The burden of disease due to COVID-19 in Florianópolis, Santa Catarina, Brazil, over a one-year period

Jefferson Traebert (https://orcid.org/0000-0002-7389-985X) [1]
Bruna Müller Martins (https://orcid.org/0000-0002-5643-2529) [2]
Pâmela Nogueira da Silva Vilela Ferreira (https://orcid.org/0000-0002-1319-1649) [1]
Leandro Pereira Garcia (https://orcid.org/0000-0002-8601-7166) [1,3]
Fabiana Schuelter-Trevisol (https://orcid.org/0000-0003-0997-1594) [1]
Eliane Traebert (https://orcid.org/0000-0001-9667-7216) [1,2]

Abstract *COVID-19 has had a powerful impact on society with high rates of morbidity and mortality. The use of an epidemiological indicator that estimates the burden of a disease by aggregating early mortality and non-fatal cases in a single measure has the potential to assist in the planning of more appropriate actions at different levels of health care. The scope of this article is to estimate the burden of disease due to COVID-19 in Florianópolis/SC from April 2020 through March 2021. An ecological study was carried out with data from notification and deaths by COVID-19 in the period of 12 months. The burden indicator called Disability-Adjusted Life Years (DALY) was used, obtained by adding the Years of Life Lost (YLL) to the Years of healthy life lost due to disability (YLD). A total of 78,907 confirmed COVID-19 cases were included. Of these, 763 died during the period under study. Overall, 4,496.9 DALYs were estimated, namely a rate of 883.8 DALYs per 100,000 inhabitants. In males, there were 2,693.1 DALYs, a rate of 1,098.0 DALYs per 100,000 males. In women, there were 1,803.8 DALYs, a rate of 684.4 DALYs per100,000 women. The age group most affected in both sexes was 60 to 69 years. The burden of COVID-19 was high in the city studied. The highest rates were in females and in the 60-69 age group.*

Key words *Burden of disease, Years of life adjusted by disability, COVID-19*

[1] Programa de Pós-Graduação em Ciências da Saúde, Universidade do Sul de Santa Catarina. Av. Pedra Branca 25, Cidade Universitária Pedra Branca. 88132-270. Palhoça SC Brasil. jefferson.traebert@gmail.com
[2] Curso de Medicina. Universidade do Sul de Santa Catarina. Palhoça SC Brasil.
[3] Prefeitura de Florianópolis. Florianópolis SC Brasil.

Introduction

The coronavirus is a zoonotic virus, with the ability to infect several animals, as well as humans through aerosols spread in the air[1-3]. The coronavirus disease 19, or COVID-19 caused by SARS-CoV-2, emerged at the end of 2019 in China[1-5] and generates an infection that involves a receptor on the surface of the host's cell membrane. Human-to-human transmission occurs mainly via aerosols in close contact with infected and non-infected people[3-6]. However, transmissibility is not limited to the respiratory tract and the virus has high transmissibility during the asymptomatic and mild symptoms period of the disease[6].

It is a viral infection that has the respiratory system as its main target and has generated the current pandemic, with high rates of morbidity and mortality[4,5]. Named severe acute respiratory syndrome coronavirus type 2 (SARS-CoV-2) by the World Health Organization, it represents an important public health problem, with social and economic impact, given the high transmissibility, spreading in a scale of geometric progression and presenting asymptomatic to severe symptoms, with fatal outcome in a considerable number of inpatients[7,8].

On April 1, 2020, 1 million cases were confirmed worldwide with deaths reaching 50,000 patients[9]. On January 1, 2022, more than 289 million cases were reported worldwide, with the United States of America being the country with the highest number (54,859,966), followed by India (42,889,132) and Brazil (22,291,507). Until December 2021, more than 5.4 million deaths were reported worldwide, and Brazil ranked second with 619,105 deaths[10]. In relation to the State of Santa Catarina, during the same period, 2,559,036 cases[11,12] and 20,064 deaths[13] were notified.

The magnitude of this public health problem allows calculating the burden of disease due to COVID-19 and to review its impact both in terms of early mortality and morbidity or the impact on surviving cases, using the same indicator. In this way, the use of appropriate instruments for measuring the health-disease process allows public health agents to rationally use available resources, based on objective analyses, especially when epidemics such as COVID-19 occur[14].

The concept of Global Burden of Disease (GBD)[15] is based on the use of a new health indicator called Disability-Adjusted Life Years (DALY). A DALY corresponds to one year of healthy life that is lost (YLL – Years of Life Lost) or lived with disability (YLD – Years Lived with Disability). This is an innovative indicator that seeks to simultaneously measure the impact of mortality and health problems that affect the quality of life of individuals. The indicator innovated by incorporating the years lived with disability, configuring loss of quality of life. This inclusion in the indicator is relevant in at least two respects: first, because it brings to the debate the non-fatal consequences of the disease, so little measured and used as indicators of health needs. Second, because it applies to the identification of epidemiological and research priorities in the area of health, being able to subsidize the allocation of resources, either in combination with previous information on the impact of interventions, or as a denominator of cost-effectiveness analyzes oriented to the evaluation of the efficiency of interventions in terms of the additional cost they entail per DALY prevented[15].

There are still few studies on the burden of disease due to COVID-19 available in the literature. Population-based studies have been carried out in India[16], Italy[17], Germany[18], Malta[19], Iran[20] and Scotland[21]. No Brazilian population-based studies were found.

Therefore, the present study aimed to estimate the burden of disease due to COVID-19 in the city of Florianópolis, Santa Catarina, from 2020 April to 2021 March.

Methods

An epidemiological study with an ecological design was conducted, following the methodology proposed by Murray *et al.*[15] in their study entitled Global Burden of Disease (GBD) and in the Burden of Disease study in Brazil[22]. It was based on the database of confirmed COVID-19 (ICD 10 B972) cases from 2020 April to 2021 March, totaling 12 months, using the Brazilian Notifiable Diseases Information System (*Sistema Nacional de Agravos e Notificações – SINAN*) for the cases notified and Brazilian Mortality Information System (*Sistema de Informações sobre Mortalidade – SIM*) for mortality data, both concerning Florianópolis dwellers.

The demographic characteristics of the estimated resident population for the year 2020 were distributed by gender and age groups (< 9 years old, 10-14 years old, 15-19 years old, 20-29 years old, 30-39 years old, 40-49 years old, 50 - 59 years old, 60-69 years old, 70-79 years old, 80 years

old or older) according to the proportions of the 2010 census[23].

DALYs were estimated by the sum of years of life lost (YLL – Years of Life Lost) and years of life with disability (YLD – Years of Life with Disability)[24-26]. The GBD 2019 standard method was used to calculate the YLL. The cases of death according to age were multiplied by the standard normative life expectancy at each age. The normative standard life expectancy at birth was 73.5 years, 71.6 years for men and 79 years for women[26]. The calculation of the YLD was obtained by multiplying the weight of the disease by its duration, using incident cases. In order to measure morbidity and mortality in the same way, disease burden studies provide for the definition of a measure that numerically assigns a value to the time lived with a certain non-fatal condition. Thus, the weight for COVID-19 was 0.051 for mild or moderate cases, 0.133 for severe cases and 0.655 for critical cases[16,18,27]. The duration of illness considered for mild or moderate cases was 14 days (or 0.03 year) and for severe cases, 21 days (or 0.05 years) and critical cases, 32 days (or 0.08 years)[18].

Data were organized in Microsoft Excel spreadsheets. The DALY, YLL and YLD rates were calculated per 100,000 inhabitants and distributed by gender and age groups in the studied period.

The present study was submitted and approved by the Research Ethics Committee of the Universidade do Sul de Santa Catarina under Opinion No. 5.035.3.23.

Results

A total of 78,907 cases of COVID-19 confirmed in the city of Florianópolis from 2020 April 2020 to 2021 March were included; out of this total 52.9% were female (41,727) and 47.1% were male (37,180). A total of 763 patients died, 55.2% being men. The average age of death was 71.6 years (SD = 14.2).

The number of YLLs calculated was 4,285.5 which generated a rate of 842.2 YLLs/100,000 inhabitants. For males, 2,587.0 YLLs (60.4%) were estimated, with a rate of 1,054.8 YLLs/100,000 males, while for females it was 1,698.5 YLLs (39.6%), which generated a rate of 644.4 YLLs/100,000 women.

Regarding age groups, in both genders, the age group from 60 to 69 years was the most affected, with 5,483.5 YLLs/100,000 men and 2,952.1 YLLs/100,000 women, followed by the 50-59 age group with 3,055.7 YLLs/100,000 men and 1,514.9 YLLs/100,000 women as shown in Table 1.

In terms of morbidity, a total of 211.4 YLDs was estimated, which generated a rate of 41.5 YLDs/100,000 inhabitants. For males, the total calculated was 106.1 YLDs (50.2%), generating a rate of 43.3 YLDs/100,000 males, while for females 105.3 YLDs (49.8%) were found, with a rate of 39.9 YLDs/100,000 women. Among men, the most affected age group was 80 years or older, followed by the 70-79 age group, with 294.6 and 148.9 YLDs/100,000 men in this group, respectively. Among women the most affected age group was 80 years or more followed by the age group of 70 to 79 years with 136 and 79.2 YLDs/100,000 women in this group, respectively, as shown in Table 1.

In total, 4,496.9 DALYs were estimated, which generated a rate of 883.8 DALYs/100,000 inhabitants. In males, the number of DALYs was 2,693.1 (44.6%) with a rate of 1,098.0 DALYs/100,000 males, while in females, there were 1,803.8 DALYs (55.3%), generating a rate of 684.4 DALYs/100,000 women. Regarding age groups, among men, the most affected group was in the range of 60 to 69 years, with a rate of 5,581.9 DALYs/100,000, followed by 50 to 59 years old, with 3,113.1 DALYs/100,000 men in each age group mentioned. Among women, the most affected age group was in the range of 60 to 69 years, with 3,022.3 DALYs/100,000, followed by 50 to 59 years old seniors, with 1,562.0 DALYs/100,000 women in each age group, as shown in Figure 1.

Discussion

The present study estimated a rate of 883.8 DALYs/100,000 inhabitants for COVID-19 in Florianópolis over a period of one year. The Brazilian literature lacks local population data on the impact of COVID-19, which prevents any kind of direct comparison. For example, a 2009 population-based study also estimated a rate of 655.4 DALYs/100,000 inhabitants for AIDS in Florianópolis using the same method[28]. However, one study estimated the burden of disease attributable to SARS-CoV-2 infection among nursing professionals in Brazil. The adjusted rate per thousand professionals was 1,475.94 years for men and 674.23 years for women[29]. In an effort to contextualize the result of the present study, before the advent of COVID-19, the Burden of Disease Study in Brazil projecting for the year 2013,

Table 1. Distribution of YLLs and YLDs rates per 100,000 inhabitants, according to gender and age group. Florianópolis, Santa Catarina, 2020-2021.

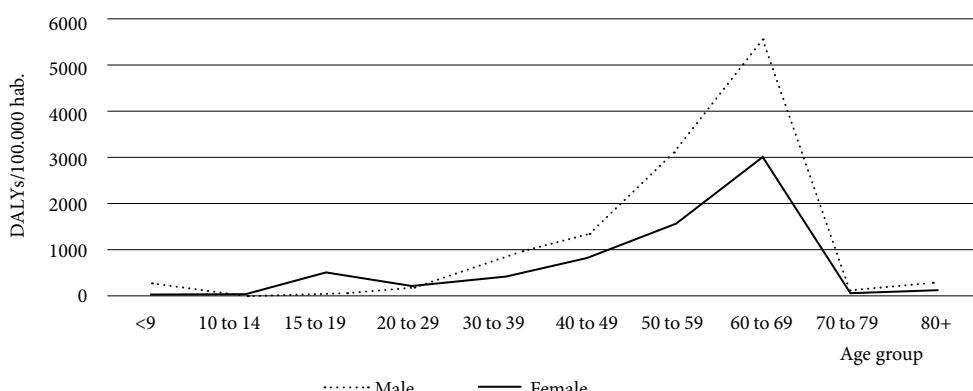| Age group	Men		Women	
	YLL	YLD	YLL	YLD
< 9	256.7	0.3	-	0.4
10 to 14	-	8.2	-	7.6
15 to 19	-	14.8	498.3	17.2
20 to 29	173.9	28.4	186.2	33.7
30 to 39	783.6	48.4	366.4	50.6
40 to 49	1,298.7	52.8	794.9	45.9
50 to 59	3,055.7	7.3	1,514.9	47.1
60 to 69	5,483.5	98.5	2,952.1	70.2
70 to 79	-	48.9	-	79.2
80 +	-	294.6	-	136.0

Source: Authors.

Figure 1. Distribution of DALY rates per 100,000 inhabitants, by gender and age group. Florianópolis, Santa Catarina, 2020-2021.

Source: Authors.

showed that respiratory diseases were among the 20 main causes of morbidity and mortality, which corresponded to 12.6% of the total DALYs in this country[30].

Of the total estimated 4,496.9 DALYs due to COVID-19 in Florianópolis, 95.3% of the burden was due to fatal cases (4,285.5 YLLs) and 4.7% due to years lived with disability (211.4 YLDs). Recent studies had already registered this reality: in Germany 99.3%[18], in India 99.2%[16] and in Malta 95%[19] of the burden was also represented by the YLL.

As observed at the beginning of the pandemic, mortality rates were higher in the elderly, especially in those with comorbidities[31]. The present study maintained the pattern of most world studies, with deaths mainly in men over 60 years of age, as observed in Germany[18], Italy[17], Uganda[32], India[33], Iran[20] and a study that covered 81 countries[31]. It differs only from the Brazilian study involving nurses, that mortality was earlier in women aged between 31-40 years[29]. This points to the elderly population as being more vulnerable to the disease, especially in terms of mortality. Regarding the genders of the COVID-19 cases notified and reported in the present study, 52.9% were women, similar to the results of studies carried out in Brazil[29] and Germany[18], different from India where men constituted the most notified cases[16].

The characterization of the burden of disease is essential to provide support so that public policies at the local level are reorganized in order to prevent events of greater impact, such as fatal cases. The results of the present study raise several questions concerning the burden of COVID-19, especially about the high impact of early mortality since the YLL component was responsible for 96.7% of the burden. An important issue to be highlighted is that in the review period of this study, the vaccination program against COVID-19 was started. Most likely, the disease burden indicator will be reduced from the implementation of mass vaccination. In Florianópolis vaccination started in 2021 January, therefore already in the last three months of the period under review. In 2021 January, 6,194 vaccine doses were applied corresponding to a rate of 1,217.3/100,000 inhabitants[11]. In 2021 February, 19,042 doses were applied, a rate of 3,742.3/100,000 inhabitants, and in 2021 March, 66,203 doses were applied, corresponding to a rate of 13,010.9/100,000 inhabitants[11]. Mass vaccination, with high coverage rates, reduces mortality, which is the basis of the YLL, precisely what generated the greatest burden in the municipality assessed.

The results of the present study ought to be interpreted with caution, since they were based on data of disease notification, which may underestimate the disease impact. In addition to the possibility of underreporting known cases, the potential for many unknown cases to exist should be considered, since the mild form of the disease can be quite prevalent. In addition, by assuming the burden of disease concept pursuant to the Global Burden of Disease (GBD)[15], it is reasonable to consider how much the impact on different sectors of society, such as economy and education, among others, may not have been included in the burden that generated YLD.

Furthermore, it is important to note that the parameters used to estimate the Years Lived with Disability (YLD) incorporated a certain temporality into their formula such as mild or moderate cases (14 days), severe cases (21 days) and critical cases (32 days). It would be important to consider what has been called the long COVID-19. However there are still no parameters in the GDB standard model that include this longer-term effects of the disease, with a longer time or even a different weight, perhaps because it is still a new disease with long-term unknown repercussions or that are becoming noticeable only now. Certainly, the future inclusion of parameters that include the long-term repercussions of the disease will show a burden closer to reality. Wyper *et al.*[27] also argue along this line when discussing the impact and the entire spectrum of sequelae of this disease, being still too early to be fully evaluated and should be incorporated to the indicators as soon as new robust evidence becomes available.

Finally, we believe in the potential of the study to help provide information on the impact of the disease at the local level, but also to advance understanding of the magnitude of the effects of COVID-19 on public health. It can contribute to the planning of actions to reduce the burden at different levels of health care, such as maintaining vaccination incentive programs, health promotion actions and primary and secondary prevention of chronic diseases to reduce severe forms of COVID-19. New studies are needed to know the impact of these actions on early mortality and disease morbidity.

It can be concluded about the high impact of COVID-19 in Florianópolis, fundamentally in terms of early mortality.

Collaborations

J Traebert and E Traebert: study design, methodological design, data collection, data analysis, writing of the manuscript, approval of the final version. BM Martins and PNSV Ferreira: data collection, data analysis, manuscript writing, final version approval. LP Garcia and F Schuelter-Trevisol: writing of the manuscript, approval of the final version.

References

1. Hu B, Guo H, Zhou P and Shi ZL. Characteristics of SARS-CoV-2 and COVID-19. *Nat Rev Microbiol* 2021; 19:141-154.
2. Chen X, Chen Z, Azman AS, Deng X, Sun R, Zhao Z, Chen X, Chen Z, Azman AS, Deng X, Sun R, Zhao Z, Zheng N, Chen X, Lu W, Zhuang T, Yang J, Viboud C, Ajelli M, Leung DT, Yu H. Serological evidence of human infection with SARS-CoV-2: a systematic review and meta-analysis. *Lancet Glob Health* 2021; 9(5):e598-e609.
3. Khan M, Adil SF, Alkhathlan HZ, Tahir MN, Saif S, Khan M, Khan ST. COVID-19: A Global challenge with old history, epidemiology and progress so far. *Molecules* 2020; 26(1):39.
4. Weston S, Frieman MB. COVID-19: knowns, unknowns, and questions. *mSphere* 2020; 5(2):18-22.
5. Baker RE, Mahmud AS, Miller IF, Rajeev M, Rasambainarivo F, Rice BL, Takahashi S, Tatem AJ, Wagner CE, Wang LF, Wesolowski A, Metcalf CJE. Infectious disease in an era of global change. *Nat Rev Microbiol* 2022; 20(4):193-205.
6. Wang MY, Zhao R, Gao LJ, Gao XF, Wang DP, Cao JM. SARS-CoV-2: structure, biology, and structure-based therapeutics development. *Front Cell Infect Microbiol* 2020; 10:587269 .
7. Guan WJ, Liang WH, Zhao Y, Liang HR, Chen ZS, Li YM. Comorbidity and its impact on 1,590 patients with Covid-19 in China: a nationwide analysis. *Eur Respir J* 2020; 55(5):2000547.
8. Peramo-Álvarez FP, López-Zúñiga MÁ, López-Ruz MÁ. Medical sequels of COVID-19. *Med Clin* 2021; 157(8):388-394.
9. Brasil. Ministério da Saúde (MS). Secretaria de Vigilância em Saúde. Doença pelo Coronavírus COVID-19. Semana Epidemiológica 52 (20 a 26/12/2020). *Boletim Epidemiológico Especial*. Brasília; 2020.
10. Brasil. Ministério da Saúde (MS). Secretaria de Vigilância em Saúde (BR). Doença pelo Coronavírus COVID-19. Semana Epidemiológica 52 (26/12/21 a 01/01/2022). *Boletim Epidemiológico Especial*. Brasília; 2022.
11. Brasil. Departamento de Informática do SUS (DATASUS). Open DATASUS. E-SUS Notifica – notificações de síndrome gripal. Santa Catarina, 2022. [acessado 2022 jan 25]. Disponível em: https://opendatasus.saude.gov.br/dataset/notificacoes-de-sindrome-gripal
12. Brasil. Sistema Único de Saúde (SUS). Tabulador genérico de domínio público (TABNET). Sistema de Notificações de Síndromes Respiratórias Agudas Graves (SRAG) – SIVEP. Investigação Covid-19. Santa Catarina, 2022. [acessado 2022 jan 25]. Disponível em: http://200.19.223.105/cgi-bin/dh?sinan/def/covid.def
13. Brasil. Sistema Único de Saúde (SUS). Tabulador genérico de domínio público (TABNET). Sistema de Informação sobre Mortalidade (SIM). Mortalidade Geral - Santa Catarina CID 10. Santa Catarina, 2022. [acessado 2022 jan 25]. Disponível em: http://200.19.223.105/cgi-bin/dh?sim/def/sim96.def

14. Nedel FB, Rocha M, Pereira, J. Anos de vida perdidos por mortalidade: um dos componentes da Carga de Doença. *Rev Saude Publica* 1999; 33(5): 461-469.

15. Murray CI. Quantifying the burden of disease: the technical basis for disability-adjusted life years. *Bull World Health Organ* 1994; 72:429-445.

16. Singh BB, Devleesschauwer B, Khatkar MS, Lowerison M, Singh B, Dhand NK, Barkema HW. Disability-adjusted life years (DALYs) due to the direct health impact of COVID-19 in India, 2020. *Sci Rep* 2022; 12(1):2454.

17. Nurchis MC, Pascucci D, Sapienza M, Villani L, D'Ambrosio F, Castrini F, Specchia ML, Laurenti P, Damiani G. Impact of the Burden of COVID-19 in Italy: Results of Disability-Adjusted Life Years (DALYs) and productivity loss. *Int J Environ Res Public Health* 2020; 17(12):4233.

18. Rommel A, Lippe EV, Plass D, Ziese T, Diercke M, Heiden MA, Haller S, Wengler A; Burden 2020 Study Group. The COVID-19 Disease Burden in Germany in 2020-Years of Life Lost to Death and Disease over the course of the pandemic. *Dtsch Arztebl Int* 2021; 118(9):145-151.

19. Cuschieri S, Calleja N, Devleesschauwer B, Wyper GMA. Estimating the direct Covid-19 disability-adjusted life years impact on the Malta population for the first full year. *BMC Public Health* 2021; 21(1):1827.

20. Taheri Soodejani M, Abedi Gheshlaghi L, Bahrevar V, Hosseini S, Lotfi MH. Burden of severe COVID-19 in center of Iran: results of disability-adjusted life years (DALYs). *Int J Mol Epidemiol Genet* 2021; 12(6):120-125.

21. Wyper GMA, Fletcher E, Grant I, McCartney G, Fischbacher C, Harding O, Jones H, de Haro Moro MT, Speybroeck N, Devleesschauwer B, Stockton DL. Measuring disability-adjusted life years (DALYs) due to COVID-19 in Scotland, 2020. *Arch Public Health*. 2022; 80(1):105.

22. Schramm JMA, Valente JG, Leite IB, Valente JG, Gadelha AMJ, Portela MC. Transição epidemiológica e o estudo de carga de doença no Brasil. *Cien Saude Colet* 2004; 9(4):897-908.

23. Instituto Brasileiro de Geografia e Estatística (IBGE). *Censo Brasileiro de 2010*. Rio de Janeiro: IBGE; 2010.

24. Murray CJ, Lopez AD. *The global burden of disease: a comprehensive assessment of mortality and disability from diseases, injuries, and risk factors in 1990 and projected to 2020*. Harvard University Press: Cambridge; 1996.

25. GBD 2016 Mortality Collaborators (2017). Global, regional, and national under-5 mortality, adult mortality, age-specific mortality, and life expectancy, 1970-2016: a systematic analysis for the Global Burden of Disease Study 2016. *Lancet* 2017; 390(10100):1084-1150.

26. GBD 2019 Demographics Collaborators. Global age-sex-specific fertility, mortality, healthy life expectancy (HALE), and population estimates in 204 countries and territories, 1950-2019: a comprehensive demographic analysis for the Global Burden of Disease Study 2019. *Lancet* 2020; 396(10258):1160-203.

27. Wyper GMA, Assunção RMA, Colzani E, Grant I, Haagsma JA, Lagerweij G, Von der Lippe E, McDonald SA, Pires SM, Porst M, Speybroeck N, Devleesschauwer B. Burden of Disease Methods: a guide to calculate COVID-19 Disability-Adjusted Life Years. *Int J Public Health* 2021; 66:619011.

28. Traebert J, Silva MF, Nickel DA, Schneider IJC. Estimativa da carga de doença por aids em Florianópolis, 2009. *Epidemiol Serv Saude* 2015; 24(3):517-522.

29. Silva RCL, Silva CRL, Machado DA, Peregrino AAF, Marta CB, Pestana LC. Carga da infecção pelo SARS-CoV2 entre os profissionais de enfermagem no Brasil. *Rev Bras Enferm* 2021; 74(Supl. 1):e20200783.

30. Leite IC, Beltrão KI, Rodrigues RN, Valente JG, Campos MR, Schramm JMA. Projeção da Carga de Doença no Brasil (1998-2013). In: Buss PM, Temporão JG, Carvalheiro JR, organizadores. *Vacinas, soros e imunizações no Brasil*. Rio de Janeiro: Editora Fiocruz; 2005. p. 51-65.

31. Pifarré I, Arolas H, Acosta E, López-Casasnovas G, Lo A, Nicodemo C, Riffe T, Myrskylä M. Years of life lost to COVID-19 in 81 countries. *Sci Rep* 2021; 11(1):3504.

32. Bell D, Hansen KS, Kiragga AN, Kambugu A, Kissa J, Mbonye AK. Predicting the impact of COVID-19 and the potential impact of the public health response on disease burden in Uganda. *Am J Trop Med Hyg* 2020; 103(3):1191-1197.

33. John D, Narassima MS, Menon J, Rajesh JG, Banerjee A. Estimation of the economic burden of COVID-19 using (DALYs) and productivity losses in Kerala, India: a model-based analysis. *BMJ Open* 2021; 11(8):e049619.