

The Present Value of Human Life Losses Associated with Coronavirus Disease in Africa

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Abstract

The coronavirus disease (COVID-19) continues to ravage human lives, social systems, and economies around the world. The objective of this study was to estimate the total present value (TPV_{AFC}) of human life losses associated with COVID-19 in Africa continent as of 1 August 2020. A human capital approach model was used to estimate the TPV_{AFC} of the 19,682 human lives lost due to COVID-19 in Africa continent (excluding 44 deaths in Sahrawi Arab Democratic Republic and territories of Mayotte and Reunion). The average life expectancy for 54 countries with data and a 3% discount rate were used. A sensitivity analysis was conducted at 5% and 10% discount rates. The human lives lost due to COVID-19 had a TPV_{AFC} of Int\$1,721,030,766, and average TPV_{AFC} of Int\$87,442 per human life lost. About 81.3% of TPV_{AFC} accrued to persons below 60 years. The TPV_{AFC} of human life losses from COVID-19 will continue growing until the pandemic is eradicated.

Keywords

Coronavirus, COVID-19, Gross Domestic Product, Value of Human Life

1. Introduction

Africa continent has 55 countries (plus territories of Mayotte and Reunion), with an estimated total population of 1,340,598,113 persons (17.2% of the global population) in 2020 (Worldometer, 2020). The continent has an estimated gross domestic product (GDP) of Int\$7.6 trillion and a per capita GDP of Int\$5720 in 2020 (International Monetary Fund (IMF), 2020).

As of 1 August 2020, the world had a total of 17,757,496 confirmed coronavi-

rus disease (COVID-19) cases, among them 682,998 deaths, 11,160,054 recovered cases, and 5,914,444 active cases (Worldometer, 2020). By the same date, all countries and territories in Africa had reported a total of 931,777 confirmed cases, including 19,726 deaths, 583,665 recovered cases, and 328,386 active cases. In Africa, COVID-19 deaths varied widely from one in the Sahrawi Arab Democratic Republic to 8005 in South Africa (Worldometer, 2020).

Africa's capability of containing the spread of COVID-19 depends on the resilience of national health systems (NHS), disease surveillance and response systems (DSRS), and other systems that tackle social determinants of health (SDHS). The universal health coverage (UHC) service index (a proxy for NHS) for the WHO African Region (AFR) was 46 (on a scale of 0 to target of 100), and that of the WHO Eastern Mediterranean Region (EMR) was 57 in 2017, which implied the existence of gaps in essential health services coverage of 54 and 43, respectively (WHO and The World Bank, 2017). Among the Africa continent countries, the UHC index gap varied widely from 22 in Algeria to 75 in Somalia in 2019 (Kirigia, Rutere, Muthuri, & Kirigia, 2020).

The average of International Health Regulations [IHR] (a proxy for DSRS) core capacity scores for AFR was 44% and 66% for EMR in 2019, denoting IHR gaps of 56% and 34%, respectively (WHO, 2013, 2020a). The population using a hand-washing facility with soap and water (a proxy for the SDHS) in AFR was 28% and 66% in EMR in 2017, signifying gaps of 72% and 34%, respectively (WHO, 2020a). The population without basic hand-washing facilities in Africa varied from 10% in Egypt to 99% in Liberia in 2017 (Rutere, Muthuri, Kirigia, & Kirigia, 2020).

According to Rice (2000), "*cost of illness studies translates the adverse effects of diseases or injuries into dollar terms, the universal language of decision-makers and the policy arena*" (p. 178). Studies in Canada (Kirigia & Muthuri, 2020a), China (Kirigia & Muthuri, 2020b), Spain (Kirigia & Muthuri, 2020c), Turkey (Kirigia, Muthuri, & Nkanata, 2020), the United Kingdom [UK] (Kirigia & Muthuri, 2020d), and the United States of America [USA] (Kirigia & Muthuri, 2020e) assessed the monetary value of human life losses associated with COVID-19 for use in advocacy for increased investments in NHS, DSRS, and SDHS to combat current and future pandemics. There is a dearth of evidence on the total present value (TPV_{AFR}) of human lives lost due to COVID-19 in the continent. This study estimated the TPV_{AFR} of human life losses associated with COVID-19 in the Africa continent as of 1 August 2020.

2. Materials and Methods

2.1. Ethical Considerations

The study did not require ethical approval since it relied exclusively on secondary data from international databases that are in the public domain (Worldometer, 2020; International Monetary Fund (IMF), 2020; WHO, 2019, 2020b).

2.2. Study Location and Design

This study encompassed 54 countries of the Africa continent. The Sahrawi Arab Democratic Republic (Western Sahara) was excluded because data on GDP per capita and current health expenditure per capita was missing. It was a cross-sectional assessment of the monetary value of all the 19,682 human life losses associated with COVID-19 as of 1 August 2020 (Worldometer, 2020). Since the study involved the cumulative number of deaths up to 1 August 2020, sampling was not relevant.

2.3. Analytical Framework

Three approaches exist for monetary valuation of a statistical life, i.e. the human capital approach (HCA), the revealed preferences approach, and the willingness-to-pay approach (WTP) (Jones-Lee, 1985). The HCA was applied in the current study to value human life losses associated with COVID-19 in Africa due to the availability of relevant data.

The HCA employed in the current study owes its antecedents to the seminal work of Landefeld and Seskin (1982). Weisbrod (1961) and WHO (2009a) clarified that human life is to be valued using discounted future earnings net of the individual's consumption. Any premature death from COVID-19 (or any other cause) results in potential years of life lost (YLL), which are equal to the average life expectancy at birth for a specific country minus the age of onset of death (Kirigia & Muthuri, 2020a, 2020b, 2020c, 2020d, 2020e; Kirigia, Muthuri, & Nkanata, 2020). In line with Weisbrod (1961) and WHO (2009a), the net per capita GDP (i.e., specific country's per capita GDP minus current health expenditure per person) is used in monetary valuation of YLL.

The economic model used in the current study was that applied to estimate discounted monetary value human life losses associated with COVID-19 in Canada (Kirigia & Muthuri, 2020a), China (Kirigia & Muthuri, 2020b), Spain (Kirigia & Muthuri, 2020c), Turkey (Kirigia, Muthuri, & Nkanata, 2020), the UK (Kirigia & Muthuri, 2020d), and the USA (Kirigia & Muthuri, 2020e).

The TPV_{AFC} is the sum of present value of human lives lost from COVID-19 as of 1st August 2020 in each of the 54 countries ($CPV_{j=1,\dots,55}$). That is:

$$TPV_{AFC} = CPV_1 + CPV_2 + CPV_3 + \dots + CPV_j \quad (1)$$

The present value of human lives lost through COVID-19 in the j^{th} country ($CPV_{j=1,\dots,55}$) is the sum of the discounted present value of lives lost among the 0 - 9-year-olds (PV_{0-9}), 10 - 19-year-olds (PV_{10-19}), 20 - 29-year-olds (PV_{20-29}), 30 - 39-year-olds (PV_{30-39}), 40 - 49-year-olds (PV_{40-49}), 50 - 59-year-olds (PV_{50-59}), 60 - 69-year-olds (PV_{60-69}), and the 70-year-olds and above ($PV_{\geq 70}$) (Kirigia & Muthuri, 2020a, 2020b, 2020c, 2020d, 2020e; Kirigia, Muthuri, & Nkanata, 2020). Formally:

$$CPV_j = \sum_{i=1}^I PV_i \quad (2)$$

The t^{th} age group present value (PV) equals a product of discount factor, YLL, net per capita GDP (NPCGDP), and COVID-19 deaths for age group (Kirigia & Muthuri, 2020a, 2020b, 2020c, 2020d, 2020e; Kirigia, Muthuri, & Nkanata, 2020). That is:

$$PV_{i=1,\dots,9} = \sum_{t=1}^T A_1 \times (A_2 - A_3) \times (A_4 - A_5) \times (A_6 \times A_7) \tag{3}$$

where: A_1 is the discount factor obtained using the formula $1/(1+r)^t$, r is the discount rate, which was 3% in the current study (Kirigia & Muthuri, 2020a, 2020b, 2020c, 2020d, 2020e; Kirigia, Muthuri, & Nkanata, 2020); $\sum_{t=1}^{t=n}$ is the summation from year $t = 1$ to T ; t is the first YLL and T is the final year of the total number of YLL per COVID-19 human life lost within an age group; A_2 is the per capita GDP for a specific country in International Dollars (Int) or Purchasing Power Parity (PPP); A_3 is the current health expenditure per person for a specific country; A_4 is the average life expectancy at birth for a specific country; A_5 is the average age of onset of death for each age group; A_6 is the total number of human lives lost from COVID-19 in a specific country; A_7 is the proportion of COVID-19 human lives lost borne by a specific age group. The base year for the analysis was 2020. Equations 1, 2 and 3 were estimated using the Excel Software (Microsoft, New York, USA).

2.4. Sensitivity Analysis

The economic model was reanalyzed three times assuming 1) 5% and 10% discount rates (Kirigia & Muthuri, 2020a, 2020b, 2020c, 2020d, 2020e; Kirigia, Muthuri, & Nkanata, 2020); and 2) the world’s highest life expectancy of 87.17 years in 2020 (i.e., Hong Kong’s average female life expectancy at birth) to gauge the impact on TPV_{AFC} (Worldometer, 2020). After each rerun of the economic model, the change was calculated by subtracting the original TPV estimate (TPV_{OLD}) from the new TPV estimate (TPV_{NEW}). The percentage change equals the change in TPV divided by the original TPV_{OLD} estimate, multiplied by 100. Algebraically:

$$\text{Percentage change} = \frac{(TPV_{\text{NEW}} - TPV_{\text{OLD}})}{|TPV_{\text{OLD}}|} \times 100$$

For example, in this study, $TPV_{\text{OLD}} = \text{Int}\$1,721,030,766$; and following a reanalysis of the HCA model with the world highest life expectancy the $TPV_{\text{NEW}} = \text{Int}\$4,064,146,193$. Thus:

$$\text{Percentage change} = \frac{(4064146193 - 1721030766)}{|1721030766|} \times 100 = 136.1\%$$

2.5. Data and Data Sources

The analysis included 54 countries in the African continent (see **Table S1** for the names). The Sahrawi Arab Democratic Republic (Western Sahara) and the territories of Mayotte and Reunion (which had a total of 44 COVID-19 deaths)

were excluded because of missing data on per capita GDP (International Monetary Fund (IMF), 2020) and current health expenditure per person (WHO, 2020b). The discount rates of 3%, 5%, and 10% were from recent studies that estimate the monetary value of human life losses associated with COVID-19 (Kirigia & Muthuri, 2020a, 2020b, 2020c, 2020d, 2020e; Kirigia, Muthuri, & Nkanata, 2020).

The average life expectancies at birth for each of the 54 countries and the world's highest life expectancy of 88.17 years in 2020 were from the Worldometer database (see Table S2) (Worldometer, 2020). The ages of onset of death were 4.5 years for group 0 - 9 years, i.e. $(0 + 9)/2$; 14.5 years for group 10 - 19 years; 24.5 years for group 20 - 29 years; 34.5 years for group 30 - 39 years; 44.5 years for group 40 - 49 years; 54.5 years for group 50 - 59 years; 64.5 years for group 60 - 69 years; and 70 years for group 70 years and above.

The data on per capita GDP expressed in International Dollars (Int\$) (or Purchasing Power Parity) in 2020 for each of the 54 countries were from IMF World Economic Outlook Database (see Table S3) (International Monetary Fund (IMF), 2020). The 2017 (latest available) data on current health expenditures per person for each of the 54 countries were collated from the WHO Global Health Expenditure Database (see Table S4) (WHO, 2020b). The estimated NPCGDP data is in Table S5.

Data on the total number of COVID-19 deaths as of 1 August 2020 for each of the 54 countries were from the Worldometer database (see Table S6) (Worldometer, 2020). The proportions used to share the number of COVID-19 deaths in each country across the eight age groups was calculated using 2020 data from Statista database (see Table S7) (WHO, 2019). The estimated YLL by age group per country are in Table S8.

3. Results

3.1. Findings Assuming Each Country's Life Expectancy at Birth and a 3% Discount Rate

Table 1 presents the discounted value of human lives lost from COVID-19 in continental Africa by 1 August 2020.

The 19,682 human lives lost (equal to 198,575 YLL) due to COVID-19 in Africa had TPV_{AFC} of Int\$1,721,030,766. Out of which, approximately 0.6% accrued to 0 - 9-year-olds, 0.9% to 10 - 19-year-olds, 4.1% to 20 - 29-year-olds, 15.8% to 30 - 39-year-olds, 26.5% to 40 - 49-year-olds, 33.4% to 50 - 59-year-olds, 12.9% to 60 - 69-year-olds, and 5.8% to the 70-year-olds and above. The average was Int\$87,442 per human life lost due to COVID-19; and Int\$1.29 per person in the population.

As shown in Figure 1, the CPV of human lives lost varied widely from Int\$0 in Eritrea and Seychelles (where there were no reported COVID-19 deaths) to Int\$697,921,220 in Egypt.

Twenty-eight (52%) countries had CPV of less than Int\$1 million, 20 (37%)

countries had between Int\$1 million and Int\$10 million, and six (11%) countries had Int\$11 million and above. Three countries (Algeria, Egypt, and South Africa) accounted for 90% of the TPV_{AFC} of human lives lost in the continent.

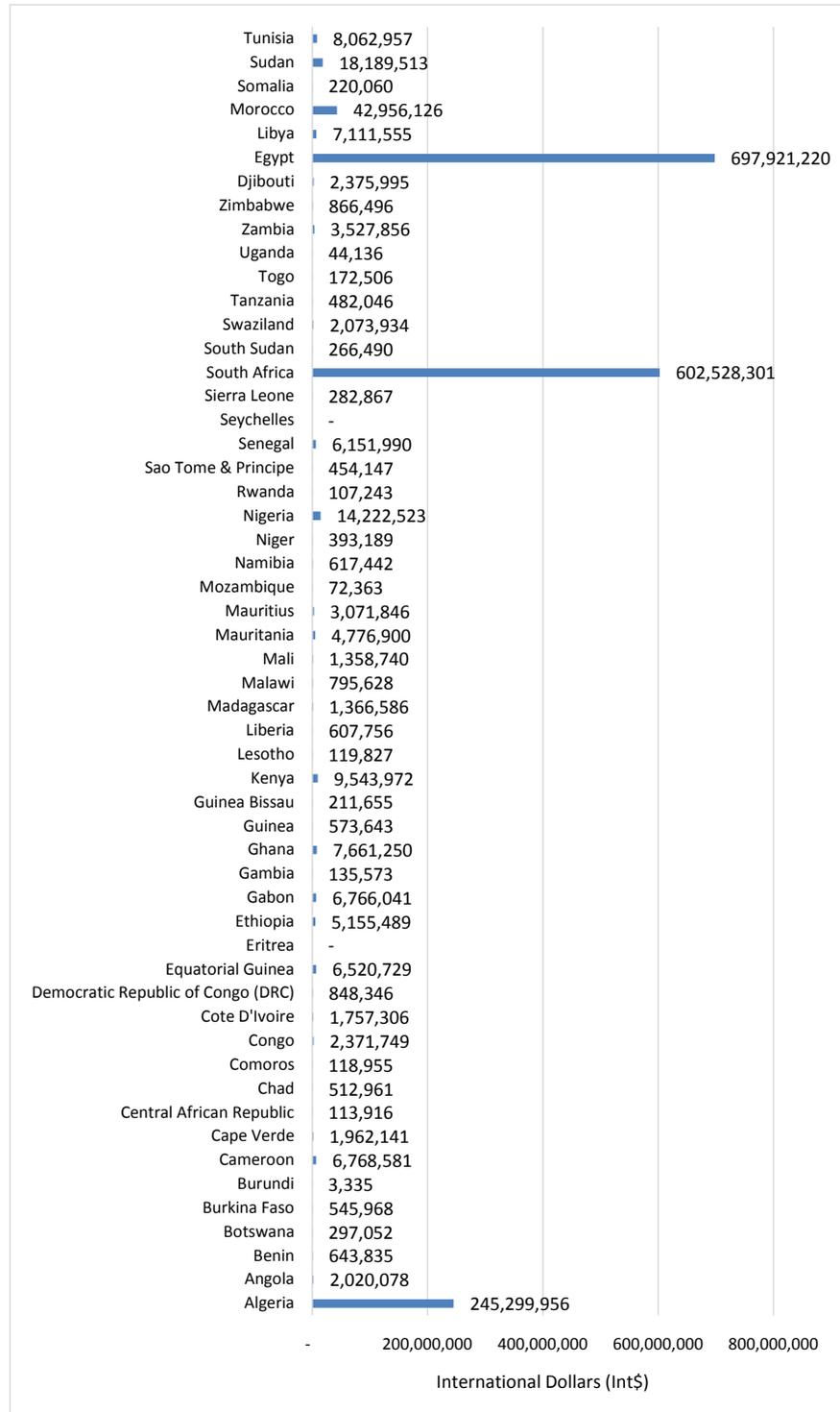


Figure 1. Present value of human life losses associated with COVID-19 in Africa by 1 August 2020 (in International Dollars).

Table 1. The present value of human life losses from COVID-19 in Africa as of 1 August 2020 (in 2020, Int\$ or PPP).

Country	Population in 2020* [A]	COVID-19 deaths as of 1 August 2020* [B]	Total present value of human life lost (Int\$) [C]**	Present value per human life lost (Int\$) [D = C/B]**	Present value of human life lost per person in population (Int\$) [E = C/A]**
Algeria	43,851,043	1210	245,299,956	202,727	5.59
Angola	32,866,268	52	2,020,078	38,848	0.06
Benin	12,123,198	36	643,835	17,884	0.05
Botswana	2,351,625	2	297,052	148,526	0.13
Burkina Faso	20,903,278	53	545,968	10,301	0.03
Burundi	11,890,781	1	3335	3335	0.00
Cameroon	26,545,864	391	6,768,581	17,311	0.25
Cape Verde	555,988	23	1,962,141	85,310	3.53
Central African Republic	4,829,764	59	113,916	1931	0.02
Chad	16,425,859	75	512,961	6839	0.03
Comoros	869,595	7	118,955	16,994	0.14
Congo	5,518,092	54	2,371,749	43,921	0.43
Cote d'Ivoire	26,378,275	102	1,757,306	17,228	0.07
Democratic Republic of Congo (DRC)	89,561,404	215	848,346	3946	0.01
Equatorial Guinea	1,402,985	83	6,520,729	78,563	4.65
Eritrea	3,546,427	0	0	0	0
Ethiopia	114,963,583	274	5,155,489	18,816	0.04
Gabon	2,225,728	49	6,766,041	138,082	3.04
Gambia, The	2,416,664	9	135,573	15,064	0.06
Ghana	31,072,945	182	7,661,250	42,095	0.25
Guinea	13,132,792	46	573,643	12,471	0.04
Guinea-Bissau	1,967,998	26	211,655	8141	0.11
Kenya	53,771,300	341	9,543,972	27,988	0.18
Lesotho	2,142,252	13	119,827	9217	0.06
Liberia	5,057,677	75	607,756	8103	0.12
Madagascar	27,691,019	106	1,366,586	12,892	0.05
Malawi	19,129,955	114	795,628	6979	0.04
Mali	20,250,834	124	1,358,740	10,958	0.07
Mauritania	4,649,660	157	4,776,900	30,426	1.03
Mauritius	1,271,767	10	3,071,846	307,185	2.42
Mozambique	31,255,435	11	72,363	6578	0.00
Namibia	2,540,916	10	617,442	61,744	0.24
Niger	24,206,636	69	393,189	5698	0.02

Continued

Nigeria	206,139,587	879	14,222,523	16,180	0.07
Rwanda	12,952,209	5	107,243	21,449	0.01
Sao Tome and Principe	219,161	15	454,147	30,276	2.07
Senegal	16,743,930	205	6,151,990	30,010	0.37
Ghana	31,072,945	182	7,661,250	42,095	0.25
Seychelles	98,340	0	0	0	0
Sierra Leone	7,976,985	67	282,867	4222	0.04
South Africa	59,308,690	8005	602,528,301	75,269	10.16
South Sudan	11,193,729	46	266,490	5793	0.02
Swaziland (Eswatini)	1,160,164	41	2,073,934	50,584	1.79
Tanzania	59,734,213	21	482,046	22,955	0.01
Togo	8,278,737	19	172,506	9079	0.02
Uganda	45,741,000	3	44,136	14,712	0.00
Zambia	18,383,956	151	3,527,856	23,363	0.19
Zimbabwe	14,862,927	67	866,496	12,933	0.06
Djibouti	988,002	58	2,375,995	40,965	2.40
Egypt	102,334,403	4805	697,921,220	145,249	6.82
Libya	6,871,287	74	7,111,555	96,102	1.03
Morocco	36,910,558	353	42,956,126	121,689	1.16
Somalia	15,893,219	93	220,060	2366	0.01
Sudan	43,849,269	746	18,189,513	24,383	0.41
Tunisia	11,818,618	50	8,062,957	161,259	0.68
TOTAL	1,338,826,591	19,682	1,721,030,766	87,442	1.29

Source: *Worldometer (2020). **Authors estimates.

3.2. Findings Assuming Each Country's Life Expectancy and 5% and 10% Discount Rates

Alternate reanalysis of the economic model (in subsection 2.3) using 5% and 10% discount rates reduced the TPV_{AFC} by Int\$273,841,437 (15.9%) and Int\$695,688,478 (40.4%), respectively. In turn, the average present value per human life diminished by Int\$13,913.3 and Int\$35,346.

3.3. Findings Assuming World Highest Life Expectancy and 3% Discount Rate

Re-calculation of the economic model (in subsection 2.3) substituting individual country's national life expectancy with the world highest life expectancy of 88.17 years increased the TPV_{AFC} by Int\$2,343,115,427 (136.1%) and the present value per human life by Int\$119,049.

4. Discussion

4.1. Key Findings

Our study succeeded in estimating the TPV_{AFC} of human lives lost due to COVID-19 in the Continent as of 1 August 2020. The TPV_{AFC} of Int\$1,721,030,766 was equivalent to 0.023% of the total GDP of the African Continent. The present value of Int\$87,442 per human life loss associated with COVID-19 was 15-fold Africa's GDP per capita in 2020.

4.2. Comparison with Similar Studies

The present value per human life lost from COVID-19 in Africa was lower than Canada's Int\$231,217 per death (Kirigia & Muthuri, 2020a), China's Int\$356,203 per death (Kirigia & Muthuri, 2020b), Spain's Int\$470,798 per death (Kirigia & Muthuri, 2020c), Turkey's Int\$228,514 per death (Kirigia, Muthuri, & Nkanata, 2020), the UK's Int\$225,104 per death (Kirigia & Muthuri, 2020d), and the USA's Int\$292,889 per death (Kirigia & Muthuri, 2020e). The lower present value per human life lost in Africa may be due to both lower GDP per capita, and lower life expectancy at birth (leading to a smaller number of YLL) (Kirigia & Muthuri, 2020a, 2020b, 2020c, 2020d, 2020e).

4.3. Research Innovation

To the best of our knowledge, this was the first study to have estimated the present value of human life losses associated with coronavirus disease in Africa. As explained in the WHO guide to identifying the economic consequences of disease and injury (WHO, 2009a), the evidence contained in this article can be used by the ministries of health in African countries to advocate for increased investments into health-related sectors to bridge existing gaps in the coverage of essential health services, IHR core capacities, and water and sanitation services.

4.4. Study Limitations

First, the completeness of cause-of-death data in the AFR was 6% and 32% in EMR, implying cause-of-death for 94% and 68% of deaths, respectively, is not recorded (WHO, 2019). The relatively low completeness of cause-of-death during the ordinary non-pandemic period implies that the notified COVID-19 cases and deaths could be a gross underestimate for many African countries. The under-reporting is exacerbated by the low level of COVID-19 testing in Africa (Worldometer, 2020).

Second, the cost of societal resources used in the prevention, diagnosis, contact tracing, isolation/quarantine, hospital management of COVID-19 cases; and funerals for the dead was omitted (Kirigia & Muthuri, 2020a, 2020b, 2020c, 2020d, 2020e; Kirigia, Muthuri, & Nkanata, 2020). Third, the macroeconomic effects of COVID-19 on education, financial services, trade, tourism, travel, and manufacturing sectors were omitted (Kirigia, Muthuri, & Nkanata, 2020).

Fourth, according to Jones-Lee (1985) the HCA when strictly applied, it would value YLL among retirees and homemakers at zero. Jones-Lee (1985) advocates for elicitation of WTP for small changes in probability death (e.g. from COVID-19) because the approach “... is firmly rooted in the principles of *ex-ante* Paretian welfare economics and the related precepts of conventional social cost-benefit analysis (p. 143)”.

4.5. Future Research Directions

First, the quality of economic evaluation studies hinges on the quality of underlying epidemiological evidence. Thus, there is need for quality epidemiological studies on morbidity and mortality due to pandemics; effectiveness of existing and potential preventive, diagnostic, management, and rehabilitative interventions from randomized controlled effectiveness trials; effectiveness of alternative ways of delivering interventions; and human behaviour in intervention uptake and adherence to recommended procedures.

Second, once the pandemic is eradicated, there will be a need for comprehensive studies into the macroeconomic effects of COVID-19 on education, financial services, trade, tourism, travel, manufacturing, and other sectors. Such evidence could be used in advocating for coordinated and managed inter-sectoral action for implementation of health-in-all policies to leapfrog equitable health development, mitigate, and better combat future public health emergencies (WHO, 2009b, 2010, 2012a, 2012b).

Third, the health policy development and decision-making processes require evidence on both costs and consequences (or benefits) of preventive, management, and rehabilitative interventions for COVID-19 (Drummond, Sculpher, Torrance, O'Brien, & Stoddard, 2007; Kirigia, 2009; Cookson, Griffin, Norheim, & Culyer, 2020). For comparative purposes, future studies should consider applying the WTP approach to value human life losses associated with COVID-19, which would facilitate comparison with those obtained in the current study using the HCA.

5. Conclusion

The estimated TPV_{AFC} of human lives lost due to COVID-19 in Africa is likely to be an underestimate due to abovementioned limitations. COVID-19 is a burden on the NHS, the DSRS, the SDHS, and the economies of African countries. The TPV_{AFC} will continue growing until the pandemic is eradicated. The TPV_{AFC} evidence, in conjunction with human rights arguments (rights to life, health, medical care, clothing, food, housing, and social security) (United Nations (UN), 1948), can be used in advocacy for increased domestic and external investments to bridge existing gaps in NHS, DSRS, and SDHS. Since our study was of limited scope, assessments of the economy-wide impact of COVID-19; and costs and consequences of preventive, treatment, and rehabilitative interventions are needed to guide policy (Kirigia & Muthuri, 2020a, 2020b, 2020c, 2020d, 2020e;

Kirigia, Muthuri, & Nkanata, 2020).

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Authors' Contributions

JMK, RNDKM, LHKN, and NGM designed the study; reviewed the literature; extracted data from the international databases; analyzed and interpreted findings; and drafted the manuscript together. All the authors approved the version of the manuscript submitted.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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Supplement

Table S1. Names of countries and territories in the Africa continent.

Country and Territories Names
Algeria
Angola
Benin
Botswana
Burkina Faso
Burundi
Cameroon
Cabo Verde
Central African Republic
Chad
Comoros
Congo
Côte d'Ivoire
Democratic Republic of the Congo
Equatorial Guinea
Eritrea
Ethiopia
Gabon
Gambia
Ghana
Guinea
Guinea-Bissau
Kenya
Lesotho
Liberia
Madagascar
Malawi
Mali
Mauritania
Mauritius
Mozambique
Namibia
Niger
Nigeria
Rwanda

Continued

Sao Tome and Principe
Senegal
Seychelles
Sierra Leone
South Africa
Swaziland (Eswatini)
Togo
Uganda
United Republic of Tanzania
Zambia
Zimbabwe
South Sudan
Djibouti
Egypt
Libya
Morocco
Somalia
Sudan
Tunisia
Sahrawi Arab Democratic Republic (Western Sahara)
Territories
Reunion
Mayotte

Source: Worldometer (2020).

Table S2. Africa continent countries average life expectancies at birth in 2020.

Country	Average life expectancy in 2020
Algeria	77.5
Angola	62.2
Benin	62.8
Botswana	69.9
Burkina Faso	63
Burundi	62.7
Cameroon	60.3
Cape Verde	73.6
Central African Republic	54.4

Continued

Chad	55.2
Comoros	65
Congo	65.2
Côte d'Ivoire	58.8
Dem. Rep. of the Congo	61.6
Equatorial Guinea	59.8
Eritrea	67.5
Ethiopia	67.8
Gabon	67
Gambia	63.3
Ghana	64.9
Guinea	62.6
Guinea-Bissau	59.4
Kenya	67.5
Lesotho	55.7
Liberia	65
Madagascar	68.2
Malawi	65.6
Mali	60.5
Mauritania	65.6
Mauritius	75.5
Mozambique	62.1
Namibia	64.9
Niger	63.6
Nigeria	55.8
Rwanda	70
Sao Tome and Principe	71
Senegal	68.9
Seychelles	73.7
Sierra Leone	55.9
South Africa	64.9
Swaziland	61.1
Togo	62.1
Uganda	64.4
United Republic of Tanzania	66.4
Zambia	64.7
Zimbabwe	62.2

Continued

South Sudan	58.7
Djibouti	67.9
Egypt	72.5
Libya	73.4
Morocco	77.4
Somalia	58.3
Sudan	66.0
Tunisia	77.4
Sahrawi Arab Democratic Republic (Western Sahara)	71.1
Territories	
Reunion	82
Mayotte	80

Source: *Worldometer (2020)*.

Table S3. Africa countries per capita gross domestic product (2020, Int\$ or PPP).

Country	Per capita gross domestic product (Int\$)
Algeria	16,091
Angola	6763
Benin	3648
Botswana	19,388
Burkina Faso	2181
Burundi	724
Cameroon	4099
Cape Verde	8176
Central African Republic	864
Chad	2603
Comoros	2898
Democratic Republic of the Congo	873
Congo	7336
Côte d'Ivoire	4754
Equatorial Guinea	19,961
Eritrea	1103
Ethiopia	2702
Gabon	19,839
Gambia	2892
Ghana	7343

Continued

Guinea	2574
Guinea-Bissau	2113
Kenya	4078
Lesotho	3655
Liberia	1428
Madagascar	1776
Malawi	1292
Mali	2569
Mauritania	5158
Mauritius	26,461
Mozambique	1372
Namibia	11,451
Niger	1152
Nigeria	6172
Rwanda	2642
São Tomé and Príncipe	3499
Senegal	4079
Seychelles	33,118
Sierra Leone	1765
South Africa	13,965
Swaziland	11,319
Tanzania	3562
Togo	1913
Uganda	2753
Zambia	4174
Zimbabwe	2778
South Sudan	1715
Djibouti	5855
Egypt	14,800
Libya	9446
Morocco	9667
Somalia	904
Sudan	3986
Tunisia	13,093

Source: *International Monetary Fund (IMF) (2020)*. Note: Int\$: International Dollars (Int\$). PPP: Purchasing-power-parity.

Table S4. Africa countries current health expenditure per capita.

Country	Current health expenditure per person (Int\$)
Algeria	975
Angola	186
Benin	85
Botswana	1044
Burkina Faso	129
Burundi	59
Cameroon	174
Cabo Verde	357
Central African Republic	42
Chad	87
Comoros	123
Democratic Republic of the Congo	37
Congo	165
Cote d'Ivoire	176
Equatorial Guinea	759
Eritrea	59
Ethiopia	67
Gabon	500
Gambia	56
Ghana	147
Guinea	89
Guinea-Bissau	123
Kenya	158
Lesotho	266
Liberia	105
Madagascar	85
Malawi	115
Mali	84
Mauritania	170
Mauritius	1278
Mozambique	62
Namibia	895
Niger	79
Nigeria	221
Rwanda	134
Sao Tome and Principe	134

Continued

Senegal	143
Seychelles	1485
Sierra Leone	205
South Africa	1098
Swaziland	600
Tanzania	104
Togo	104
Uganda	123
Zambia	180
Zimbabwe	201
South Sudan	176
Djibouti	117
Egypt	614
Libya	429
Morocco	438
Somalia	275
Sudan	314
Tunisia	863

Source: WHO (2020b).

Table S5. Africa countries net gross domestic product per capita in 2020.

Countries	Net GDP per capita (Int\$)
Algeria	15,116
Angola	6577
Benin	3563
Botswana	18,343
Burkina Faso	2052
Burundi	664
Cameroon	3926
Cabo Verde	7819
Central African Republic	822
Chad	2515
Comoros	2775
Congo	7172
Côte d'Ivoire	4578
Democratic Republic of the Congo	836
Equatorial Guinea	19,202
Eritrea	1043

Continued

Ethiopia	2635
Gabon	19,340
Gambia	2836
Ghana	7196
Guinea	2485
Guinea-Bissau	1990
Kenya	3920
Lesotho	3390
Liberia	1323
Madagascar	1691
Malawi	1178
Mali	2485
Mauritania	4988
Mauritius	25,183
Mozambique	1311
Namibia	10,555
Niger	1073
Nigeria	5951
Rwanda	2507
Sao Tome and Principe	3364
Senegal	3935
Seychelles	31,633
Sierra Leone	1560
South Africa	12,867
South Sudan	1539
Swaziland	10,719
Togo	1809
Uganda	2630
Tanzania	3457
Zambia	3994
Zimbabwe	2577
Djibouti	5738
Egypt	14,187
Libya	9017
Morocco	9229
Somalia	629
Sudan	3672
Tunisia	12,229

Source: Authors estimates using data from *International Monetary Fund (IMF) (2020)* and *WHO (2020b)*.
 Note: Net GDP per capita equals GDP per capita minus current health expenditure per person.

Table S6. Africa countries coronavirus disease deaths as of 1 August 2020.

Countries	COVID19 Deaths in 2020: 1 August 2020
Algeria	1210
Angola	52
Benin	36
Botswana	2
Burkina Faso	53
Burundi	1
Cameroon	391
Cabo Verde	23
CAR	59
Chad	75
Comoros	7
Congo	54
Cote d'Ivoire	102
Democratic Republic of Congo (DRC)	215
Djibouti	58
Egypt	4805
Equatorial Guinea	83
Eritrea	0
Ethiopia	274
Gabon	49
Gambia	9
Ghana	182
Guinea	46
Guinea-Bissau	26
Kenya	341
Lesotho	13
Liberia	75
Libya	74
Madagascar	106
Malawi	114
Mali	124
Mauritania	157
Mauritius	10
Morocco	353
Mozambique	11
Namibia	10

Continued

Niger	69
Nigeria	879
Rwanda	5
STP	15
Senegal	205
Seychelles	0
Sierra Leone	67
Somalia	93
South Africa	8005
South Sudan	46
Sudan	746
Swaziland/Eswatini	41
Togo	19
Tunisia	50
Uganda	3
Tanzania	21
Zambia	151
Zimbabwe	67
Reunion	4
Mayotte	39
Western Sahara	1
TOTAL	19726

Source: *Worldometer (2020)*.

Table S7. Proportions used to share COVID-19 deaths across eight age groups.

Age brackets	(A) COVID-19 deaths in South Africa as of as of 22 June 2020	(C). Proportion [C = A/B]
0 - 9	3	0.001563314
10 - 19	5	0.002605524
20 - 29	26	0.013548723
30 - 39	116	0.06044815
40 - 49	244	0.127149557
50 - 59	471	0.245440334
60 - 69	506	0.263678999
70 & above	548	0.285565399
(B) TOTAL	1919	

Source: *Statista (2020)*. Note: The 11 deaths whose age was unknown were not included in calculations of the proportions.

Table S8. Africa continent countries years of life lost from COVID-19 by 1st August 2020.

Countries	Years of life lost per age group								TOTAL
	0 - 9	10 - 19	20 - 29	30 - 39	40 - 49	50 - 59	60 - 69	70+	
Algeria	138	199	869	3145	5077	6831	4148	2592	22,998
Angola	5	6	27	87	117	99	-	-	341
Benin	3	5	19	62	84	74	-	-	246
Botswana	0	0	1	4	6	8	3	-	23
Burkina Faso	5	7	28	91	125	110	-	-	365
Burundi	0	0	1	2	2	2	-	-	7
Cameroon	34	47	190	610	786	559	-	-	2226
Cape Verde	2	4	15	54	85	108	55	24	347
Central African Republic	5	6	24	71	74	-	-	-	179
Chad	6	8	31	94	102	12	-	-	253
Comoros	1	1	4	13	18	18	1	-	56
Congo	5	7	30	100	142	142	10	-	437
Cote D'Ivoire	9	12	47	150	185	106	-	-	508
DRC	19	26	108	352	467	375	-	-	1348
Equatorial Guinea	7	10	40	127	162	108	-	-	454
Eritrea	-	-	-	-	-	-	-	-	-
Ethiopia	27	38	161	552	812	895	239	-	2724
Gabon	5	7	28	96	140	151	33	-	460
Gambia	1	1	5	16	21	19	-	-	63
Ghana	17	24	100	335	473	466	21	-	1436
Guinea	4	6	24	78	106	92	-	-	310
Guinea Bissau	2	3	12	39	49	31	-	-	137
Kenya	34	47	199	680	996	1086	267	-	3307
Lesotho	1	1	5	17	18	4	-	-	47
Liberia	7	10	41	138	195	193	10	-	595
Madagascar	11	15	63	216	320	357	104	-	1084
Malawi	11	15	64	214	306	311	34	-	955
Mali	11	15	61	195	253	184	-	-	718
Mauritania	15	21	87	295	421	427	44	-	1310
Mauritius	1	2	7	25	39	52	29	16	170
Mozambique	1	1	6	18	25	21	-	-	72
Namibia	1	1	5	18	26	25	1	-	78
Niger	6	9	37	121	168	154	-	-	495

Continued

Nigeria	70	94	372	1129	1257	270	-	-	3193
Rwanda	1	1	3	11	16	19	7	-	58
STP	2	2	9	33	51	61	26	4	188
Senegal	21	29	123	426	635	723	236	-	2193
Seychelles	-	-	-	-	-	-	-	-	-
Sierra Leone	5	7	29	87	97	23	-	-	249
South Africa	756	1051	4380	14,701	20,743	20,394	802	-	62,826
South Sudan	4	5	21	67	83	48	-	-	229
Swaziland	4	5	20	66	86	66	-	-	247
Tanzania	2	3	12	40	58	61	10	-	187
Togo	2	2	10	32	43	36	-	-	124
Uganda	0	0	2	5	8	7	-	-	23
Zambia	14	20	82	276	388	378	8	-	1166
Zimbabwe	6	8	34	112	150	126	-	-	437
Djibouti	6	8	34	117	172	190	52	-	579
Egypt	511	727	3127	11,049	17,131	21,275	10,186	3485	67,492
Libya	8	11	49	174	272	344	174	73	1106
Morocco	40	58	253	916	1478	1987	1204	749	6684
Somalia	8	11	43	134	164	88	-	-	446
Sudan	72	100	420	1421	2040	2107	297	-	6457
Tunisia	6	8	36	130	209	281	170	105	943
TOTAL	1930	2704	11,395	38,941	56,885	61,502	18,170	7047	198,575
Percent	1.0	1.4	5.7	19.6	28.6	31.0	9.2	3.5	100.0

Source: Author estimates. Note: Years of life lost (YLL) in an age group equals national life expectancy minus average age at onset of death from COVID-19 in an age group.