***Epidemiology and Infection***

**Social Network Analysis of COVID-19 Transmission in Karnataka, India**

S. Saraswathi, A. Mukhopadhyay, H. Shah, T.S. Ranganath.

*Supplementary Material*

Contents

[Table S1: Important Definitions used in Social Network Analysis 2](#_Toc49711085)

[Table S2: District-wise Caseload, and Sources of Infection 4](#_Toc49711086)

[Table S3: Distribution of the 37 Largest Clusters by District and Source of Infection 5](#_Toc49711087)

[Figure S1: Trend of Cases (March 9 to May 17, 2020) 6](#_Toc49711088)

# **Table S1: Important Definitions used in Social Network Analysis**

|  |  |  |
| --- | --- | --- |
| **S. no.** | **Term** | **Definition** |
|  | **Degree centrality** | The number of social connections or links of a node, expressed as an integer or count [21]. |
|  | **Indegree** | The number of incoming links to a target node from source nodes. |
|  | **Outdegree** | The number of links to target nodes from a source node. |
|  | **Betweenness centrality** | The number of times a node appears on the shortest paths between other nodes. Denotes the bridging role of a node between two otherwise unconnected nodes [22]. |
|  | **Closeness centrality** | Mean shortest path length from a node to every other node. Calculated as the reciprocal of the sum of distances from the node to all other nodes [23]. |
|  | **Harmonic closeness** | Measure of closeness centrality in networks with unconnected nodes. Calculated as the sum of the inverted distances from a node to all other nodes [23]. |
|  | **Edge betweenness** | The number of the shortest paths that go through an edge in a graph or network [24]. |
|  | **Clustering coefficient** | Measures the degree to which nodes in a graph tend to cluster together [25]. |
|  | **Network density** | The number of existing ties between nodes, divided by the number of possible ties [26]. |
|  | **Network diameter** | The shortest path between the two most distant nodes in a network [25]. |
|  | **Mean path length** | The average of the shortest path lengths between all possible node pairs [25]. |
|  | **Network component** | An island of interlinked nodes that are disconnected from other nodes of the network [12]. |
|  | **Super-spreader** (operational definition) | Any node in our study with an outdegree ≥5 |

Citation numbers in this table indicate the position at which the reference first appeared in the main manuscript.

# **Table S2: District-wise Caseload, and Sources of Infection**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **District** | **F** | **M** | **Total** | **%** |
| Bengaluru | 75 | 154 | 229 | 19.97 |
| Belagavi | 46 | 61 | 107 | 9.33 |
| Kalaburagi | 45 | 60 | 105 | 9.15 |
| Mysuru | 11 | 79 | 90 | 7.85 |
| Davanagere | 37 | 52 | 89 | 7.76 |
| Bagalkote | 27 | 52 | 79 | 6.89 |
| Mandya | 24 | 47 | 71 | 6.19 |
| Others | 140 | 237 | 377 | 32.87 |
| Total | 405 | 742 | 1147 | 100.00 |
| **Source type** | **F** | **M** | **Total** | **%** |
| International travel | 24 | 66 | 90 | 7.85 |
| Domestic travel | 59 | 150 | 209 | 18.22 |
| Delhi hotspot | 70 | 130 | 200 | 17.44 |
| Karnataka hotspot | 23 | 90 | 113 | 9.85 |
| Secondary cases | 193 | 240 | 433 | 37.75 |
| Unknown | 36 | 66 | 102 | 8.89 |
| Total | 405 | 742 | 1147 | 100 |

# **Table S3: Distribution of the 37 Largest Clusters by District and Source of Infection**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Source  District | Unknown | Karnataka hotspot | Delhi hotspot | Domestic travel | International travel | Total |
| Bengaluru | 3 | 2 | 2 |  | 1 | 8 |
| Belagavi |  |  | 5 |  |  | 5 |
| Kalaburagi | 3 |  | 1 | 1 |  | 5 |
| Mysuru |  | 1 |  |  |  | 1 |
| Davanagere | 5 |  |  |  |  | 5 |
| Bagalkote | 3 |  |  |  |  | 3 |
| Mandya |  |  | 1 |  |  | 1 |
| Others | 5 |  | 3 | 1 |  | 9 |
| Total | 19 | 3 | 12 | 2 | 1 | 37 |

Cell values indicate count of clusters.

Bengaluru, the major transit point for international passengers, had only one cluster traced to a returnee from abroad. It is notable that 11 of the 37 clusters (29.73%) originated in Delhi. All the Belagavi clusters (including the 2nd largest cluster with 45 nodes) were traced to travellers from Delhi.

# **Figure S1: Trend of Cases (March 9 to May 17, 2020)**

This graph shows the number of cases detected every week. Week 1 begins on 9 March and week 10 ends on 17 May 2020. Cases spiked in the second half of April and continued to rise in May as lockdown regulations were relaxed and migrant workers returned from other states. However, these were mostly isolated nodes with few instances of cluster formation (Figure 7), which we may attribute partly to the effective implementation of quarantine measures in the early stage of the outbreak, and also because the clusters originating from these out of state travellers would become apparent only at a later date.