

# How Universal is the Use of Facemask During COVID-19 Pandemic? A Photo-Epidemiology Study from the Indian State of Kerala

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## ABSTRACT

**Background & Objectives:** Kerala state was the first to report COVID-19 case in India and was initially successful in curbing the spread of the virus. However, Kerala witnessed a surge of cases subsequently. This study aimed to estimate the prevalence of face mask use and social distancing in public places in Kerala.

**Methods:** We did a cross-sectional photo-epidemiology study; wherein photographs of people in public places were taken across Kerala. Photos were analysed to determine the usage of mask, whether it was properly worn and the type of mask. Crowding was taken as a surrogate for social distancing. We compared mask use and crowding across district zones with low, medium and high COVID-19 burden.

**Results:** We analysed 1445 photos capturing 4500 people with clear view of the face. Prevalence of mask use was 96% across the state. We found near complete mask use in the districts with high COVID-19 burden (99%) compared to districts with low (96%) and medium burden (95%). 20% of the people in public spaces either did not wear a mask or wore it improperly. Crowding was higher in high burden districts with a weak but positive correlation with case burden.

**Conclusion:** Prevalence of face mask use was high across all districts in the Kerala State, but a considerable number of people were unprotected due to improper or non-usage of masks. Crowding in high burden districts indicate that inadequate social distancing could have contributed to increased cases, despite a high compliance to mask usage even in these districts.

## Introduction

The state of Kerala (population 34 million) was the first to report the Corona Virus Disease 2019 (COVID-19) case in India on January 30, 2020 in three medical students who returned

from Wuhan, China [1]. Prompt quarantine measures effectively stopped transmission from these cases. The state government initiated a series of public health measures including lockdown,

social distancing and mandatory wearing of facemasks [2,3]. The next wave of cases was reported subsequent to the return of non-resident Keralites from the gulf countries and Europe. This wave of infection was contained to double digits by May 2020, with no case of infection reported for nearly 5 days in the first week of May [4]. However, with the repatriation flights and interstate travel in June, the next wave was reported. This surpassed the previous wave of transmission with daily reported cases in the state surpassing 3000 and subsequent declaration of community transmission in the state. Despite aggressive epidemic control measures which included testing, contact tracing and quarantine supported by a very strong grassroot primary health care network and public health measures, Kerala continued to see rising cases of infection six months into the epidemic. Of the fourteen administrative units called districts, Thiruvananthapuram (the capital city) followed by Malappuram reported the highest daily and cumulative number of cases during August. The state reported 66761 cases as on August 28, 2020 (1964 cases/million population).

Universal face mask usage is considered as one of the key strategies to control the spread of COVID-19 in addition to hand washing, social distancing and avoiding closed spaces [5-7]. The role of mask was initially thought to be for source control; recommended for patients with upper respiratory symptoms to prevent spread of the virus from them [8]. Furthermore, asymptomatic and pre-symptomatic patients were also found to have viral shedding equivalent to symptomatic patients [9] with risk of transmission starting a few days before symptom onset and infectivity peaking at the time of symptom onset for the Severe acute respiratory syndrome coronavirus (SARS CoV-2) [10]. This mandated universal mask use particularly, in places with potency for community transmission and high risk of viral spread. In addition to preventing transmission from infected patients, masks protect the wearer from becoming infected by blocking viral particles from entering the nose and the mouth [11]. The type of mask and the technique of mask usage is key to ensuring effectiveness of universal masking [12]. Although the cloth mask is inferior to the surgical mask or the N95 masks in terms of virus filtering capacity, in a low transmission-risk setting such as in public places, cloth masks are thought to be sufficient [13].

If infection happens despite mask usage, masks are thought to reduce the inoculum of the virus which may lead to asymptomatic or only mild infection [14]. The usage of masks has been commonly noted to be improper with inadequate coverage of the nose or sometimes with full exposure of the nose and mouth with the mask being pulled down to the neck which makes the mask usage ineffective [15]. This study aimed to estimate the prevalence of face mask usage amongst the public in Kerala during the COVID-19 pandemic using photo-epidemiology. Photo epidemiology is a simple and effective method to study the mask usage and social

distancing. Mobile phone cameras can be used to capture photos in public setting with relatively less intrusion into privacy [11,16]. Specifically, the study tried to estimate the extent of mask use across the districts of Kerala, the urban-rural and gender difference variations. We counted faces per photo frame and used it as an indicator of crowding and social distancing. We also tried to correlate the COVID-19 case load at the district level with mask use and crowding.

## Material & Methods

We used a cross-sectional design and obtained photos in public spaces across all the 14 districts of Kerala. Master of Public Health students at the Global Institute of Public Health, Thiruvananthapuram took photographs across the day for nine consecutive days from August 28 to September 5, 2020. This helped cover a range of days with varying levels of crowding in public places as these dates overlapped with the public holidays marking the Onam festival season (official state festival of Kerala). We took photos from a range of relevant locations including public places, hospital premises, indoor gathering locations etc. Two authors independently checked all the photos to select those with a clear view of faces to confirm if they were wearing a mask. We defined proper use of mask as adequate coverage of the nose and mouth. We identified three types of masks namely cloth mask, surgical mask and N95. We used the average number of people per photo frame as a measure of crowding. We excluded photos with inadequate resolution. Children who seemed to be below 12 years of age on visual inspection were not included in the analysis.

Further, two other authors independently analyzed a random sample of the selected photos to verify the recordings. Any discordance was settled by a referee. We divided the 14 districts into three zones based on the cumulative number of COVID-19 cases reported as of 28 August 2020 as follows: High zone (districts with total cases > 8000), Mid Zone (Cases 4000-8000) and Low Zone (Cases < 4000). We retrieved data on COVID-19 cases per million population for the districts from the official web portal of the government of Kerala [4]. In addition, we also analyzed the mask wearing practice as captured by the Closed-circuit television (CCTV) footage of shoppers from a shopping mall in one of the districts with a high COVID 19 burden number of cases. In this mall, COVID-19 protocols to ensure mask usage was supervised by security personnel at the entrance as well as inside the premises. We used this sample as a comparison group to study the mask usage in a supervised environment. Institutional Ethics Committee of Ananthapuri Hospitals and Research Institute, Thiruvananthapuram gave ethical clearance for the study.

## Results

We took 1445 photos capturing 6208 people from all the 14 districts of Kerala. We included 4500 (73%) people in the analysis

as the rest of the faces were not clear enough for analysis. Of them, 1841 (52%) were from the low zone, 1342 (30%) from the mid zone, and 1317 (29%) from the high zone. Half (50%) of the photos

were taken from roadside, and around 56% were from urban areas. Sample had 1026 (22.8%) women. Characteristics of the photo samples are presented in Table 1.

**Table 1:** Characteristics of photo samples.

	Total Photos	Total faces in photos	Average Number of faces per photo <sup>s</sup>	Number of clear faces analyzed	People with mask	Mask usage (%)	Proper use of mask (%) <sup>#</sup>	No mask or improper mask usage (%)
Low Zone	755	2448	3.2	1841	1765	95.9	80.8	22.5
Kannur	100	381	3.8	292	275	94.2	87.6	17.5
Trissur	83	367	4.4	255	243	95.3	85.2	18.8
Wayanad	34	268	7.9	222	211	95	79.6	24.3
Idukki	115	323	2.8	255	242	94.9	65.7	37.6
Kottayam	162	422	2.6	341	329	96.5	86.0	17.0
Pathanamthitta	146	403	2.8	251	241	96	82.2	21.1
Kollam	115	284	2.5	225	224	99.6	75.9	24.4
Medium Zone	395	1997	5.1	1342	1268	94.5	84.9	19.7
Kasaragod	110	343	3.1	252	226	89.7	79.2	29.0
Kozhikode	90	398	4.4	311	298	95.8	83.2	20.3
Palakkad	43	252	5.9	204	189	92.6	92.1	14.7
Ernakulum	100	697	7.0	369	365	98.9	83.8	17.1
Alappuzha	52	307	5.9	206	190	92.2	89.5	17.5
High Zone	295	1763	6.0	1317	1297	98.5	86.9	14.4
Malappuram	62	300	4.8	239	232	97.1	88.4	14.2
Trivandrum	233	1463	6.3	1078	1065	98.8	86.6	14.5
Kerala	1445	6208	4.3	4500	4330	96.2	83.8	20.6

## Mask Usage

Overall, we found very high mask use, with 96% people using masks, with no difference between men and women or between urban and rural areas. We found near complete mask use in the districts with high COVID-19 burden (99%) compared to districts with low (96%) and the medium burden (95%). There was statistically significant variation ( $p < 0.001$ ) between the zones. The mask usage ranged from 99.6% in Kollam district to 89.7% in Kasaragod district. We found higher mask use outdoors (96%) than indoors (91%). We did not find differences between hospital premises (98%), political gatherings (98%), or religious (100%) gatherings. We identified the type of masks in 96% of cases. Majority (87%) used clothes, 10% used surgical masks and 3% used N95 masks. We found higher use of surgical masks in hospital premises (20%) compared to other public places (9%); while N95 use was similar. Of those using masks ( $N = 4330$ ), 84% used it properly (men 82%, women 90%).

Proper mask use was high in urban areas (86%) than in rural (82%); and high in the high burden zone (86%) compared to medium (85%) and low burden zones (82%). We found relatively lower proportion of people wearing masks properly in public places (84%) compared to hospital premises (95%). Of all the mask

users, nine percent did not cover their nose (men 9%, women 7%). This ranged from four percent in hospitals to nine percent in public places. Eight percent of mask users did not cover their nose and mouth (men 9%, women 3%). This ranged from four percent in hospital premises, to seven percent in other public places. There was significant difference in improper mask usage between zones with highest proportion in low zone followed by mid zone and high zone ( $p < 0.05$ ). The analysis of data on 1059 people (63% men) at the supervised mall showed 100% mask use. Almost all (99.4%) wore their mask properly and majority of them (87%) were cloth mask.

## Crowding and Social Distancing

The average number of faces per photo frame was 4.3 for the whole state, ranging from 2.5 per frame in Kollam to 7.9 in Wayanad. Overall, the number was significantly higher in photos from high zone (6) indicating crowding in public places in districts with high COVID-19 burden. Medium zone (5.1) and low zone (3.2) had relatively low crowding (Figure 1). The total cases of COVID-19 in the districts varied from 3,643 cases in Wayanad to 34,481 in Thiruvananthapuram, as on September 30, 2020. Cases per million population varied from 3,292 in Idukki to 10,055 in Thiruvananthapuram.<sup>4</sup> We found a weak positive correlation between crowding and cases/million population (Figure 2).

District	Crowding	Proper mask use	COVID 19 cases
Wayanad	7.9	75.7	3643
Idukki	2.8	62.4	3792
Pathanamthitta	2.8	78.9	7845
Kottayam	2.6	83	10717
Kasaragodu	3.1	71	10785
Kannur	3.8	82.5	11489
Palakkad	5.9	85.3	11863
Trissur	4.4	81.2	13633
Kollam	2.5	75.6	14003
Alappuzha	5.9	82.5	14261
Ernakulam	7	82.9	18232
Kozhikode	4.4	79.7	18819
Malappuram	4.8	85.8	22543
Thiruvananthapuram	6.3	85.5	34481

Figure 1.

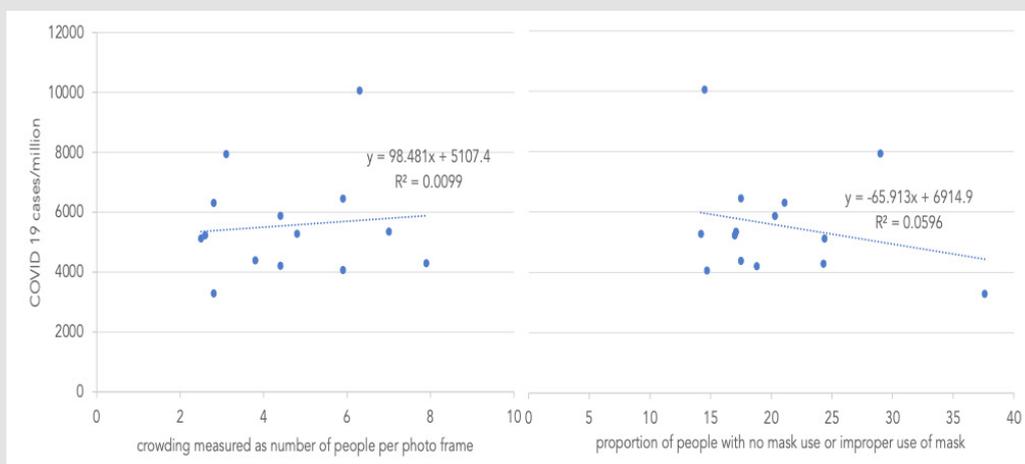


Figure 2.

### Discussion

This study is the first comprehensive report on the prevalence of face mask use in any Indian state during the COVID-19 pandemic. A high prevalence of face mask usage (96%) was found across all districts in the Kerala State, but a considerable number of people (20%) were unprotected due to improper or non-usage of masks. The districts in high zone with higher reported cases in-fact had greater compliance to face mask usage, likely indicating the possibility that the public were more cautious due to the higher infection spread in these districts as against a possibility of low mask usage as a contributory factor for higher disease spread. A survey of self-reported mask usage from 15 countries in April 2020 reported 76% mask usage in India, 76-91% in Asia and 16-34% in Europe and 50% in USA [16,17]. Kerala has the highest number of non-resident nationals [18] and the State received the highest number of repatriation flights (25% of the total repatriation flights

by Government of India) as part of the Vande Bharat Mission [19]. This along with high interstate travel and being the 4th most densely populated state in the country puts Kerala at very high risk of import of cases as well as transmission within the state.

Despite these factors, the state of Kerala was 13th in terms of COVID-19 prevalence compared to other Indian states in the months leading up to the study period which may be attributable to the higher compliance to face mask usage in addition to many other measures [20]. In the weeks following the study, there was a surge in cases in the Kerala state with daily cases reportedly crossing 10,000 with the state climbing to 7th position in terms of cumulative cases, 3rd position in terms of active cases and topping the charts with highest new cases per million population across the country on certain days. This could be due to several factors of which inadequate masking even in a smaller proportion of the population combined with lack of social distancing could have contributed. Previous study models have suggested that even

80% compliance to facemask usage in public could bring about a considerable reduction in COVID-19 transmission [19,21]. The high usage of masks in Kerala may be due to several factors including a higher literacy level and health awareness amongst the public, a robust primary health system, the “Break the Chain” campaign supported by the media as well as the political commitment of the state government. Universal masking being only one of the several aspects of disease containment, the compliance to other strategies such as hand hygiene and social distancing requires scrutiny due to the rising spread of the epidemic despite high mask compliance.

A high prevalence of mask usage was seen despite it being the Onam festive season. High compliance to face mask usage was seen across districts, even though there was a significant variation in district-wise total cases. A uniformly high usage of mask use was also seen across urban and rural areas and in various public settings. Campaigns to use masks in indoor settings had been taken up in the state to reinforce mask usage while with co-workers, friends and family indoors. But routine mask use amongst family members in residential setting may not be practical. Improper mask use was noted in 16% people with higher improper use amongst men (18% versus 10% in women) which could be an Achilles heel to the universal mask usage campaign. The improper mask use with nose exposed versus lack of coverage of nose and mouth were equally prevalent (9% vs 8%). We could identify the type of mask in 96% of people much higher than what has been previously reported by the photo-epidemiology technique.<sup>9</sup> Cloth masks were the most commonly used masks (87%) as is recommended for the public with a low usage of N95 masks (3%) and a relatively higher usage of surgical mask in hospital premises (20% versus 9% in other public places).

The mask usage at a shopping mall in Thiruvananthapuram was collected as a comparison group to assess mask compliance in a supervised setting. This mall has been seen to ensure strict COVID-19 protocols with the help of security personnel ensuring mask usage at the entrance as well as inside the mall. As expected, a higher prevalence of mask usage was seen in this group with 99.4% of proper mask usage. Unabated and uncontrolled spread of COVID-19 infection suggests that mask usage alone may not be effective to prevent infection. Social distancing, hand washing, reducing the time of interaction and avoiding closed and poorly ventilated environments might be equally important to reduce infection. Average people per photo frame were used as a measure of crowding in the study. This was significantly higher in the high zone followed by medium zone and low zone. This indicates that inadequate social distancing measures could have contributed to higher cases in certain districts, despite a high compliance of mask usage across districts. The strength of the study is a relatively higher sample size representing all the districts in the State, with data collected by trained public health professionals. We could obtain only limited photos from indoor settings which limited our

analysis. There is an element of subjectivity in the way photos are captured, and being a cross-sectional view, the findings reflect the behavior of people at that moment in time. Even then, the study gives a bigger picture of the mask use in the state. The crowding in photo frame as an indirect indicator of lack of social distancing may also be cautiously interpreted.

## Conclusion

This cross-sectional study using photo-epidemiology method shows a high prevalence of universal mask compliance in the Indian State of Kerala during the COVID-19 pandemic. Nonetheless, the state has a surge in COVID-19 cases indicating the importance of equally emphasizing on multiple measures like social distancing, and hand hygiene, as well as the need for early diagnosis through enhanced testing.

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## Conflicts of Interest

None.

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