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Received: 9 December 2019 Accepted: 31 December 2019 Published: 15 January 2020

Abstract

Background: In a short span of four months, the COVID-19 pandemic has added over 0.6 million deaths worldwide, which are untimely, premature and unwarranted. The USA, Italy, Germany and Sweden are four worst affected countries, accounting to over 40

Index terms— COVID-19, mortality, life expectancy, USA, italy, germany, sweden.

1 Introduction

OVID-19 attributable deaths are soaring each day in most of the countries with uncertainties over projected numbers, infection fatality ratio, development of a vaccine and possible end of pandemic. Globally, with over 16 million confirmed infections and additional deaths of over 650 thousand by end of July, 2020, the COVID-19 attributable deaths accounts for 1% of total all-cause mortality. If the COVID-19 mortality continues with same pace, the life expectancy would begin to shrink by end of the year though the survival threat is more among the elderly and the chronically ill. Rapid spread of the infection as well as its associated fatality may well be due to novel disease, lack of medical know how, ill-prepared health care system, crowding in urban cities, administrative inefficacy, demographic and social determinants etc.

The case fatality ratio (CFR) is a crude measure of mortality, underestimate the mortality impact of COVID-19. An alternative CFR with 14 days' delay depicts at least twice higher mortality than CFR [1]. The mortality impact of COVID-19 is higher than many other disease [2].The standardized metrics such as disability adjusted life years (DALY) and years lost due to disability (YLD) are suggested to infer infection fatality by age [3].

Considerable attempts are made on tracing future trajectories, estimation of infection and fatality rate and risk factors of COVID-19 [4][5][6][7][8][9][10][11][12].Demographic structure, co-morbidities and health-care burden explain COVID-19 attributable mortality to some extent [13][14][15]. Most common observation made as regard COVID-19 fatality is its greater risk among elderly and people with co morbidities including hypertension, diabetes, cardiovascular disease, myocardial injury [4,[16][17][18][19][20][21][22]. The Diamond Princes cruise ship study of Japan, a standard estimate of infection, estimated the overall case fatality ratio of 2.6% as against the same being 13% among the older aged 70 and above [23].

Inadequate testing and misclassification of deaths by cause underestimate the extent of COVID-19 deaths. In USA, the excess deaths due to pneumonia and influenza raise an apprehension as regard missclassification of COVID-19 deaths in the absence of adequate testing [24]. In Italy, 54% deaths were attributed to COVID-19 making a case for misclassification of cause of death. The COVID-19 attributable mortality has potential to reduce life expectancy in India and seasonal life expectancy in Italy [25][26]. In United States, 1 million deaths from COVID-19 would increase mortality by one-third and reduction in period life expectancy by 3.9 years in 2020 [27].

Mortality impact of COVID-19 is higher in urban counties and the social determinants are significant predictors of its mortality **??**28]. High and low fatality due to COVID-19 attributed to density and age structure in terms of elderly in UK **??**29]. Demographic vulnerability of COVID-19 mortality is lower in younger countries in Sub-Saharan Africa than the industrialized countries **??**30]. The spread of infection and mortality depends on containment measures, health system response and micro-management of epidemic which may alter reproduction number **??**31].

By April 2020, the case fatality rate varied from 2.2% in South Korea to 13.0% in Italy. USA, Italy, Sweden and Germany were worst hit countries by the pandemic. By end of May 2020, USA had over 1.8 million confirmed cases and over 106 thousand deaths. About 80% of deaths occurred among adults aged 65 years or more [16]. In Italy, the CFR increased from 4.2% to 13.0% within 43 days and 90% of the change was due to increasing age

specific case fatality rates **??**32]. In Italy, USA and Germany, estimated cases of infections are 6 times, 2 times and 1.2 times higher than the number of confirmed cases, respectively **??**33].

Existing studies of the pandemic on fatality is limited. Given its rise in intensity it becomes pertinent to gauge impact of COVID-19 attributable mortality on longevity, premature mortality and DALY. This will answer questions like "Would additional deaths due to COVID-19 reduce longevity and increase premature mortality and DALY".

2 II.

3 Data and Methods

We have analysed four worst affected countries; namely USA, Italy, Sweden and Germany that accounts over 40% of all COVID-19 attributable deaths worldwide. The selection of country is guided by the availability of age-specific infection and mortality data and severity of infection. Estimates are provided under four scenarios; no COVID-infection, COVID-infection as of 20 th July, 2020 and estimates under 6% and 10% COVID-

4 a) Years of Potential Life Lost (YPLL)

The YPLL is a summary measure of premature mortality that estimates the average years a person would have lived had he or she not died prematurely. It gives higher weight to the deaths occurring at younger ages and lower weight to the deaths at higher ages **??**40] **??**41]. YPLL is estimated as:???????? = ? ?? ?? * ?? ?? ? ??=0

where, L i is the life expectancy at age i and d i is the number of deaths at age i. The deaths are weighted by life expectancy at each age.

5 b) Disability Adjusted Life Years (DALY)

DALY measures the health of a population by combining data on mortality and non-fatal health outcomes into a single number. The DALY measures health gaps as opposed to health expectancies. It measures the difference between a current situation and an ideal situation where everyone lives up to the age of the standard life expectancy, and in perfect health. It combines in one measure the time lived with disability and the time lost due to premature mortality:???????? = ?????? + ??????

where, YLL= years of life lost due to premature mortality and YLD= years lived with disability.

We have calculated YLL and YLD with discounting rate of 3% where discounting health with time reflects the social preference of a healthy year now, rather than in the future. The value of a year of life is generally decreased annually by a fixed percentage. For many years, a discount rate of 5% per annum has been standard in many economic analyses of health and in other social policy analyses, but recently environmentalists and renewable energy analysts have argued for lower discount rates for social decisions. The World Bank Disease Control Priorities study and the GBD project both used a 3% discount rate, and the US Panel on Cost-Effectiveness in Health and Medicine recently recommended that economic analyses of health also use a 3% real discount rate to adjust both costs and health outcomes **??**42].

The YLL is estimated as:?????? = ?? ?? (1 ? ?? ?????)

where, N= number of deaths L= Life expectancy at age of death r= discount rate (we have also used 3% discount rate)?????? = ??? * ???? * ?? * (1 ? ?? ?????)?

?? where, I= number of incidence/prevalence cases. For acute diseases, incidence is considered same as prevalence DW= disability weight (a weight factor that reflects the severity of the disease on a scale from 0 (perfect health) to 1 (dead) L= duration of disability r= discount rate As COVID-19 is a novel disease, its disability weight is not available. Since COVID-19 is a severe infectious disease having acute period, we have used the disability weight of 0.133 for Infectious disease (acute episode, severe category) as proxy for COVID-19 **??**43]. The duration of disability of 60 days is used because the patients of COVID-19 have been hospitalized for on average 30 days and after discharge and quarantined for 14-28 days approximately.

6 IV.

7 Results

Table 1 presents the key indicators of COVID-19 attributable mortality in four countries under study. With additional 1,43,504 deaths in USA, 35,058 deaths in Italy, 9168deaths in Germany and 5639 deaths in Sweden in a span of about seven months, the share of COVID-19 deaths amounts to 4.8% of total deaths in USA, 5.2% in Italy, 1.0% in Germany and 5.8% in Sweden. The COVID-19 attributable deaths can be considered as additional deaths avoidable without this infection. The case fatality ratio was very high in Italy (14.3) followed by Sweden (7.2) and Germany (4.5). The pandemic has infected at least 1.2% of the population in USA, 0.4% in Italy, 0.8% in Sweden and 0.2% in Germany. The COVID-19 attributable deaths has already lower life expectancy by 0.6 years for USA, 0.5 years each in Italy and Sweden and 0.1 years in Germany. At 10% share, the reduction in life expectancy would be 1.2 years for USA, 1 years for both Italy and Germany and 0.9 years for Sweden.

Fig 1 shows the reduction in life expectancy under varying scenarios of COVID-19 attributable deaths in USA, Italy, Germany and Sweden. Estimates suggest that the life expectancy is already lowered by 0.6 years in USA,

0.5 years each in Italy and Sweden and 0.1 years in Germany due to COVID-19 attributable deaths. In case of the COVID-19 attributable deaths would amount to 6% of total deaths in each country, the life expectancy at birth would reduce by 0.8 years in USA, 0.6 years each in Italy and Germany and 0.5 years in Sweden. The additional deaths due to COVID-19 results in a rise in CDR from 10.5 to 11.1 in Italy and this would rise to 11.6 with the COVID-19 death share rising to 10%. In case of USA, it has also increased from 8.6 to 9.5 with 10% share of COVID-19 death and the pattern is similar in Germany and Sweden as well.

Table 2 and 3 presents the estimates of life expectancy under varying scenarios of COVID-19 attributable deaths in USA, Italy, Germany and Sweden. Estimates from life table with and without COVID-19 for these four countries exhibit the changing age-specific survival patterns. The life expectancy for 2020 was 79.5 years in USA, 83.6 years in Italy, 81.5 years in Germany and 82.7 years in Sweden.

Table 4 and 5 shows the age specific assessment of Years of potential life lost (YPLL) under varying scenario of COVID-19 death share in USA, Italy, Germany and Sweden. While YPLL without COVID-19 was 55.2 million in USA, 8.9 million in Italy, 14.4 million in Germany and 1.3 million in Sweden, COVID-19 has added 1.55 million, 0.48 million, 0.12 million and 0.06 millions of YPLL in USA, Italy, Germany, and Sweden, respectively. Rate of YPLL (per 1000 population) is highest in Italy (7.9) followed by USA (7.1) and Sweden **??**6.4). With rising share of COVID-19 deaths to the tune of 6% and 10%, The share of YPLL on this count will rise from 7.1 to 8.8 and 14.3 per 1000 population, respectively in USA. Similar pattern has been observed for Italy, Germany and Sweden. Higher age-groups (45 years and above) are contributing more than 70% of YPLL in all the countries. death share, the DALYs would be 7.2 per 1000 population in Italy, 6.7 in USA, 7.1 in Germany and 0.7 in Sweden. Similarly, when COVID-19 accounts 10% death share, DALYs is 12.0 per 1000 population in Italy, 11.2 in USA, 11.9 in Germany and 1.1 in Sweden. Among all the four countries, the population 70 years and above account more than three-fourth contribution in DALY while younger ages have relatively low contribution in all the scenarios.

V.

8 Discussion and Conclusion

The COVID-19 pandemic is one of the worst ever misery posed to mankind. While epidemics in the past have gripped limited geographical boundaries, the COVID-19 has engulfed the entire world within a brief period of four months with a reasonable degree of spread potential. Apart from threat to human life, its containment measures have led to economic loss and generated psychological scare among individuals, households, community and the nation at large. The COVID-19 pandemic has paralysed the economic activities, deepened the global recession and has assumed a crisis proportion worldwide. Given the scale and intensity of this pandemic, this is first attempt in our knowledge to assess the mortality attributed to COVID-19 in four worst affected countries. Such an assessment involves the extent of reduction in life expectancy, person year life lost and DALY that are yet to be made available so far. Selection of countries are primarily based on the extent of severity of the pandemic and availability of data but the exercise can very well be replicated elsewhere. The following are the salient findings.

First and foremost, COVID19 induced fatalities have undoubtedly contributed towards rise in the overall mortality rate in all four countries. The death rate has increased from 8.6 without COVID-19 to 9.5 with COVID-19 in USA, from 10.5 to 11.6 in Italy, 11.0 to 12.1 in Germany and 9.1 to 10.0 in Sweden. Second, the life expectancy has compressed by 0.6 years in USA, 0.5 years each in Italy and Sweden and 0.1 years in Germany. Within a few months, the COVID-19 attributable death share amounts to about 5% each in USA and Italy, 1% in Germany and 6% in Sweden. If this trend of mortality continues till end of the year, reduction in life expectancy would be substantial in these countries. Third, most of the COVID-19 deaths are unwarranted, un timely and premature. COVID-19 attributable deaths have already added 1.5 million, 0.5 million, 0.1 million and 0.06 millions of YPLL in USA, Italy, Germany, and Sweden, respectively. Fourth, with less than 1% infection, the DALY a from COVID-19 was 5.4 per thousand populations in USA, 6.3 in Italy, 1.2 in Germany and 0.6 in Sweden. If the spread of COVID-19 goes unabated, the loss of DALY would be similar to high fatality disease.

These findings are markers of tragedy experienced in countries ranked high in the level of human development, higher income level and are said to be having a better health care system. Hence the failure of preparedness to confront this pandemic by the developed world exposes our vulnerability to emerging infection of similar kind in future. In the absence of a vaccine as well as no systematic medical intervention, the only way out is the containment of its spread or developing a herd immunity in due course. At present great efforts are made by national and local government for management and control of pandemic by diverting the resources (financial and physical) for health care and lock down measures.

We acknowledge that the COVID-19 attributable deaths are to some extent underestimated due to lack of comprehensive testing, under-reporting and misclassification of COVID-19 deaths in these countries. Despite these limitations, these estimates of mortality pattern do signals about its long-term implications towards structural and compositional balance of population across world regions. Though it is very early to gauge its final impact on population structure and composition, its persistence with its virulence unless curbed by introduction of an effective vaccine and means of cure may well change the world order to a significant extent.

9 Epidemics

6

Figure 1: Table 6

[1] [2]

[2]© 2020 Global Journals Impact of COVID-19 Attributable Deaths on Longevity, Premature Mortality and DALY: Estimates of USA, Italy, Germany and Sweden

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Figure 2: Table 1 :

2

Age group	Life expectancy without COVID-19	Life expectancy at current COVID-19 share of 4.8%	Life expectancy at current COVID-19 share of 6%	Life expectancy at current COVID-19 share of 10%
0-1	79.5	78.9	78.7	78.3
1-4	78.8	78.2	78.0	77.6
5-14	74.9	74.3	74.2	73.7
15-24	65.0	64.4	64.3	63.8
25-34	55.5	54.9	54.7	54.3
35-44	46.2	45.6	45.4	44.9
45-54	37.0	36.4	36.2	35.8
55-64	28.3	27.8	27.6	27.2
65-74	20.5	20.0	19.8	19.4
75-84	13.3	12.8	12.7	12.4
85+	7.6	7.2	7.2	6.9

Figure 3: Table 2 :

3

Year 2020 20 Volume XX Issue IX Version I Global Journal of Medical Research (D D D D)	Life expectancy with COVID-19 deaths in 2020 in Italy, Germany and Sweden,	Life expectancy with COVID-19 deaths in 2020 in Italy, Germany and Sweden,	Life expectancy with COVID-19 deaths in 2020 in Italy, Germany and Sweden,	Life expectancy with COVID-19 deaths in 2020 in Italy, Germany and Sweden,	Life expectancy with COVID-19 deaths in 2020 in Italy, Germany and Sweden,
	Sweden	Life expectancy with actual number of deaths	Life expectancy without COVID-19	Life expectancy with actual COVID-19 deaths	Life expectancy with expectancy
	Italy	Age expectancy with actual number of deaths	Life expectancy without COVID-19	Life expectancy with actual COVID-19 deaths	COVID

[Note: F]

Figure 4: Table 3 :

4

Age Group	YPLL Without COVID-19	YPLL with COVID-19 deaths as of 20th July, 2020	COVID-19 deaths accounting 6% death share	COVID-19 deaths accounting 10% death share	Share of YPLL without COVID-19 deaths	Share of YPLL with COVID-19 deaths as of 20th July, 2020
0-1	1597660	839	1042	1726	2.89	0.04
1-4	528026	740	918	1521	0.96	0.03
5-14	404728	1230	1527	2529	0.73	0.05

Figure 5: Table 4 :

5

Sweden	Years of Potential Life Lost (YPLL)	COVID-19 deaths	COVID-19 deaths accounting for 6% death share	as of 20th July,2020	10% death share	CO
	Deaths		from cause	Without COVID-19	all	
Germany	Years of Potential Life Lost (YPLL)	COVID-19 deaths	COVID-19 deaths accounting for 6% death share	as of 20th July,2020	10% death share	COVID
	Deaths		from cause	Without COVID-19	all	
Italy	Years of Potential Life Lost (YPLL)	COVID-19 deaths	COVID-19 deaths accounting for 6% death share	as of 20th July,2020	10% death share	COV
	Deaths		from cause	Without COVID-19	all	
			Age Group			

[Note: F]

Figure 6: Table 5 :

6

Age Group	DALY COVID-19 deaths as of 20th July, 2020	COVID-19 deaths accounting 6% death share	COVID-19 deaths accounting 10% death share	DALY per 1000 Population deaths as of 20th July,2020	COVID-19 deaths accounting 6% death share	COVID-19 deaths accounting 10% death share	
0-1	342	425	708	0.07	0.09	0.14	
1-4	303	377	628	0.02	0.03	0.04	
5-14	524	652	1086	0.01	0.02	0.03	
15-24	5650 28810	7026 35826	11710 59709	0.13 0.61	0.16 0.76	0.27 1.27	Year
25-34	66453	82633	137722	1.59	1.97	3.29	2020
35-44							
45-54	161056	200272	333786	3.96	4.93	8.21	23
55-64	333419	414604	691007	7.90	9.82	16.37	
65-74	458616	570286	950477	14.25	17.73	29.54	
75-84	416425	517822	863036	25.72	31.99	53.31	
85+	324939	404059	673432	48.60	60.43	100.72	
Total	1796537	2233981	3723302	5.4	6.7	11.2	

[Note: F]

Figure 7: Table 6 :

7

	per 1000 Population	COVID-19	COVID-19		deaths	deaths	accounting	accounting		6%
										10% o
	DALY	COVID-		19		deaths	as of			20th
		COVID-19			deaths		accounting			10% o
Sweden		COVID-19			deaths		accounting			6% de
	DALY	COVID-		19		deaths	as of			20th
		COVID-19			deaths		accounting			10% o
	DALY per 1000 Population	COVID-19	COVID-19	deaths	deaths	as	accounting	of	20th	6% death July,2020 share
		COVID-19			deaths		accounting			10% o
Germany		COVID-19			deaths		accounting			6% de
	DALY	COVID-		19		deaths	as of			20th
		COVID-19			deaths		accounting			10% o
	DALY per 1000 Population	COVID-19	COVID-19	deaths	deaths	as	accounting	of	20th	6% death July,2020 share
		COVID-19			deaths		accounting			10% o
Italy	DALY	COVID-19			deaths		accounting			6% de
		COVID-		19		deaths	as of			20th
							Group Age			0-9

Figure 8: Table 7 :

.1 Conflict of interest

All authors have indicated no potential conflicts of interest to disclose.

.2 Financial disclosure

No financial disclosures were reported by the authors of this paper.

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