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Research Letter

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Focus on international and domestic travellers are equally important for successful SARS-COV-2 mitigation: ecological comparison of emigrant and migrant travel patterns and COVID-19 trends in Kerala State, India

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On 7 May 2020 India began the largest civilian repatriation ever conducted in modern times, for Indian citizens stranded overseas due to COVID-19 travel restrictions with 5774 flights between India and 53 countries carrying 697 779 passengers.[1] About 50% of the repatriation flights were for the Gulf Cooperation Council (GCC) countries. One-fourth of these repatriation flights were for the Indian State of Kerala, which has only 2.8% (34 million) of India's population.[2] At that time, India had reported relatively lower COVID-19 burden as compared with other countries, leading to the speculation that international emigrant returnees would serve as seeds of infection.

Kerala was the first state to report COVID-19 in India on 30 January 2020 that prompted the state to be a trailblazer in pandemic mitigation in India and the State achieved successful pandemic mitigation (zero cases reported on 3 May 2020), hailed as a model for India.[3] However, Kerala's COVID-19 cases exponentially increased in later months (10 000 cases/day on 7 October 2020, 8402 cases per million). Phylogenetic studies revealed that Kerala's resurgence of cases may have originated from internal transmission within India than from returning international emigrants.[4]

To clarify these seeding and community transmission dynamics in Kerala, we analysed the trends in Kerala State's reported cases of COVID-19 by travel history correlated with COVID-19 status in both GCC and other States of India. We categorized our analysis to three time periods: January to 6 May (mitigated phase); 7 May to 30 June (period commencing with repatriation of emigrants and relaxation of interstate travel); 1 July to 30 September (phase of extensive transmission).[5]

Early phase: Kerala was put on high alert for after the first case of SARS-CoV-2 was detected.[6] Fearing potential suspension of international flights to Kerala, Kerala's emigrants from the GCC began returning to Kerala through 22 March when Kerala suspended all transportation to the state international and domestic (except for urgent domestic travel based on travel pass). International returnees were subjected to mandatory monitored quarantine organized by the Ministry of Health and arrival COVID-19 testing when it became available. Domestic

Table 1. COVID-19 in Kerala State, India through September 2020: Reported cases, distribution of cases among emigrants, migrants and permanent residents of Kerala and test positivity rates

	30 January to 5 May[a]	6 May to 30 June[b]	[3]1 July to 30 September[c]
Number of cases	502	3939	191 664
Average test positivity rate	1.5%	2.1%	6.3%
Distribution of cases as percent of total cases			
Emigrants[d]	56.0%	55.0%	4.5%
Migrants[e]	9.0%	35.7%	5.8%
Permanent residents[f]	35.1%	9.3%	89.8%

[a]Mitigation phase (including cessation of all international and domestic transport networks and restriction of movement of people within and to the state).
[b]Relaxation of travel restrictions including repatriation of international emigrants.
[c]Acceleration of reported cases.
[d]People of Kerala origin who live or work in other countries.
[e]People of Kerala origin who live or work in other states of India.
[f]Kerala residents who did not report any recent travel.

travellers were allowed home quarantine and testing was limited to symptomatic persons.

Reported COVID-19 cases remained <100 through 23 March (Table 1). Sporadic cases were detected after completion of the 14 days of incubation cycle from the date of cessation of air and land transport (the period from 7 April to 5 May) (86 resident cases; 60 emigrants, 29 domestic migrants) indicative of residual community transmission. No cases were reported on 3 May 2020 suggesting that clusters seeded by international emigrant returnees may have died out, as no international transport existed since 23 March 2020.

During this first phase of the epidemic, the majority of infections were reported among international emigrant returnees (56%) followed by permanent residents of Kerala (35%) and the lowest among domestic migrants (9%) (Table 1) SARS-COV-2 seropositivity remained well below mitigated status (average 1.5%).

The second phase: The phased relaxation of mitigation measures in Kerala such as the resumption of passenger train services on 12 May and the lifting of lock down from 8 June (unlock 1.0) helped rapid increase in inflow of domestic migrants form the other states and the distribution of cases began to shift with increases among domestic migrants. During this period domestic migrant returnees as a percentage of total COVID-19 cases reached 36% (compared with 9% in earlier phase) (Table 1) with slightly increased average overall seropositivity rate (2.3%).

Third phase: By July, despite continuous inflow of emigrant and domestic migrant returnees, community transmission dominated as the leading contributor (89%) to reported cases and this trend remained thereafter, and overall seropositivity further increased (average, 17.2%) (Table 1). By August, all the districts (the lowest administrative regions) reported COVID-19 cases, suggesting that the reach of SARS-COV-2 is extensive and no rural areas are free from the virus.

Daily COVID-19 cases among returning domestic migrants from other states increased and peaked during July 2020. Among the domestic migrants with COVID-19, the majority originated from the four states with the highest COVID-19 rates in India. Of the four states two were neighbouring states (Tamil Nadu: population 78 million, Karnataka: population, 68 million) and the other two were major economic hubs of India (Maharashtra: population 123 million, Delhi: population, 30 million).[7]

This ecological review of COVID-19 transmission in Kerala State of India suggests that, consistent with genetic epidemiologystudies,[5] seeding of COVID-19 in Kerala leading to the ongoing transmission may not be attributable to Kerala's international emigrant returnees, rather to domestic travellers arriving from other states of India. Kerala state achieved COVID-19 mitigation through 6 May 2020 and sporadic community seeding of SARS-CoV-2 by international emigrant returnees were interrupted successfully due to combination mitigation measures (as indicated by zero cases on 3 May 2020) including mandatory testing, tracing and quarantine of all international arrivals, the lockdown, social and public event cancellations, risk communication and enforced face coverings and physical distancing. However, Kerala was less successful in averting influx of cases from the rest of India through domestic travellers and seeding of local communities.

The state overlooked the risk from domestic migrant returnees probably due to low number of reported cases in other states of India prior to May 2020. Community transmission had, in fact, began much earlier than the repatriation flights.

The natural history of COVID-19 in Kerala reaffirms that synchronized multiple layers of pandemic mitigation efforts at the onset of an outbreak can help achieve pandemic mitigation.[8] Kerala data also indicate that premature lifting of critical components of mitigation efforts diminishes the impact of mitigation.[9,10] Further, during an outbreak when extent and patterns of transmission are unclear focus exclusively on a single transmission route (international travellers in this case) may not achieve optimum outcome.

Conflicts of interest

None declared.

Authors' Contributions

S.H.E. conceived the idea, S.F.K. conducted the data analysis and developed the graphics, Kerala-based authors provided incident related data including on COVID-19. S.H.E. wrote the initial draft and received comments from all authors and developed the final draft. All authors approved the final draft.

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