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Review Article

An Exploratory Review of Magnitude of COVID19 Cases in Non-Leprosy affected Countries to Leprosy Endemic Countries

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The magnitude of COVID19 cases and death in the non-endemic leprosy countries compared with the 39 highly affected leprosy endemic countries in the recent past and presently shows a strong association reflecting its much higher magnitude among the former group of countries. It warrants further detail research on the related topic which may help in preventing Corona virus infections in future as SARS CoV and MERS CoV have also not been observed in the 39 highly endemic leprosy affected countries.

Review of Literature

The estimated prevalence of leprosy was 38.1/10000 population by 1951 and 57.2/10000 by 1981 in India.[1] The prevalence rate of cases of leprosy was reported to be 57.5/10000 population in the country with highest prevalence in order of 173/10000 in Daman Diu, 163 in Dadra Nagar Haveli, 123 in Odissa, 106 in Bihar.[2] Currently as of March 2019 there were 85336 recorded cases of leprosy with prevalence rate of 0.62/10000 as of 31st March 2019 with highest recorded prevalence in order of 3.54/10000 in Dadra N. Haveli, 1.98 in Chhattisgarh, 1.53 in Odisha, 1.14 in Chandigarh, 0.99 in Bihar. Out of total cases on record 18.2% is contributed by tribals.[3] In the year 2015 as per WHO report of leprosy, the global new case detection was 210,758 cases and the new case detection rate was 3.2/ lac population. In the year 2015, 14 countries reported >1000 newcases. These countries represented 95% of the global leprosy burden with the remaining 5 % of the new cases reported by 92 other countries worldwide. Among the top 3 countries reporting high number of new leprosy cases India reported 127326 new cases accounting for 60% of the global new leprosy cases, Brazil reported 26395 new cases representing 13% of the global new cases;and Indonesia reported 17,202 new cases, 8% of the case load. 11 countries reported between 1000 to 10,000 new cases; from African region, the Democratic Republic of Congo, Ethiopia, Madagascar, Mozambique, Nigeria, and United Republic of Tanzania; from SEARO region, Bangladesh, Myanmar, Nepal and Sri Lanka; and Western Pacific Region, the Philippines. Collectively these countries reported 19,069 new leprosycases, 14% of the newleprosy cases globally.[4] As per the latest WHO COVID19 status report 81 as of 10th April 2010; 15,21252 cases of COVID19 has been reported globally with total death of 92798.[5]

Though leprosy can occur in any country, it is common in South East Asia including India, Africa and South America.[6] Widely held assumption is that >90% of the general human population is naturally immune to infection of Mycobacterium Leprae (Trautman 1984).[7]

Most people within leprosy endemic populations have been exposed to M. Leprae, but few develop disease and it seems likely that the majority of the population develops protective immunity. If the site of initial infection is nose, the dissemination of the bacilli around the body to skin and nerve implies that the initial infection is bacilleferous and it has been shown that nasal M. Leprae are detectable by PCR of nasal swabs. Since salivary anti-M leprae IgA (sMLIgA) levels are correlated with protection. In a study of 304 PCR and mucosal challenge test performed in 204 individuals, sMLIgA was present in 66% of the treated patients, 76% of leprosy workers and in 72% of healthy contacts.[8] According WHO report, from 1990-1999 the CDR increased in all WHO region except in the eastern Mediterranean region and Western Pacific region, where the CDR has remained less then 1.6/100 thousand inhabitants since 1990 (WHO 2000).

Bacteria and viruses have also been fighting each other for a very long time. This battle between them is about the ability to reproduce. Both bacteria and viruses reproduce by making identical copies of themselves and instruction for doing this are stored in their DNA. Certain viruses need to infect bacteria in order to reproduce, but the bacteria don't want to be infected. How do the bacteria that survive viral infection make sure that it does not happen again? Many kind of bacteria have developed a process called CRISPR that helps them to remember viruses they have seen before. CRISPR also allows bacteria to keep the virus from destroying them. The bacterium clips a bit of the viral DNA and adds it to its own DNA. If the virus comes back the bacterium makes RNA from the region of CRISPR specific for that virus. These RNA copies pair up with some CAS (CRISPR associated) Proteins. The RNA guides the CAS protein to the invading viral DNA, so the protein can destroy it. No more viral DNA, no new viruses.[19] Human coronavirus (HCoV) is one of the most common causes of respiratory tract infection throughout the world. In humans, coronaviruses (HCoV) are proved to cause respiratory tract infection, most frequently common cold, but can also cause severe respiratory illness including Severe Acute Respiratory Syndrome (SARS) and Middle East respiratory syndrome (MERS). By now, in addition to COVID19 six other human coronavirus species have been identified, including OC43, 229E, NL63, HKU1, SARS-CoV, and MERS-CoV. HCoV-OC43 and HCoV-229E were identified nearly 50 years ago, which mainly cause common cold in humans, and the recently identified NL63 and HKU1 are reported to cause mild respiratory tract infection, and these 4 coronaviruses can also cause severe lower respiratory tract infections in young children or elderly adults with underlying diseases. HCoV-NL63 is also associated with acute laryngotracheitis (croup). SARS-CoV, a group 2b β-coronavirus, initially emerged in 2002–2003 in Guangdong province, south China, which caused severe lower respiratory tract infection with high morbidity and mortality (approaching 50% in individuals over 60 years of age) known as SARS. In 2012, a novel group 2c β-coronavirus MERS-CoV was firstly identified in Saudi Arabia. It is the causative agent in a series of highly pathogenic lower respiratory tract infections with high mortality (20% to 40%), which is mainly epidemic in the Middle East, but also brought an outbreak in South Korea in 2014 cited by Su Fen Zhang et al.[20]

Incidentally based on the 2002-03 epidemic of SARS -CoV, it appeared in November 2002 in the Guangdong province of southern China and other countries/ areas in which chain of human to human transmission occurred after early importation of cases are Toronto in Canada, Hong Kong special administrative region of China, Chinese Taipei, Singapore and Hanoi in Viet Nam (cited by WHO-international travel and health- emergency preparedness response report on SARS dates 21st April 2004.[21] It spreads in a similar way to cold and flu. Since 2017, a total of 27 countries have reported cases of MERS including Algeria, Austria, Bahrain, China, Egypt, France , Germany, Greece, Iran, Italy, Jordan, Kuwait, Lebanon, Malaysia, the Netherland, Oman, Philippines, Qatar, Republic of Korea, Kingdom of Saudi Arabia, Thailand, Tunisia, Turkey, United Arab Emirates, United Kingdom, United States and Yemen, and 80% of human cases reported from Saudi Arabia, cited buy WHO.[22] It spreads from infected person like other corona viruses from respiratory secretions through coughing when there is close contact with the infected person. Morphology & structure of the saponite particles studied under TEM photomicrographs revealed the sites with irregular small clay aggregates (<10nm) composed of even smaller individual clay nanocrystallites.[23]

Material and Methods

WHO published weekly epidemiological records, WHO publications on leprosy, relevant leprosy research published papers and Monthly progress report of NLEP since starting of the programme were reviewed and compared with the COVID 19 country wise reports, 36 countries identified listed as highly affected by leprosy based on their report between 2000-2010 by WHO technical advisory group published by Marika L.F Penna[9] were considered leprosy endemic countries. The WHO COVID19 status Report 81 of these countries including India as of 10th April 2020 (5) were compared with other countries by WHO region. For COVID19 data of the states/UTs with in India , figures given under COVID situation update report 11 of WHO ,India as of 12th April 2020 based on M/O HFW report of 12.04.2020 (17.00 PM) was used.[10]

For India, the figure of prevalence rate of leprosy - one or more than one per 10,000 population as of 31st March 1997

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was taken to consider the states endemic as by the year 1996-97 MDT was made available for all cases of leprosy in India throughout the country and the cases previously recorded taking DDS monotherapy were also assessed for their eligibility for MDT covering all states /UTs (2) and the current prevalence as of 31st March 2019 was also kept into consideration for current ranking.[1] Countries not listed with COVID19 case in WHO COVID19 status report 81 was considered to be having no COVID19 positive case. Similarly, state/UT not showing COVID19 cases in India were considered to be having no positiveCOVID 19 case.

The leprosy data of the countries reporting to WHO and published in WHO weekly epidemiological record 2000, 2005, 2010 were reviewed and classified countries as highly endemic if they had reported a prevalence rate higher than 1 per 10,000 in inhabitants or a CDR higher than 9 per lac inhabitants in one of the years studied. Data from 36 countries and territories with at least one prevalence value higher than 1/10000 inhabitants. Total 52.8% of these countries were in African region, 11.1% were in Americas, 22.2% were in the Western Pacific region, 11.1% were in the SEARO region and 2.8% were in the eastern Mediterranean region. These are Tonga, P.N.Guinea, Palau, Nauru, Micronesia, Marshall Island, Kiribati, American Samoa, East Timor, Nepal, Myanmar, India, Sudan, Suriname, Paraguay, Guyana, Brazil, United Republic of Tanzania, Sierra Leone, Niger, Mozambique, Mali, Madagascar, Liberia, Guinea Bissau, Guinea, Gambia, Ethiopia, Cote d'Ivoire, Congo, Democratic Republic of Congo, Comoros, Chad, Central African Republic, Cameroon, Angola. In the above review the countries with at least one CDR report bigger than 9 per 100 thousand were identified as under: Papua New Guinea, Palau, Micronesia, Nauru, Marshall Island, Kiribati, Bangladesh, Myanmar, Sri Lanka, India, East Timor, Nepal, Suriname, Brazil, Gambia, Mali, Cameroon, Benin, Congo, Niger, Chad, Code d'Ivoire, Angola, Mozambique, Central African Republic, United Republic of Tanzania, Guinea, Madagascar, Democratic Republic of the Congo, Sierra Leone, Liberia, Comoros. These are the 36 countries considered highly endemic for leprosy, 2000-2010. The highly endemic leprosy affected countries are located in tropical areas of Indian Subcontinent, Africa, South Americas, Pacific and India Ocean Islands and many of these countries consists of small islands or regions with a very humid climate.[9]

Result

Table 1.Comparison of 3 countries from each WHO region with high leprosy detection and their COVID19 infection status is given as under

WHO Region	No. of annual Leprosy cases detectedin 2015/ % of global	Top 3 countries with Maximum Leprosy annual new case	% of Global Annual Leprosy Detection	COVID cases /Death in these countries	% of Global COVID cases in these countries
African	20004 (9.5%)	DRCongo4237# Ethiopia3970# Nigeria2892**	2.0% 1.9% 1.37%	215/20 56/2 288/7	0.014% 0.003% 0.018%
Americas	28806 (13.7%)	Brazil26395# Venezuela448** Paraguay421#	2% 0.2% 0.2%	15927/800 166/7 124/5	1.046% 0.010% 0.008%
EastnMedi	2167 (1.03%)	Sudan 624# Egypt 583@ Pakistan 446@	0.3% 0.3% 0.2%	15/2 1699/118 4601/66	0.001% 0.11% 0.30%
SERO	156118 (74.1%)	India 127326# Indonesia17202** BanglaD 3976#	60.4% 8.2% 1.9%	6412/199 3512/306 330/21	0.42% 0.23% 0.02%
W.Pacific	3645 (1.73%)	Philippines1617** China 678* Papua NG 388#	0.8% 0.3% 0.2%	4076/303 83305/3345 2/0	0.267% 5.48% 0.0001%
Europe	18 (0.008)	Spain 8* UK 4* Germany 2* Israel 2* Portugal 2*	0.008% 0.0 0.0 0.0 0.0	152446/15238 65081/7978 113525/2373 9755/79 13956/409	10.02% 4.28% 7.46% 0.64% 0.91%
Global total	210,758	-	-	-	-

*Non endemic, @Low Endemic, # High Endemic, **Moderate Endmic.

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Table 1, indicates that the COVID19 infection when seen in the top three leprosy endemic countries of the WHO region, it is much lower in all the countries having higher annual leprosy case detection. However, the number of leprosy cases are very small in China in comparison to its population as it contributes only 0.3 % of annual leprosy cases detection. The number of COVID19 cases contributed so far by India is 0.42 % and for Brazil 1.0 % of the globally recorded so far till date of the study which may be due to high population and diverse geography of these two countries.

Table 2, indicates that when the top 3 country of the WHO region with high number COVID positive cases among them, it is seen that every region does not have very high number of COVID cases. The countries which had very high number of COVID cases of all region put together, the annual new case of leprosy contributed by them was very small e.g. USA, China, Iran, Spain, Italy, Germany.

India, Indonesia in SEARO region and Brazil in the American region which contribute high annual leprosy case detection showed less COVID cases compared to rich developed non-leprosy endemic countries. Although within the particular WHO region their COVID cases was more than other smaller countries in these 3 countries which is due to large population and diverse geography of these 3 countries and if it is seen per million population the number of COVD19 cases in these countries is very small compared to the non leprosy affected countries.

Table 2.Comparison of 3 countries from each WHO region with highest no of COVID19 confirmed cases and % of Global Annual leprosy case detection contributed by them in 2015

WHO Region	3 Highest COVID-19 affected countries with no of COVID cases in the region	No. of COVID-19 Death in these countries	No.&% of Global Leprosy annual case detection
African	S. Africa 1934 Algeria 1666 Cameron 730	18 235 10	35 (0.01%)* NR 361 (0.17%) #
American	USA 425889 (27.9%) Canada 19759 (1.3%) Brazil 15927 (1.0%)	14665 (15.8%) 461 800	178 (0.08%)* 0.0 %* 26395 (12.5%) #
*Eastn Mediteranian	Iran 66220 Pakistan 4601 S Arabia 3287	4110 66 44	17 (0.008%)* 446 (0.21%)@ 3 (0.001%)*
SEARO	India 6412 (0.4%) Indonesia3512 (0.23%) Thailand 2473	199 (0.2%) 306 33	127326 (60.4%)# 17202 (8.16%)** 187 (0.89%)@
West. Pacific	China 83305 (5.5%) R of Korea 10450 (0.7%) Australia 6252 (0.4%)	3345 (3.6%) 208 52	678 (0.32%* 2 (0.0009%)* 13 (0.006%)*
European	Spain 152446 (10.02%) Italy 143626 (9.4%) German113525 (7.5%)	15238 (16.4%) 18121 (19.5%) 2373 (2.5%)	8 (0.004%)* 0.0* 2 (0.0009%)*
Global Total	Total globally 1521252	92798	-

*Non endemic, @Low Endemic, # High Endemic ,**Moderate Endmic.

Table 3.The COVID19 number of cases reported from 39 high leprosy endemic countries of the world

WHO Region	36 Highly Leprosy Endemic Countries by PR	Their COVID19 status by number/ death	Additional High endemic Leprosy countries with CDR>9/lac # (COVID Case/Death)
Western Pacific (8)	Tonga	Nil	Highly Endemic(H.E)
	P.N. Guinea	2/0	H.E
	Palau	Nil	H.E
	Naura	Nil	HE

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	Micronesia	Nil	HE
	Marshall Island	Nil	HE
	Kirbati	Nil	HE
	American Samoa	Nil	HE
SEARO (6)	East Timor (Timor Liste)	1/0	HE
	Nepal	9/0	HE
	India	6412/199	HE
	Myanmar	27/3	HE
	-	-	Bangladesh 330/21@
	-	-	Sri Lanka190/7@
Eat Med (1)	Sudan	15/2	HE
Americas (4)	Suriname	Nil	HE
	Paraguay	124/5	HE
	Guyana	37/6	HE
	Brazil	15927/800	HE
Africa (20)	United Republic of Tanzania	25/1	HE
	Sierra Leone	Nil	HE
	Niger	410/11	HE
	Mozambique	17/0	HE
	Mali	59/7	HE
	Medagascar	95/0	HE
	Liberia	31/4	HE
	Guinea Bissau	35/0	HE
	Gambia	4/1	HE
	Ethiopia	56/2	HE
	Core d' Ivoire	384/3	HE
	Congo	60/5	HE
	Dem. Rep of Congo	215/20	HE
	Comoros	Nil	HE
	Chad	11/0	HE
	Central African Republic	10/0	HE
	Cameroon	730/10	HE
	Angola	19/2	HE
	-	-	Benin 30/1@
	Guinea	194/0	
Europe (0)	NIL	NA	Non Endemic
Total (36)	36 country	24909/1081*	4 country (550/29)

*39 countries (36 + 3) .Total COVID19 cases & death: 25459/ 1110.

#Based on CDR=Case detection rate in the year.

@No. of COVID19 cases/ Death in 3 additional countries are Bangladesh (330/21), Sri Lanka (190/7), Benin (30/1) respectively.

Table 3, Shows the COVID 19 cases and Deaths in 36 plus 3 highly endemic leprosy affected countries which indicated that all togather they have a total of only 25,459 (1.67% of global) COVID cases and 1110 (1.19% of global) deaths which is far less than most of the major single Non leprosy endemic country.

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Map: 39 countries considered highly endemic for leprosy 2000-2010

(Source: Maria Luna Fernandes Penna et al, Leprosy frequency in the world 1999-2010, Mem.Inst.Oswaldo Cruz Volu.107 Suple 1, Rio de Janeiro, Dec 2012.)

Table 4.State-wise PR of leprosy in India and its comparison with COVID19 cases (as of 12th April2020, 17.00GNT+5.30)

States	PR of Leprosy/ 10000 by 3/2019	PR of leprosy per 100000 popln as of March 1997*	No of COVID cases/cured/ Death by 12th April 2020
Maharashtra	0.74	37.7	1761/208/127
Kerala	0.22	20.8	374/142/2
Delhi	0.98	85.5	1069/25/18
D & NH	3.54	163.0	0
Odissa	1.53	123.5	54/12/1
Bihar	0.99	106.1Include Jha	64/19/1
Chhatisgarh	1.98	Included in MP	25/10/0
Jharkhand	0.94	Included in Bihar	17/0/1
Andhra & Telangana	0.64	61.8 Include Telangana	381/11/6+504/43/9 (T)
Arunachal P	0.19	51.7	1/0/0
Assam	0.26	30.9	29/0/1
Goa	0.7	27.4	7/5/0
Gujarat	0.46	34.4	432/44/22
Haryana	0.15	3.0	185/29/3
HP	0.19	30.5	32/6/1
J & K	0.13	22.7	224/6/4
Karnataka	0.31	35.1	226/37/6
MP	0.64	67.3 Include Chh	564/0/36
Manipur	0.05	31.5	2/1/0
Meghalaya	0.04	45.1	0

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Mizoram	0.04	12.9	1/0/0
Nagaland	0.14	34.4	0
Punjab	0.15	6.7	151/5/11
Rajasthan	0.15	20.7	700/21/3
Sikkim	0.14	22.4	0
Tamil Nadu	0.18	84.0	969/44/10
UP	0.55 includes UK	49.9	452/45/5
Tripura	0.05	21.5	2/0/0
Uttarakhand	0.23	Included in UP	35/5/0
West Bengal	0.72	79.2	134/19/5
A & N	0.32	43.5	11/10/0
Chandigarh	1.14	57.6	19/7/0
Daman Diu	0.39	171.1	0
Lakshadweep	0.0	44.1	0
Puducherry	0.15	43.6	7/1/0
Ladakh	Included in JK	Included in J &K	15/10/0
Total	0.62	57.5	8447/765/273

PR below 10/100000 was only Punjab & Haryana in 1997.

Table 4 reflects that all the state/UT are high and moderately endemic for leprosy with PR >10/100000 population and Haryana and Punjab low endemic and COVID status as of 12 the April 2020.[10] Out of total globally reported COVID19 cases of 1521252 India is contributing 0.55% cases and out of total COVID19 death of 92798 India is contributing 273 (0.29%).

Six states/ UT high endemic for leprosy has not yet reported any COVID19 case including the Union territory of DNH which used to be having one of the highest PR of leprosy in India and still ranks on top among states/UTs affected by leprosy. Presence of M.Leprae in the iron rich soil of the environment , fine nano crystal shaped sharp iron containing invisible particles in the soil, habit of travelling bare foot in the rural areas particularly in the tribal areas of India which is rich iron mineral resource in Chhatisgarh, Odissa, Jharkhand etc may also be causing leprosy in addition to its transmission by naso oral route. The exposure of M.Leprae to human body as well as the current leprosy disease status and its history in recent past may have association with COVID19 risk.

Discussion

There appear to be a strong association between endemicity of leprosy and number of COVID19 cases occurring in various countries across all the five WHO region, in the 39 high endemic countries including India. The reported pattern of cases and no of deaths due to COVID19 is much higher in the countries which are non-endemic for leprosy having no case of leprosy or a very low number of cases when data is compared in the countries by WHO region. All the 39 highly endemic leprosy affected countries together are contributing only 1.67% of globally reported COVID19 cases and 1.19 % of globally reported death due to it.

This association is also reflected with in India showing that some of the highly endemic states/UTs have not even reported a single COVID19 positive case. It can also be argued that the leprosy affected countries are mostly poor and less reported COVIDcases could be due to less tests done in these countries in comparison to non-leprosy affected countries which have high number of COVID19 morbidity and mortality. The severe COVID19 cases with difficulty in breathing mostly are expected to report to the health facilities in the developing countries and will be identified and get tested and number of such cases in 39 highly affected leprosy endemic countries would have been substantial and cannot remain unnoticed and unrecorded. Since the COVID19 disease has spread to more than 190 countries and its magnitude in these 39 high leprosy endemic countries can be expected to be devastating if it is of same magnitude and severity as happening in developed countries not affected by leprosy. Most of people are under nourished, suffering from many other illness and quality of health care facilitiesare also inadequate in these poor, leprosy affected countries.

As the pandemic spread more and more the future data may also be compared with respect to the number of infected persons reflecting morbidity, proportion of mild cases, moderate illness, severe casesreporting with

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respiratory distress and mortality. China having very low leprosy case detection although shows higher COVID 19 cases and death but it is far less in comparison to USA and European countries as apparent from table 1. The initial quantum of exposure to the pathogen must have been much higher and spread of it should have been much faster compared to other countries in absence of no clue in the beginning. Spain recorded 10.02% of global COVID cases, China being first country affected which had full blown infection having no clue about disease in the beginning and has small number of leprosy cases and its report of 5.5% of COVID19 cases and 3.6% of death out of Globally recorded is not understood. Thus, it can be estimated that the Chinese figure of COVID19 infected as well as death appear to be unrealistic as apparent from the pattern of disease seen in on leprosy affected countries elsewhere.

With the kind of association seen in India people living in DNH, Bihar, Chhattisgarh, Odisha, Jharkhand particularly from tribal areas, other poor people living for long time in congested areas may have more protection against COVID19 infection. Where as people with high socio-economic conditions and people form very low endemic state of Haryana and Punjab having lowest prevalence of leprosy may be at higher risk. Prevalence of leprosy is high in UT of Chandigarh and Delhi also but many cases are coming from neighbouring states and also present in the migratory population from endemic areas. This association between prevalence of leprosy and magnitude of COVID19 cases is relevant for comparison of data of a country, state and for the larger community and would not be relevant for an individual from rich and poor soci economic status. The fine sharp nano crystals of iron containing soil can easily penetrate into the superficial part of the skin without noticing any pain and causing bleeding which is likely to be the additional route of leprosy transmission causing high endemicity of disease in such areas.

Incidentally it is also seen that SARS CoV and MERS CoV pandemics spread and cases reported are mainly in some of the non-endemic countries with no leprosy/ very few cases of leprosy. Confirmed cases of SARS appear to have not been reported from these 39-leprosy high endemic countries including India (MERS has also not reported from any of these 39 leprosy high endemic countries). In both of these diseases, human to human transmission happens mainly thorough respiratory route by droplets. It may be realised that this association in 39 leprosy high endemic countries is aggregate at the national level. In the endemic provinces/ districts where the reported cases of leprosy are mainly in the migrant people coming from neighbouring other states, the type of association between leprosy endemicity and COVID19 cases is likely to be different.

It may also be possible that in addition to smaller number of clinical cases of COVID being reported, the proportion of asymptomatic COVID19 cases may be more in the leprosy affected endemic countries/ province. There should be no reduction in supply of logistics, medical services and welfare support for the leprosy affected endemic areas who at the moment need special extra care in view of their deformity, poor socio economic condition, and unemployment.

Conclusion

The magnitude of COVID 19 cases and death is seen very low in the 39 highly endemic leprosy affected countries in comparison to its magnitude in the non-leprosy affected/ non leprosy endemic countries. This association between leprosy infection history including present leprosy status of the country and COVID 19 pandemic magnitude in them is very strong as seen across all the countries. However, the COVID19 response in these 39 leprosy endemic countries and elsewhere should not be relaxed based on such finding. Nationwide lock down along with adequate contaiment measures being taken on war footings in India appear to be an important additional factor responsible in preventing un precedented explosion of COVID19 pandemic in the country. It warrants further detail research on the related subject which may help in preventing Corona virus infections in future as SARS CoV and MERS CoV have also not been observed in the 39 highly endemic leprosy affected countries on the basis of review done by the investigator.

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Conflicts of Interest: None

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