanks with the wells and inadequate chlorination and cleansing activities by the households. Climate could influence water borne disease was confirmed by WHO.\textsuperscript{19} In Kozhikode 74 percent of leptospirosis cases are reported in monsoon season and higher rate of contamination in Delhi in the same season.\textsuperscript{11,20} Fatality rate of 7.4 of leptospirosis in this study was higher compared to 3.5% in Mangalore (Holla et al 2005) and consistent with 7.7 in Orissa (Jena et al 2004).\textsuperscript{21,22}

Despite appointing arogya sena and health volunteers at the grass root level to report communicable diseases at the earliest, emerging and remerging infectious diseases were public health threat even now in Kerala. Public health risks can be detected through good quality of data. DHS data suffered under reporting of many diseases. In some years, data of some diseases were missing and we could not be able to find out whether the disease was not recorded or actually the disease was absent. This was one limitation of the study. Under reporting or partially reporting was the major issue when approaching these types of data. WHO reported that diarrheal diseases remain vastly under-reported even in nations with highly developed surveillance systems mainly related to multiple factors including lack of diagnosis, lack of specimen collection, lack of reporting, and lack of treatment sought.\textsuperscript{19} Hence data management through expertness was necessary in order to tackle the issues timely in the state. Seasonal variations or higher number of cases in rainy season indicated the importance of planning in health activities. Even though people were educated and kept personal hygiene, waterborne disease were increasing was a matter of concern.

Limitations

As some diseases are missing in some years, we could not be able to find out whether the disease was not recorded or actually the disease was absent. There was no regular recorded data in the portal. It was the limitation of the study.

CONCLUSION

Morbidity due to water borne diseases is mainly limited to ADD which can be reduced through effective grass root level coordination. Identification of seasonality dependent water borne diseases helps to improve pre monsoon activities, human and other resources in peripheral health institution for better service and to adopt effect control strategies. Continued and regular data availability is the major hindrance in preventing the communicable diseases. Only available public health data in the state is the data in the DHS portal. Our study highlights the importance of surveillance data monitoring...
in the study to better understand disease pattern and trend and seasonality.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: Not required

REFERENCES

1. WHO. The global burden of disease: 2004 update. Geneva, World Health Organization. 2008.
2. WHO. Fact sheet: Diarrhoeal disease 2017. Available at: https://www.who.int/news. Accessed on 20 May 2021.
3. Megha PU, Kayya P, Murugan S, Harikumar PS. Sanitation mapping of groundwater contamination in a rural village of India. J Environment Protect. 2015;6(1):34-44.
4. Chitra GA, Nair VM. Prevalence of diarrhoeal diseases-an indicator for poor environmental sanitation. Kerala Med J. 2010;3(1):7-10.
5. Thankappan KR. Diarrhoea morbidity among under-five children: a comparative study of two villages. Kerala Res Progr Local Level Develo. 2002;5-36.
6. Rakesh PS, Sherin D, Sankar H, Shaji M, Subhagan S, Salila S. Investigating a Community-Wide Outbreak of Hepatitis A in India. J Glob Infect Dis. 2014;6(2):59-64.
7. Sebastian B, Mathai S, Mathew G, Ouseph M, Balakrishnan P. An outbreak of hepatitis A in central Kerala-clinical profile. Indian J Gastroenterol. 1998;17:10.
8. Arankalle VA, Devi KLS, Lole KS, Shenoy KT, Verma V, Haneephabi M. Molecular characterization of hepatitis A virus from a large outbreak from Kerala, India. Indian J Med Res. 2006;123(6):760-9.
9. Kuriakose M, Eappen CK, Paul R. Leptospirosis in Kolenchery, Kerala,India. Epidemiology, Prevalent local serogroups and serovars and a new serovar. Europe J Epidemiol. 1997;13(6):691-7.
10. Pappachan MJ, Mathew S, Aravindan KP, Khader A, Bharghavan PV, Abdul Kareem, et al. Risk factors for mortality in patients with leptospirosis during an epidemic in Northern Kerala. Natl Med J India. 2004;17(5):240-2.
11. Swapna RN, Tuteja U, Nair LJ, Sudarsana J. Seroprevalence of leptospirosis in high risk groups in calicut, North Kerala, India. Indian J Med Microbiol. 2006;24(4):349-52.
12. Kulinkina AV, Mohan VR, Francis MR, Kattula D, Sarkar R, Plummer JD, et al. Seasonality of water quality and diarrheal disease counts in urban and rural settings in South India. Sci Rep. 2016;6:20521.
13. Kalyani D, Shankar K. Assessment and seasonal variations of communicable diseases: 3 year study. Int J Res Med Sci. 2016;4(4):1186-92.
14. Manjula VD, Bhaskar A, Sobha A. Surveillance of communicable disease from a tertiary care teaching hospital of central Kerala, India. Int J Med Public Health. 2015;5(4):317-21.
15. Martinez ME. The calendar of epidemics: seasonal cycles of infectious diseases. PLoS Patho. 2018;14(11):1007327.
16. Shukla D, Nayak P, Mishra RN. Burden of infectious diseases and their seasonal variation in India. Int J Health Sci Res. 2016;6(12):33-40.
17. Sreekant P, Jayapraksh T, Iyenger P. Seasonal distribution of diarrhea among children aged 1-5 years in slums of Southern India: a cross-sectional door to door survey. Int Healthc Res J. 2020;4(6):158-61.
18. Mohan A, Reghunath R, Rajeevan A, Achu A, Mathew J, Valamparampil, et al. Contamination of household open wells in an urban area of Trivandrum, Kerala state, India: a spatial analysis of health risk using geographic information system. environmental health insights. 2018;12:1-9.
19. WHO. Fact sheet: Module 9: Water & food-borne diseases, 2015. Available at: https://www.who.int/d. accessed on 20 May 2021.
20. Agrawal SK, Chaudhry R, Gupta N, Arif N, Bhadur T. Decreasing trend of seroprevalence of leptospirosis at all india institute of medical sciences New Delhi: 2014-2018. J Family Med Prim Care. 2018;7(6):1425-8.
21. Holla R, Bhagwan D, Pandey L, Unnikrishnan B, Kumar N, Thapar R, et al. Leptospirosis in coastal South India: a facility based study. Bio Med Res Int. 2018.
22. Jena AB, Mohanty KC, Devadasan N. An outbreak of leptospirosis in Orissa, India: the importance of surveillance. Tropic Med Int Health. 2004;9(9):1021.

Cite this article as: Soorya V, Raj J, Kumari KRA. Trends in water borne diseases in Kerala: an analysis of directorate of health services portal data. Int J Res Med Sci 2021;9:2381-8.