



The COVID Chronicles: Prevalence of COVID-19 in India *Podcast Transcript*

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BEGIN TRANSCRIPT

Satchit Balsari: Hello and welcome to Covid Chronicles, part of the 'India in Focus' podcast. My name is Satchit Balsari. Today we have Professor Manoj Mohanan, Associate Professor at the Sanford School of Public Policy at Duke University. Manoj has had over 15 years of research experience in health economics in India, Professor Mohanan led Covid- 19 prevalence studies in Karnataka, was co-author on the Mumbai seroprevalence study and on testing returning workers in Bihar.

His team's paper in the Lancet Global Health reports that seroprevalence in Mumbai varies from 55 to 61% in the slums in Mumbai to 12 to 19% in non-slum settings. Manoj, how did we get here?

Manoj Mohanan: Thank you so much Satchit, it's wonderful to be here with you and talk about some of our work, also think about exactly the question you asked, how did we get here? Overall, my view has been that there's been a surprisingly large amount of Covid transmission that has happened in India and there could be a number of reasons why, but just to reiterate what you just told us, we found that the seroprevalence in the slum areas in Mumbai was up to 55 to 62%. But more importantly, in some of the other works that we are doing in Karnataka, which is one of the first studies that looks at rural areas, we find very large numbers there as well. We're still analyzing the data, so I am not giving you an exact number but the point simply is that a lot of the public debate in India has been focused on the urban areas, the numbers discussed come from urban areas, and in some sense some of the political officers across India have also claimed that this is largely an urban epidemic. From what we find and what I strongly believe in is that's not the case. It's true that the numbers have come from urban areas, but the rural areas have been equally, if not exactly equally, they've been very largely affected by the epidemic as well.

Satchit Balsari: Manoj, in this factor of time, would it be fair to say that had you looked in March, you would see large numbers in urban areas and then if you look in now in September and October, of course, the pandemic is raging through rural India as well. I suspect that is not what you are saying.

Manoj Mohanan: Excellent point. I am sure you know this as well, in late March, when the lockdown happened, one of the things that happened in India along with the lockdown was a massive migration of daily workers from the big cities back to rural areas. And in some sense that started the immediate migration of the epidemic as well from urban to rural. So, you mentioned the work that Anup and I had done along with our colleagues in Bihar on testing the migrant workers, and what we found was pretty stunning is workers coming from Bombay, Delhi, the percentage of those workers who were currently positive was stunningly high. If 12 to 15% of the workers currently coming from cities, and this is in March, were positive on RTPCR studies, that's a significant amount of transmission that started even as far back as March. The second thing that seems to have happened in India is, while so much of the lockdown and suppression efforts were happening in urban areas, rural areas because they are mainly agricultural were given a lot more flexibility and as a result of combination of lack of adherence to masking, social distancing protocols, combined with relaxation in rural areas, the epidemic was spreading quite rapidly. So, that is something that we worry about and I think there's a behavioral issue here as well, what we've seen is India's response started with a very strict lockdown and then very quickly, in about 4 to 6 weeks,

when it became politically untenable to keep these lockdowns going, even economically untenable, government started relaxing it, but the relaxation happened really quick and so people went back to living their lives as if things were normal. You would see streets of Bangalore, for example, people walking about, going to malls like it was normal, and so that has led to this second wave that we are currently experiencing but it is also now happening in rural areas as well, much as you said.

Satchit Balsari: We had the opportunity some time ago to speak with Professor Mushfiq Mobarak at the Yale University who made this observation that there is a difference, there's a large difference in the responses you get when you ask people whether they have masks, and whether they are actually using masks correctly, and you make the point that people are being seen out and about in market places as if the pandemic is over. This is a challenging problem around the world, it has been six months, globally we have gone through a societal experience that we have not encountered before and people are tired, six months later folks are tired, they want to go about the business and I think one of the concerns in India is that are we overdoing this, are we overplaying this? Look around, it has the highest recovery rate, the infection, fatality rates don't seem to be that high, yes of course, many have died but millions seem to have survived and are doing okay, maybe India should resume activities because the economic fallout is untenable in a population that is so poor.

Manoj Mohanan: I really agree with you that perhaps it's time for India to start responding to its own epidemic. What I mean by that is, in the early days of the epidemic, India had no information, no data on the state of its own epidemic. In fact, there were many efforts even by the government itself to actively ignore what could have been learned about the epidemic at that point in time, because the focus was very much on trying to identify cases coming into the hospital and deal with it in the healthcare and hospital settings. The net result was, countries around the world like India were responding to the massive epidemic outbreaks that were in Italy and New York, assuming that's what was happening there. So, what happens is exactly what you've described, fast forward six months and the fatigue of dealing with the lockdowns and the restrictions in place sets in, especially in a setting where, for reasons frankly I just don't understand why, the infection fatality rate or even the acute hospitalization rates in India have not been what we feared. To be very honest, I am really, really thankful that our fears did not play out but why, if there's any clear explanation about one factor or two explains that. I'm sure you do remember this as well Satchit, is in April we were worried that our hospitals were going to be overflowing with acute critical patients, and that we don't have enough ventilators and ICUs and mortuaries would be full, that never happened, yet, by some estimates, 20-30% of India's population has already been exposed. That's just a stunning number that just does not make sense, so, it's understandable that people are losing patience, but what we fail to do in the process is nudge them towards a shift in behavior of patterns where people understand that yes, it might be lower risk than it was in say early stages in Italy or New York but we need to take care and so we need to do better at masking and dispensing.

Satchit Balsari: You've raised many important points that I want to try and sort of dissect what you just said. The first comment was that we were not responding to our pandemic, we were not responding to our epidemic, many countries around the world were responding to what was going on in Europe and Spain, and the defense would be 'well, there was no time to wait for the pandemic to happen in India, would you not be critiqued or criticized if you do not learn from these other countries.' What do you think we should have done differently, it is March, we have very little information, we know very little about the disease, we are still debating whether it is transmitted by droplets or whether it is airborne, what have we not learnt from Spain or Italy, what should we have done differently?

Manoj Mohanan: I know hindsight is 2020 and so I do want to recognize that. I don't envy the position of folks who had to make tough decisions then, but many of us, me included, and I know you have written about possible ways we could have dealt with policy solutions differently. Key point here is, even going back to March, April we knew that pool testing whereas other than testing every single patient, you could pool samples from five or larger numbers, depending on the technology and the viral load, five or six samples from patients, and then be able to test the pool and if a pool tests positive then you deconvolute it and then test every single patient, you could save a lot of money in that sense.

Satchit Balsari: I see. So, you're saying that we didn't have enough tests and if you wanted to test 15 people and you did not have 15 tests and you just had a few maybe begin with three tests, test five people and then whittle it down. And then, if you got lucky in five people were tested negative then you

were done with those five, and then you just needed to focus on the remaining ten and all you used up is one test. Is this actually done? Is this a theoretical exercise?

Manoj Mohanan: Yes, it's very much done. In fact, my own home University of Duke, we are doing about 15,000 tests a week now and it's all done with pool testing and the reason why they can do such large samples is precisely because of this. In fact, I would go one step further, even in India the study that Anup and Anu Acharya and I did in Karnataka, that's exactly what we did. We collected samples and we pooled them. One big lesson, however, is if India had to do this in March it was feasible, as the epidemic starts growing a lot and there are lots of positive people who are currently infectious then it doesn't become a sensible thing to do, you might actually end up test finding that somebody in every given pool is positive and that would totally ruin the numbers there.

Going back to your question Satchit, what could you've done. One, you could have got a really good data collection process in place, so you have to respond assuming the worst but then you don't have to continue doing that for months at a time. You could have done testing to find out what share of the population has already been infected, we didn't know that until the studies from Delhi, Bombay started coming out.

Satchit Balsari: Were those tests invented, were those tests available in March and April? Was it possible to do those tests?

Manoj Mohanan: Yeah, I don't remember the exact date but going at least as far back as May, some of these tests had started becoming available. So, RTPCR was available, the serology tests, initial ones that came in were not so good but the problem was, we ended up throwing the baby out with the bathwater in some sense. What I mean is, there is a huge amount of heterogeneity in the quality of tests that came in and we just didn't have the ability to check the accuracy of these tests, the specificity, the sensitivity of these tests that were coming in and then pick and choose which one's we got because the demand was so high at that point. So, we lost that window and you are absolutely right, that was happening in March and April. But that doesn't mean that, May things didn't change, June things didn't change, but there was an unwillingness to use the pool testing techniques for population level samples because the key parts, remember again, is it's not so much about what test but about whom you test.

Satchit Balsari: Let's pause there for a second. Who should you test? There were clear directives from ICMR, as well as local public health officials, including warnings in many cities, including in Mumbai for doctors to not test anyone other than that were symptomatic. And the defense, of course, is there are very few tests and therefore, should we not test just the symptomatics when you have a limited number of tests. Others have argued that in the middle of a pandemic, you know that the symptomatics have the disease, should you not aggressively test all possible asymptomatic exposures because those are the folks that may not realize that they have testing. So, how would have this played out if you could do this differently with the recognition that, as you said hindsight is 2020, how would you use these tools of pool testing and the kinds of tests that were available to test folks? What would be the ideal scenario for Mumbai in April or May 2020?

Manoj Mohanan: Satchit, I'll take those couple of points that you mentioned very seriously, in the sense, yes, tests were few, but if we decide that we are going to use those tests only for the patients, that assumes there's an underlined model, that is, everybody who gets sick with this particular virus will sooner or later show up in the hospital, part one. Part two is, it's possible that they don't have Covid, they have something else, we need to check that it is Covid, once we verify, we have a specific drug that will cure the patient. That's the clinical way of thinking about it and as a doctor you know better than I do that oftentimes, we do diagnostic testing for patients because that influences our treatment regimen and that's typically how one would think about it, except here it was symptomatic management. It's not like we had any drugs that we could say 'aha! this is Covid and I am going to give you drug A,B,C and D and then if you don't have Covid I will not give you.' So, in that sense, the clinical management approach to diagnostic testing was what was driving those policy decisions in the first place.

Now, the second thing you said, which really informs what we should have done, and to be fair, a lot of us going back to April of this year had been arguing that testing asymptomatic is going to be the key to handling this epidemic. The reason is simple, let's say you and I are both infected and infectious, you are

asymptomatic, meanwhile, I am showing all the symptoms, I am breathless, I am clearly febrile, I am probably sneezing or coughing, people will stay away from me just by looking at me, being a visibly sick person, they will probably step back in the times of pandemic and not want to come too close.

On the other hand, if you're asymptomatic, you might go on with your life as normal and all your friends might go on with their lives as normal hanging out with you, effectively, you might end up spreading the epidemic a lot more than I would and that's a key part of understanding whom we want to test if we want to prevent spreads of the epidemic. So, in some sense, again, it goes back to what was happening was they were using tests as if they were going to treat a patient, instead we should have used whatever limited number of tests we had to try and say, 'can I get a representative sample from various parts of the geography, here are 15 pockets that I think might be where the infection is raging, let me go in there, quickly do those tests and come back and learn something,' and maybe we should have targeted interventions to limit mobility outside of those areas so then we can do something about it.

Satchit Balsari: So, I want to pick up on that. So, you're saying that a clinical solution and thinking around testing was applied to a public health problem and the reason you test as a clinician is very different from how a public health practitioner would want to use the very same test. So, as a clinician, I want to test to make sure that indeed what you have is Covid, especially in India where people present with fever and respiratory symptoms for a variety of other diseases, various viruses, certainly pneumonia and tuberculosis, and then you want to make sure that you are going down the right diagnostic pathway. And as a public health practitioner, the goal of your test is not about treating that particular patient only, while that is an important objective without getting in to whether treatments are available or not, but the goal of testing is also to inform your strategies around isolation, quarantine and maybe even containment of entire neighborhoods. I am testing to see whether the pandemic is here, whether it has arrived in this neighborhood and what I should do were those tests positive. Is that correct?

Manoj Mohanan: Absolutely. I'll add one more thing to that is, in terms of whom you test and for what, because if we were able to go back to April and start testing random subsets of population, we might have learned that there are some types of individuals who are actually infectious and we might have been able to inform their surrounding community members to take more care. It's not without problems and I'll be very upfront about this, I think the scare factor that had already come in, the fear factor, could have meant it could create more problems and I think there's no easy solution to this, I just think this is something we have to confront.

Satchit Balsari: Here is a very important point you talk about fear and whether it's fear about the disease or the impact of the disease. You happen to be in Bangalore on your sabbatical during the pandemic, can you describe what was happening around you, what would be the concern about? I mean, of course, there were the social media reports from Europe that talked about ventilator scarcity and just how devastating this disease could be to societies. But by April or May, we also had reports from other parts in the world that began to show irrefutably that the disease had very different impact in different age groups, so people were scared based on these social media reports that they were seeing from Italy and Spain about how the lives of hundreds of thousands were imperiled when these hospitals were completely overflowing with very sick Covid 19 patients. So, say more about the fear, why is that not the right response?

Manoj Mohanan: I think fear is helpful when it's based on some either the facts or some understanding of what might be happening. The fear factor that I was referring to earlier was in some sense either you would turn people into pariahs simply because they had travelled somewhere and their entire house would be barricaded and people will not be allowed to come in and it just led to weird social problems. And so, the fear of the disease versus fear of people who have the disease are two separate things, and there was definitely, at least initially, a phase where the government had done well-intentioned but I would say slightly naive things like posting names of people who had arrived from other countries, this is happening at the beginning of March. And then, that led to a lot of people getting not just isolated but also being treated as if they have done something wrong and that was not very nice, difficult to deal with. But you asked me about what was happening in Bangalore is, soon after the lockdown was announced, Bangalore actually did a really good job in enforcing such lockdowns and they were maybe a little too well because soon people started losing their willingness to participate in the lockdown and there were protests happening and the political lobbies were getting together and saying certain industries and labor

sectors needed to be helped out so on and so forth. But then, what was also happening is exactly as we spoke earlier, the infection had already been seeded and so, once the infection is seeded and you have imposed lockdown then you are essentially enforcing the infection or rather forcing the communities to interact among themselves. And so, then we started seeing growth of infection within these communities, so just to give you one anecdotal instance, the neighborhood I was living in had about 80 staff members, it was a fairly large complex and they tested all of them in the month of June or July, if I am not mistaken, pretty sure it was June or July. About half of these staff workers had already developed antibodies to the infection, there were no symptomatic cases but all of them, about half of them had already developed antibodies and that's the stunning part, as this is during the lockdown, the infection was already spreading internally. And so, once a lockdown is released, people start mingling more and that changed everything in Bangalore, which initially looked like it was doing very well.

Satchit Balsari: Could the lockdown not have actually helped slow the disease, right? So, you are saying that even in the lockdown, there was such high prevalence, had the lockdown not happened wouldn't have been even more, overwhelmed the health system even more?

Manoj Mohanan: Yes, absolutely. I am not saying I agree with you hundred percent that the lockdown was necessary but then what you do during the time of the lockdown and how you introduce it and how you communicate that information becomes important. I really think it comes down to the communication aspect, there was so much misinformation that was happening at the same time and then the government was giving conflicting messages about turning districts into red, green, yellow areas based on who is reporting what, it prevented, in some sense, an honest intellectual discussion about the nature of an epidemic. My very cynical view on this is, we treated the Covid-19 epidemic, which is serious and extremely infectious, as if it were Ebola that's being transmitted like it's measles and it wasn't. And that's part of what happened, there's a day people woke up and said, 'wait a minute this is not Ebola, it's not going to kill half of us,' they just stopped worrying about it.

Satchit Balsari: Economists, especially behavioral economists, will have a lot to say and write about how the world has responded to this epidemic, including the unmasked masses in America that continue to believe that the pandemic is a hoax. In India, we have a largely blind population, there is a lot of criticism about folks wanting to return to their lives and not cooperating but to be fair, this is a population that was given four hour notice for a lockdown and folks stayed at home, there is still belief in government and there is by and large trust over 70 years of India's history, not at particular political moments in time. This is a population that trusts the government unlike the United States, for example, currently or several democracies in the world where there is high levels of mistrust of public messaging. Despite that this particular intervention of forced quarantine and isolation is what I as a clinician, as a public health practitioner, have found very disturbing.

It seems like we did not learn from the risks of stigmatization we have seen with the leprosy in recent memory in India and in even more recent memory, just somewhat current experience with HIV, that stigmatization gets you nowhere, it not only really makes access to care very hard for people with the disease but it, as you said, it creates such rifts in society that a cogent public health response is very difficult. And, what was concerning from the outside is that folks with symptoms, irrespective of the severity, they along with their family members were being asked to leave their homes, being taken to isolation facilities or quarantine facilities that were away from their homes and entire neighborhoods were being sealed, and that resulted in a few different things. So, the fear and the concern that you raise is very legitimate, irrespective of what socio-economic class you are in, you don't want to be dragged away from your home, all you have access is to these social media messages about how terrible the disease is and so you're frightened but then you are also inadvertently blamed for misery upon all your neighbors. How did we go so wrong? There was no precedent, you said, 'oh, we were treating the pandemic happening elsewhere' but there was little precedent for this kind of draconian locking of individuals, how did we get there?

Manoj Mohanan: I don't know Satchit. I think the first half of your question was somewhat related to the trust in government and government willing to say that there are people who are spreading it but it was not value-free statement. It almost made it look like there were some individuals, some populations who are bringing in the infections. In times of great social disasters like this one, it's always convenient to

identify someone or someone else and blame them for our miseries and in some sense that was happening. To give you a very concrete example, mid-March to late March, when the return of the return of the daily laborers started migrating back to their home states, there were no transport, they were walking thousands of miles and yes, many of my friends, many of whom you know as well, would complain how sitting in their high-rise apartments, they were able to see the migrants who are gathering and trying to walk home and how they are spreading the disease. It very quickly turns into an 'us and them' because you can blame someone else and that stigma issue that you mentioned is extremely important. To prevent stigma, we might rely on the infrastructure or the resources we have available to not subject ourselves to the state's whim at that point to try and not send us to isolation centers, but then there is a huge socio economic difference in terms of who can do that. If I am a poor person who lives in a small little house surrounded by other neighbors and they get to know I am sick, they have every reason to complain that I need to be moved verses I live in a really plush complex with lots of space between me and my neighbors, I might be able to go through the entire episode without anyone knowing about it. And so, the way the stigma and the discrimination played out was very much along socio-economic line, that's another aspect to it.

Satchit Balsari: And that is what your studies have shown as well that the disease has had a differential impact on populations not unique to India, all the data coming out from other countries show that it varies by age, it varies by socio-economic status, it varies by race. There's structural inequalities here in the United States, where you and I both now live, where the disease has ravaged minority populations who've had high levels of underlined comorbidity, difficult access to healthcare and to some extent have not had the opportunity to have the luxury of physical distances, they cannot sit at homes and work on their laptops, those are not the kinds of jobs they have.

While it is easy, of course, for us at this point to critique government responses anywhere in the world, what would we do now? So, here we are six, seven months later after the first lockdown in India, you have observed that there are parts of India where the seroprevalence is much higher than you would expect, meaning that the tests that show whether or not you have antibodies show that large sections of the society have already gotten the disease, that not as many people as we expected fell sick, certainly we don't seem to have had the large numbers of people that we thought would have died from it. There is some intellectual heft to the argument that it would be important to look at these numbers adjusting for age. India, of course, unlike Europe, is a young country, most Indians are in their 20s and so, from what we know of the disease, the majority who would get the infection would not fall very sick because they are young, they have good immune systems. Others would argue that other than the elderly, of which we have very few about six percent of the population, that the age groups just below that may not be as healthy as in other high income settings, we may have more heart disease, more untreated diabetes, more respiratory diseases. So, given all of these various complexities, the bottom line right now, from the data that we have access to, is that vast number of Indians seem to have gotten it, most of them may have been asymptomatic infections, not too many have fallen very sick, not too many have died. So, is this what herd immunity is about? Is this the Barrington Declaration with scientists saying let the disease spread through the country and society will recover much more rapidly? Did India get it right?

Manoj Mohanan: I am hesitant to go that far, Satchit. I agree with you on all of the points you mentioned, there are all these possible reasons why India might have gotten lucky this time, but there are a couple of things that we still don't know. One is, there are growing numbers of reports, although still very, very few of reinfection, is it going to happen, are those numbers going to grow more in the future, we don't know yet.

The second thing around the concerns around herd immunity is, even going from thirty to sixty percent is going to be many hundreds of millions of people in India. So, it's very possible that individuals who first got infected because of their work and their social interaction or presence in neighborhoods outside might be very different from the next thirty percent of people who will be infected. For exactly reasons you mentioned, once you account for age profile and who leaves the home, who doesn't leave the home, which as you know the aging population in India does not leave homes or interacts as much as they do in say Europe and North America. How that's going to play out is something we honestly still don't know, I agree with you that it's very likely that once you account for the age structure and social interactions, we might find slightly different numbers, considerably different numbers even.

So, going back to herd immunity, I am not sure one can feel comfortable quite yet that India is nearing herd immunity. If the epidemic continues as it is currently going through, it's very likely that at least half the population by the end of the year would have been exposed in some way, shape, or form. But the worry that I have is not so much about how many people are exposed but how many people are exposed how quickly because even with the signs of India's population even if a small fraction of the population needs hospital care or needs critical care and the epidemic is allowed to just run free, our health systems will not be able to cope with it. And that's the key point, in some sense, we talked a lot early on about pushing the curve down and flattening the curve, that language seems to have an impact, we are not hearing that as much but I still think it's important even today. Even if the rest of the population will eventually get infected, I'd much rather that they get infected later than sooner so that we can cope with it as it comes along.

Satchit Balsari: These are tough challenges in India especially, so as a clinician, when I hear you say that it makes me happy to hear you about flattening the curve because the ramifications in the health system are manifold, right. It is not only that we don't have the acute care capacity in India, you can build as many ventilators and hospitals you want but we don't have the trained respiratory tech, the nurses, the ICU doctors we need to care for these patients but because of the initial fear and stigmatization which is going to be impossible to reverse in the coming months, the access to health has also been heavily compromised.

So, every time there's a peak and especially when there's a massive peak and the numbers climb, folks stop going to hospitals for routine care as well. I mean either they are not allowed to because the hospitals are shut down or they just cannot or they are under lockdown or just a fear of going to hospitals and getting Covid also impacts healthcare. So, the ramifications on both clinical care and public health around the world have been very hard. So there's, folks say be done with this sooner or done later, how long can you drag it out. What are the data saying, so these are all theories and we can hypothesize and based on our own experience, but your work has always adhered to rigorous standards of evidence collection, what are we learning about the epidemic in India? These people, let's go back to the question of why are Indians not falling as sick, are we seeing something in the tests, in the numbers that actually validate that maybe the disease is not as severe? There were theories in March and April about how our immunity may come to the rescue, there have been conversations about T-cell immunity, what do the data show?

Manoj Mohanan: Great question Satchit. I don't think we have complete answers. There are few nuggets of empirical evidence that seem to suggest there might be some truth to the theories, I must be very honest, I bristle when I hear some of our colleagues talk about how Indians have better immunity because of our diet and the temperature and the sunlight and so on and so forth. But the thing that I have seen, talking to several of our colleagues who run large testing operations, is the RTPCR viral load that we see on RTPCR, that has been reported among positive patients in India is considerably low and it's something we just don't understand why that it's so low. It's basically there's a lot of people who are just at the threshold who are testing positive but compared to the average viral load that we've seen in other large infections, whether it was in New York, Italy and so on, why that baffles me. The same thing happens with the seroprevalence studies as well, that is, the antibodies in these populations, we see a big difference in urban versus rural, what we find is there's a lot of people who have low levels of antibodies but not adequate to show a positive in the testing results. So, essentially, the test sensitivity varies dramatically between populations and that's an important point because what it's telling you is there is some low-level of exposure that a lot of folks are getting and they are registering antibodies but it's not large enough to show up as positive on current tests or at least the current thresholds we have set for the tests.

Satchit Balsari: Are these people immune even if you test or not?

Manoj Mohanan: I don't know. Well, we don't know right because all the tests will tell us if you have anti-bodies or not but in reality it's not a dichotomous result, there's a continuous range of values and we've set a cut off value. It's not like it's no antibody and then suddenly, you have a lot of antibodies. It's, in fact, what we find is a continuous distribution and then we draw a cut off line, saying above this level we will say that you have antibodies, below this level we'll say you don't, but it doesn't mean that nobody has antibodies. That's the bizarre part of this whole testing part of it, where I would go with thinking about influence to answer your question about immunity is, I think there might be a charitable way of describing

this, there might be something like a survivorship bias going on, that is, if I am a 65-year-old male, living in an urban slum in India, the fact that I am 65 and still alive after having been exposed to so many insults to my immune system and so many exposures to various different infections, is I have learned to survive, my immunity has learned to survive. I am not saying that's necessarily a good thing, what that sadly means is that a lot of other folks who might have succumbed are already dead, and that goes back to the age distribution issue that you were talking about is who's missing in the age distribution are folks who might have not survived. And that could explain some of these results, again, this is purely conjecture at this point, all we know for a fact is two things, one is the low viral loads on RTPCR, which are frankly puzzling in India, and the antibody response I think we should start reporting it as not as a zero-one but at various different levels of sensitivity and that will vastly change our estimates on how many people have been exposed.

Satchit Balsari: What an incredible learning experience for the global community of scientists and clinicians as well. You know, this notion of 'low dose' response right that inoculum matters, it's how much virus are you being exposed to, how much virus are you shedding, these super-shedders that recent articles have talked about. Early on there were articles in the lay press, one especially by Dr. Sidharth Mukherjee about how inoculum may explain the differences you are seeing and the morbidity and mortality even among healthcare providers, as doctors and nurses were better prepared, they were falling less sick from the exposures. And a very recent article in the New England Journal of Medicine that talked about how masking may, in fact, be helping with spreading this low-dose infection, saying look even if it doesn't prevent infection a hundred percent, you are both shedding less as well as inhaling less the viral load and could this, in fact, inadvertently contribute towards herd immunity because you're essentially, de facto vaccinating folks with low doses of the virus.

What do we do now? Here we are six months later, there have been challenges with testing, we pivoted from treating the pandemic elsewhere to trying to address the epidemic in India. I think there's a growing recognition that the clinical approach, as you said, to testing needs to be abandoned or complemented with a population health based approach to testing. Are we there? What should we be doing, where is India headed at the rates and the virus levels that you are seeing?

Manoj Mohanan: So, I'll put on an optimist's hat for this one because I think it's easy to keep seeing how dismal things are and they are, but I think we need to look at the bright side on some of these issues. One is, there is hope, though no guarantees that there might be a vaccine available in the next six months, year, year and half whatever that number is. When it comes along, we need a plan for distributing the vaccine and getting it to people and that there's a whole body of work on thinking about how that needs to be done, I will not comment on that.

Let's assume that somehow we can figure out how to get our vaccines to people, but between now and then, if we can do whatever is necessary to minimize the exposure to people who've not yet been exposed, in a way that does not take away their livelihoods, that's what's doing. And what that translates into is two things, one is, masks. It's not that expensive to mask, it takes behavioral change, it takes some level of commitment and signaling and clear communication from all levels of government and civil society, it can be done, frankly, we are already seeing it. Just to give you an example: Satchit, on our campus at Duke, we've all been teenagers and college students and we've all been irresponsible at that age. I am always impressed when I see young college kids today. The vast majority of them are adhering to mask wearing and they are sanitizing their hands and they are either congregating in small groups or maintaining social distance. It's very unusual to behave like that when you're a teenager and that's already happening and I see that as a positive sign, it takes time to change behavior at such a massive level, so if you can keep pushing on that.

And the second thing is, some relevance or reliance on data-based approaches. So, I can tell you for a fact that the state government of Bihar, for incidence, has been talking to us for every two weeks, they ask us to analyze data on where their epidemics are and they give us information on district level, number of cases and help them understand where the cases are growing rapidly so that they can focus their efforts on making sure there aren't too many large public gatherings or too much risk of transmission in those areas. And so, targeting the lockdown rather than saying it's statewide lockdown or statewide release and that has, if you look at Bihar's numbers, it has been really impressive how they have been able to respond to the epidemic in recent times. And so, I think approaches like that are two-fold, one is

behavioral aspects of hand washing and mask-wearing combined with a sensible way of government intervention is absolutely necessary until a vaccine comes along.

Satchit Balsari: I can't help but note how just shows initial images from Europe and reports from Wuhan terrorized, inadvertently, populations around the world and the response to this pandemic has been so infrastructure-heavy. The testing it has required, the building of hospitals and ventilators, digital contact tracing apps, and dashboards, and modeling, and forecasting, and here we are six months later, where lot of the drugs have been peddled as cures have panned out not to work and the trials have shown this irrefutably. But all we are left with is the basic principles of sanitation and hygiene that we first learnt in the 19th century that of hand washing with the added precaution of facial coverings to go on with your life. Simple elegant public health solutions have always borne such powerful results through the history of public health whether sanitation and sewage in London or oral rehydrating salts formulated in Dhaka cholera camps. It's sometimes not the most colorful flourishes that are the most effective.

Manoj Mohanan: I agree. I think future generations will also add masks to that list that you just told us about. I hope.

Satchit Balsari: Professor Mohanan, always a pleasure. Thank you kindly for your time.

Manoj Mohanan: Thank you so much, wonderful talking to you.