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Disability-adjusted life years due to COVID-19 in Sri Lanka: a retrospective cross-sectional study

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ABSTRACT

Objectives To estimate the health burden of COVID-19 in Sri Lanka using disability-adjusted life years (DALYs) and to investigate how the burden varies across age groups and sex.

Methods and analysis A retrospective study was conducted based on information obtained from the daily situation reports and monthly epidemiological reports issued by the Epidemiology Unit of the Ministry of Health, Sri Lanka. DALYs due to COVID-19 in Sri Lanka from 27 January 2020 to 30 June 2022 were estimated by age and sex. For the calculation, we also included the DALYs due to mild anxiety for the family members of the patients with COVID-19.

Results The total number of COVID-19 cases reported during this time period was 664 123, of which, 54% were males. There were 16 521 deaths reported giving a case fatality rate of 2.48%, which was higher in females as compared with males. The total years of life lost during this period is estimated to be 77 679 for males and 115 065 for females. The estimate of DALYs due to COVID-19 in Sri Lanka was 269 606 corresponding to 12.2 per 1000 population.

Conclusion Compared with other countries, the burden of COVID-19 in Sri Lanka, as assessed by DALYs, was relatively low. This may be due to the country being an island and the strict rules imposed by the government to limit the spread of the disease. Assessing the impact of COVID-19 using only DALYs does not reflect the devastating economic and social consequences experienced by the country.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Several studies have estimated the global impact of the COVID-19 pandemic.
⇒ Others have estimated the burden for individual countries.
⇒ Sri Lanka was affected by the COVID-19 pandemic and an economic crisis after the pandemic.
⇒ No study has been conducted to estimate the burden of COVID-19 in Sri Lanka.

WHAT THIS STUDY ADDS

⇒ The study highlights the burden of the COVID-19 in Sri Lanka and investigates the variation of the burden with age and sex.
⇒ Our results revealed that the case fatality rate was higher in females as compared with males, contrary to results reported in other studies.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ The findings of the study can be used as a baseline for future disease outbreaks in the country.
⇒ The findings can also be used to compare the burden of diseases during the COVID-19 pandemic.

INTRODUCTION

COVID-19 has rapidly spread throughout the world in a very short period of time.[1] By the end of 2022, 665 543 700 COVID-19 cases and 6 702 398 deaths due to COVID-19 were reported in multiple waves with the emergence of mutant variants, being second only to the 1918 Spanish influenza pandemic, despite the development of effective vaccines that were approved by WHO for emergency use.[2 3] The morbidity and mortality due to COVID-19 infection are probably underestimates given that reporting and death registration systems in many countries are not 100% accurate and complete. In addition to causing a health burden, the COVID-19 pandemic has led to social and economic consequences throughout the world.

The mortality and development of complications from the diseases vary according to the age and presence of other comorbidities of affected individuals. Evidence shows that individuals who are older and having other comorbidities such as diabetes, cardiovascular diseases and chronic respiratory diseases are at increased risk of developing severe health consequences of COVID-19 infection.[4 5]

The health impact of COVID-19 has been investigated globally. The effects of the disease have been measured using mortality-based metrices such as case fatality rate, crude mortality rate and all-cause mortality.

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Table 1 Number of COVID-19 cases and deaths reported in Sri Lanka from 27 January 2020 to 30 June 2022 and estimated YLL by age and sex

Age category (years)	Population	Number of COVID-19 cases	Deaths	CFR	95% CI of CFR	Average age at death	Life expectancy	YLL
Males								
0–9	1 786 812	23 386	21	0.0898	0.0514–0.1282	4.5	71.17	1495
10–19	1 748 965	37 207	22	0.0591	0.0344–0.0838	14.5	61.9	1362
20–29	1 581 226	69 163	56	0.0810	0.0598–0.1022	24.5	52.21	2924
30–39	1 348 493	72 446	161	0.2222	0.1879–0.2565	34.5	42.79	6889
40–49	1 383 380	57 328	369	0.6437	0.5782–0.7092	44.5	33.42	12331
50–59	1 196 927	46 042	853	1.8527	1.7295–1.9758	54.5	24.46	20867
60–69	960 057	30 715	1593	5.1864	4.9384–5.4343	64.5	16.52	26315
70–79	538 900	16 260	2210	13.5916	13.0649–14.1183	74.5	9.88	21835
80+	162 940	8575	1910	22.2741	21.3934–23.1547	85	5	9550
Total	10 707 700	361 122	7195	1.9924	1.9468–2.0380			103568
Females								
0–9	1 789 818	19 453	20	0.1028	0.0578–0.1478	4.5	75.78	1516
10–19	1 723 078	31 347	23	0.0734	0.0434–0.1033	14.5	66.4	1527
20–29	1 592 042	57 741	77	0.1334	0.1036–0.1631	24.5	56.61	4359
30–39	1 496 090	60 638	207	0.3414	0.2949–0.3878	34.5	46.84	9696
40–49	1 455 838	47 821	639	1.3362	1.2333–1.4391	44.5	37.13	23726
50–59	1 290 130	38 693	1391	3.5950	3.4095–3.7805	54.5	27.61	38403
60–69	1 122 391	26 095	2285	8.7565	8.4135–9.0994	64.5	18.54	42370
70–79	712 298	13 799	2824	20.4653	19.7921–21.1384	74.5	10.26	28984
80+	270 157	7414	1860	25.0877	24.1009–26.0745	85	5	9300
Total	11 451 842	303 001	9326	3.0779	3.0164–3.1394			159880

CFR, case fatality rate; YLL, years of life lost.

The number of deaths in a given region is never an accurate measure of mortality and does not reflect the true burden of the disease. To overcome this drawback, disability-adjusted life year (DALY) metric, developed by Murray and Lopez in 1994, is used instead. DALY is a composite measure which is calculated by taking the sum of two components: years of life lost (YLL) due to premature death and years lived with disability (YLDs).[6] DALYs were originally used in the first Global Burden of Disease (GBD) study which quantified the health effects of >100 diseases for eight regions in the world in 1990.[7] The advantage of using DALYs to measure disease burden is that it accounts for both mortality and morbidity associated with diseases which gives a more comprehensive assessment of the state of health in communities. However, the main disadvantage of DALYs is that they focus solely on health and do not capture the broader societal impact of diseases.[8] Nevertheless, DALYs are commonly used to measure disease burden, and due to their wide usage, it enables comparison of disease burden between diseases, countries and different communities.

The first case of COVID-19 in Sri Lanka was detected on 27 January 2020 in a female tourist aged 44 years from Hubei province, China.[9] The second case, which was also the first local case, was detected on 10 March 2020 in a tour guide aged 52 years who had recently been exposed to an Italian tour group.[9] Sri Lanka was able to effectively curb the spread of the virus with rigorous measures for several months. However, during the first year of the pandemic, the epidemic spread originating from four clusters that were identified probably due to the gradual lessening of stringency measures with time to kick start a failing economy.

The Epidemiology Unit of the Ministry of Health, Sri Lanka maintains morbidity and mortality statistics related to COVID-19. The aim of this study was to estimate the DALYs related to COVID-19 pandemic in Sri Lanka from 27 January 2020 to 30 June 2022 including a component that accounts for the psychological stress that contacts may have experienced due to the stringent measures that were adopted during this time.

MATERIALS AND METHODS

Study setting

Sri Lanka is an island nation in the Indian Ocean located southeast of the southern tip of India. It has a population of about 22.1 million comprising 52% females in a land area of 65 610 km^2[10]; 31.8% of the population was below

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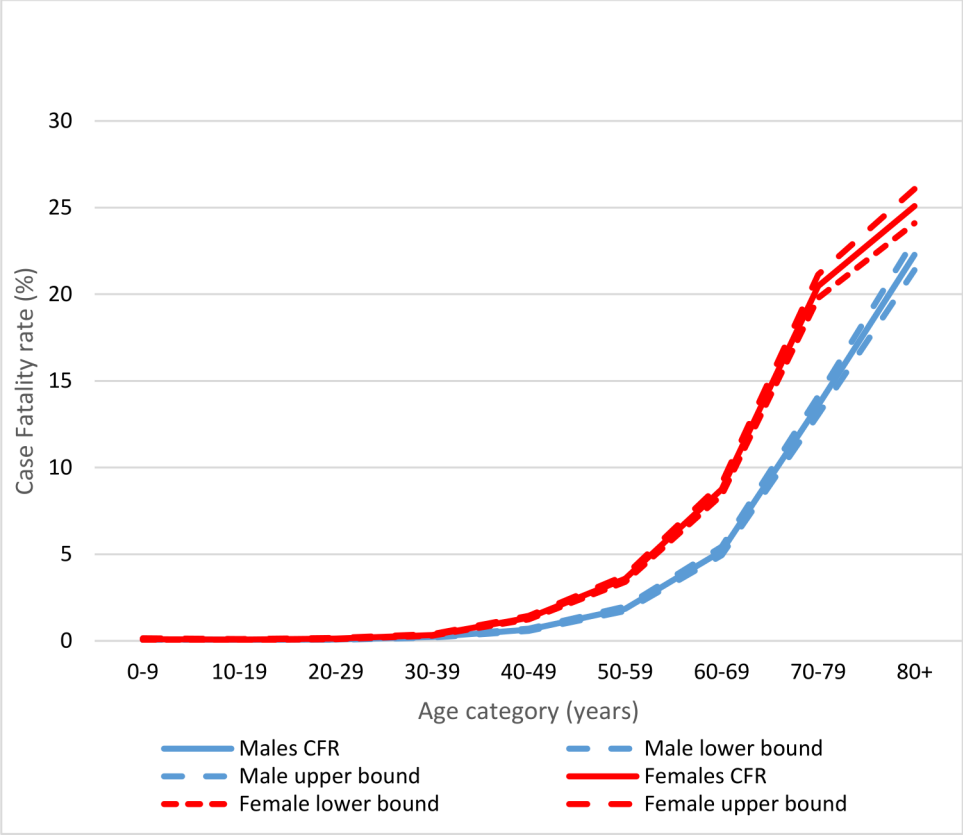

Figure 1 Case fatality rate (CFR) and its 95% CI by age category and sex.

20 years and 17% was above 60 years in 2022 based on projections.[11]

A retrospective study covering the period 27 January 2020 to 30 June 2022 was carried out using data available in the public domain.

Data sources

Data on number of COVID-19 cases and deaths due to COVID-19 were extracted from the daily situation reports and monthly epidemiological reports issued by the Epidemiology Unit of the Ministry of Health, Sri Lanka.[12] The Epidemiology Unit of the Ministry of Health is responsible for surveillance throughout the country. It has a well-recognised network of regional epidemiologists at provincial level who are fed with data from Medical Officers of Health (MOHs); each MOH is responsible for providing preventive healthcare services to a MOH area, the smallest administrative unit of the Health Ministry, comprising a population of 70 000 to 100 000. Currently, there are 357 such units in the country. The Epidemiology Unit compiles data on a weekly basis based on the returns received from the MOH offices.

Sri Lanka's health authorities developed and implemented an integrated national-level COVID-19 surveillance system to prevent spread of COVID-19 in the country. The comprehensive system focused on high-risk person tracking and surveillance, quarantine case management, suspect management, case management, self-assessment and self-monitoring. Case definitions were developed and the system was implemented in January 2020. A database using the District Health Information Software 2 (DHIS2) Tracker platform was developed and implemented at the national, provincial, district and MOH levels.[13]

The numbers of cases and deaths due to COVID-19 were extracted for 10-year age categories by sex as reported by the Epidemiology Unit.[12]

Population data by 10-year age categories were extracted from the Medium-Term Population Projection for Sri Lanka: 2012–2037.[11]

The case fatality rate was calculated as the number of deaths due to COVID-19 divided by the number of reported cases, and multiplied by 100.

Calculation of DALYs

The formula to calculate DALYs is:

$$\text{DALYs} = \text{YLL} + \text{YLD}$$

The YLLs for COVID-19 were calculated as:

$$\text{YLL}(c, s, a, t) = \text{N}(c, s, a, t) \times \text{L}(s, a)$$

where YLL(c, s, a, t) is the years of life lost due to COVID-19 for the given age a and sex s in time period t; N(c,s,a,t) is the number of deaths due to COVID-19 for the given age a and sex s in time period year t and L(s,a) is a standard loss function specifying years of life lost for a death at age a for sex s.[14]

For calculation of YLL, we assumed that the life expectancy at birth of a Sri Lankan male and a female in 2018

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Table 2 YLD due to COVID-19 in Sri Lanka from 27 January 2020 to 30 June 2022

Age category (years)	Population	Number of COVID-19 cases	Age at onset	Disability weight	Duration (years)	YLD	YLD per 1000 population
Males							
0–9	1 786 812	23 386	4.5	0.133	0.038	118	0.07
10–19	1 748 965	37 207	14.5	0.133	0.038	188	0.11
20–29	1 581 226	69 163	24.5	0.133	0.038	350	0.22
30–39	1 348 493	72 446	34.5	0.133	0.038	366	0.27
40–49	1 383 380	57 328	44.5	0.133	0.038	290	0.21
50–59	1 196 927	46 042	54.5	0.133	0.038	233	0.19
60–69	960 057	30 715	64.5	0.133	0.038	155	0.16
70–79	538 900	16 260	74.5	0.133	0.038	82	0.15
80+	162 940	8575	85	0.133	0.038	43	0.27
Total	10 707 700	361 122		0.133	0.038	1825	0.17
Females							
0–9	1 789 818	19 453	4.5	0.133	0.038	98	0.05
10–19	1 723 078	31 347	14.5	0.133	0.038	158	0.09
20–29	1 592 042	57 741	24.5	0.133	0.038	292	0.18
30–39	1 496 090	60 638	34.5	0.133	0.038	306	0.20
40–49	1 455 838	47 821	44.5	0.133	0.038	242	0.17
50–59	1 290 130	38 693	54.5	0.133	0.038	196	0.15
60–69	1 122 391	26 095	64.5	0.133	0.038	132	0.12
70–79	712 298	13 799	74.5	0.133	0.038	70	0.10
80+	270 157	7414	82.5	0.133	0.038	37	0.14
Total	11 451 842	303 001		0.133	0.038	1531	0.13

YLD, years lived with disability.

was 71.17 and 75.78 years, respectively, based on life table analysis.[15]

Based on the WHO publication (2020),[14] YLDs were calculated as follows:

$$YLD(c,s,a,t) = I(c,s,a,t) \times DW(c,s,a) \times L(c,s,a,t)$$

where I(c,s,a,t) is the number of incident cases of COVID-19 for the given age a and sex s; DW(c,s,a) is the disability weight for COVID-19, for age a and sex s; L(c,s,a,t) is the average duration of the illness.

The disability weight for COVID-19 infection was taken as 0.133, as for a severe lower respiratory tract infection[16] and the duration of illness was taken as 2 weeks which correspond to 0.038 years.[6]

For calculation of YLD for contacts, it was assumed that contacts of cases in the same household were quarantined for 2 weeks, based on regulations imposed by the Ministry of Health; a disability weight of 0.03 (as for mild anxiety)[17] and a duration of 2 weeks (0.038 years) was used for calculating years lived with disability among contacts. The household size was assumed to be 3.7.[18]

Data management and analysis

DALYs were calculated based on the formulae given above using an Excel work sheet. Case fatality rates for each 10-year age group and their 95% CIs by sex were calculated. The DALYs per 1000 population was obtained by dividing the DALYs per age group by sex by the respective population, and multiplying by 1000.

The case fatality rate was calculated as a percentage of deaths due to COVID-19 to the number of reported infections; 95% CIs of the case fatality rate was calculated for age group by sex.

Data analysis was done and charts and graphs were created using Microsoft Excel 365.

We describe our study in line with Strengthening the Reporting of Observational Studies in Epidemiology checklist[19] (online supplemental file 1).

RESULTS

A total of 664 123 COVID-19 cases (males 54%) and 16 521 deaths due to COVID-19 (44% males) were reported in Sri Lanka from 27 January 2020 to 30 June 2022 (table 1). The case fatality rate increased with age, each 10-year group having a higher case fatality rate than the preceding younger age group. Females had a significantly higher case fatality rate in all age categories except in the extremes of age (figure 1). Almost

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Table 3 Summary of DALYs due to COVID-19 in Sri Lanka from 27 January 2020 to 30 June 2022

	Males			Females			Total population		
Age category (years)	Population	DALYs	DALYs per 1000 population	Population	DALYs	DALYs per 1000 population	Population	DALYs	DALYs per 1000 population
0–9	1 786 812	1613	0.9	1 789 818	1614	0.9	3 576 630	3227	0.9
10–19	1 748 965	1550	0.9	1 723 078	1686	1.0	3 472 043	3236	0.9
20–29	1 581 226	3273	2.1	1 592 042	4650	2.9	3 173 268	7924	2.5
30–39	1 348 493	7255	5.4	1 496 090	10002	6.7	2 844 583	17257	6.1
40–49	1 383 380	12621	9.1	1 455 838	23967	16.5	2 839 218	36588	12.9
50–59	1 196 927	21100	17.6	1 290 130	38599	29.9	2 487 057	59698	24.0
60–69	960 057	26471	27.6	1 122 391	42502	37.9	2 082 448	68973	33.1
70–79	538 900	21917	40.7	712 298	29054	40.8	1 251 198	50972	40.7
80+	162 940	9593	58.9	270 157	9337	34.6	433 097	18931	43.7
Total (YLL+YLD for infected persons)	10 707 700	105393	9.8	11 451 842	161412	14.1	22 159 542	266805	12.0
YLD for contacts								2801	
Total							22 159 542	269 606	12.2

DALYs, disability-adjusted life years; YLD, years lived with disability; YLL, years of life lost.

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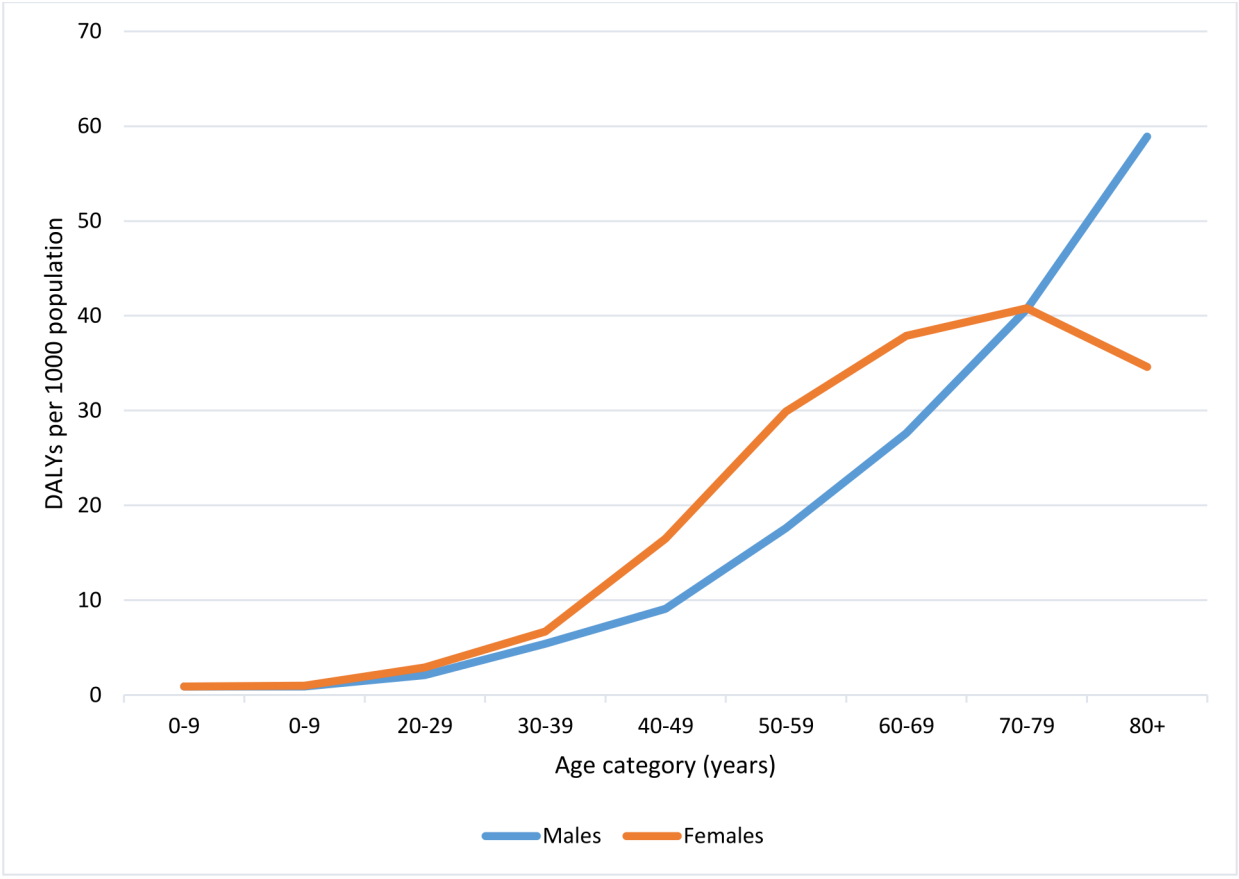

Figure 2 Disability-adjusted life years (DALYs) due to COVID-19 from 27 January 2020 to 30 June 2022 in Sri Lanka per 1000 population by age category and sex.

one-quarter of infected persons above 80 years died (table 1). The total years of life lost during this period is estimated to be 103 568 for males and 159 880 for females.

Males lived 1825 years with disability during this period and females 1531 years based on a disability weight of 0.133 (as for a severe lower respiratory tract infection assuming that the disability was for a period of 2 weeks (0.038 years)) (table 2).

Given the strict regulations imposed during the pandemic, all contacts were quarantined for 14 days; we assumed that all household members where a COVID-19 case was detected would have quarantined for 14 days where they were likely to have been anxious. Assuming that the average Sri Lankan household has 3.7 persons[18] and using a disability weight of 0.03 (as for mild anxiety)[17] for a period of 14 days (0.038 years), we estimated the YLDs for the contacts to be 2801.

Table 3 gives the summary of the DALYs due to COVID-19 in Sri Lanka from 27 January 2020 to 30 June 2022. An estimated total of 269 606 DALYs was experienced by the Sri Lankan population of 22 159 542 during this period. The DALYs per 1000 population increased with age and was higher in females than in males except in the extremes of age groups (table 3 and figure 2).

DISCUSSION

We have estimated that a total of 269 606 DALYs were lost due to COVID-19 in Sri Lanka between 27 January 2020 and 30 June 2022, the number being higher among females as compared with males primarily due to a higher case fatality rate. As expected, the number DALYs per 1000 population was higher among females except at the extremes of age.

In our study, almost 12 DALYs were lost per 1000 population. In Italy, it has been reported that since the inception of the pandemic in 2020 until the 28 April, 2020, 2.01 DALYs were lost per 1000 population.[20] In Iran, the estimated loss of DALYs per 1000 population in 2020 was 22.2 (table 4).[21] Our estimates are for over a 2.5-year period unlike the estimates for Italy and Iran, which are for shorter periods of time; it is likely that their estimates for a similar period of 2.5 years will be much higher than that for Sri Lanka which we report here.

One reason for the relatively low DALY counts we report here may be due to Sri Lanka being an island nation which limits travel and the stringent measures taken by the government to control the spread of the disease. Initially, there were curfew type lockdowns and major travel restrictions imposed. All contacts were actively tracked down and tested for COVID-19. Till about the end of June 2022, all contacts were required

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Table 4 Reported DALYs in different countries for different periods of observation

Country (reference)	Period	DALYs per 1000 population
The Netherlands[23]	27 February 2020–31 December 2020	16.4
Scotland[24]	2020	17.7–19.8
Germany[25]	2020	3.68
Malta[26]	7 March 2020–31 March 2021	10.86
Saudi Arabia[27]	July–October 2021	0.88
Denmark[28]	26 February 2020–25 February 2021	5.2
Austria[29]	27 January 2020–15 November 2020	1.63
Croatia[29]	27 January 2020–15 November 2020	2.29
Czechia[29]	27 January 2020–15 November 2020	5.34
Denmark[29]	27 January 2020–15 November 2020	1.16
Estonia[29]	27 January 2020–15 November 2020	0.55
Finland[29]	27 January 2020–15 November 2020	0.59
Germany[29]	27 January 2020–15 November 2020	1.32
Ireland[29]	27 January 2020–15 November 2020	3.5
Italy[29]	27 January 2020–15 November 2020	6.5
Luxembourg[29]	27 January 2020–15 November 2020	3.11
Malta[29]	27 January 2020–15 November 2020	1.78
The Netherlands[29]	27 January 2020–15 November 2020	4.29
Poland[29]	27 January 2020–15 November 2020	2.39
Portugal[29]	27 January 2020–15 November 2020	2.79
Slovakia[29]	27 January 2020–15 November 2020	1.01
Sweden[29]	27 January 2020–15 November 2020	5.29

DALYs, disability-adjusted life years.

to quarantine or be on home management for 2 weeks. Despite these measures, Sri Lanka experienced three waves of infection during this period; the impact of each wave was more severe than the previous one and the case fatality rate was higher in each succeeding wave.

Sri Lanka started the vaccination campaign in late January 2021 with limited stocks. The programme was expanded in the next few weeks with the availability of more vaccines. Although the uptake of the first and second doses, even though the majority was vaccinated with the Chinese Sinopharm vaccine, was relatively good, the uptake for the third and fourth doses was poor despite the availability of the Pfizer-BioNTech COVID-19 Vaccine. The partially successful vaccination programme is also likely to have contributed to the low DALY estimates.

We have included an estimate of the YLD for contacts for the first time in estimating DALYs. The reason for doing so is the stringent control measures that were implemented during this period. As contacts were required to quarantine or stay home for 14 days, we postulated that they would have suffered some amount of anxiety during this period; some of the quarantine centres were poorly equipped with minimal comforts and were situated far away. For purposes of estimations, we assumed a disability weight of 0.03, the same as for mild anxiety, for a period of 2 weeks for all household contacts estimated, on average, to be 3.7 per household. Deaths were included in the same calculation and their YLDs were considered to be the same as for non-fatal infections.

Despite the inclusion of DALYs experienced by contacts, we acknowledge that our estimates are underestimates. We believe that the actual number of cases is more as some patients with typical signs and symptoms of infection did not seek medical care due to the stigma that was associated with being infected with COVID-19 even though the reporting system of diagnosed cases was very reliable. This is likely to have underestimated the DALY count for contacts as well.

We did not take into account DALYs lost due to long COVID-19 as this information was not available for Sri Lanka; if we did, our DALY estimate would have been much higher. In calculating DALYs, we did not account for age weighting and social discounting as recommended by WHO.[14] However, we did not use 90 years as the average life span at birth in 2050 as it did not seem realistic for Sri Lanka; instead, we used life expectancies based on Sri Lankan demographic data.

YLDs do not measure the limitations of functioning, or social participation,[22] which was the main type of disability experienced by the contacts due to mandatory social isolation and the stigma attached to the disease. As suggested by Grosse *et al*, measurement of limitations of functioning, physical activities and social participation derived from information gathered from those affected is essential to the development of meaningful measures of disability.[22] In this study, we have attempted to calculate YLD of contacts by factoring in the anxiety they experienced. The impact of the disease may vary widely across countries and socio-economic strata as availability of resources and access to them vary widely across countries and among communities. Hence, even though the YLDs are comparatively smaller, their impact may have been more than that experienced in other settings.

The significantly higher case fatality rates among females in different age groups except at the extremes of ages were not expected. In Sri Lanka, there is no evidence of male preference or having access to better healthcare facilities. The literacy rate among both males and females is high at over 94%. Almost all deliveries take place in hospitals having specialised services and personnel. Females comprise about 60% of university admissions and >60% using healthy lifestyle clinics for persons 40 years and older are females. Grosse *et al* reported that the case fatality rate for COVID-19 was higher among males than among females,[22] a finding which was consistent across many countries for several age groups. In Israel, a study reported that females were 1.12 times more likely to be infected; however, mortality was higher among males. The observation that more males being infected but the case fatality rate being higher in females needs further investigation.

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Although the DALY counts due to the COVID-19 pandemic in Sri Lanka we report here are low and are probably an underestimate, resource availability and other impacts on daily life should be taken into consideration when interpreting the results and the overall impact of the pandemic.

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Contributors ARW contributed to the conceptualisation, developing the methodology, supervising data collection, data curation, writing original draft, reviewing and editing draft. ADKA and TUM contributed in data collection, data analysis and writing original draft. BPRP contributed to conceptualisation, developing methodology and writing and reviewing the manuscript supervision. ARW accepts full responsibility for the work, conduct of the study and controlled the decision to publish.

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Patient consent for publication Not applicable.

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Data availability statement No data are available.

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