IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 19, Issue 11 Ser.8 (November. 2020), PP 56-65
www.iosrjournals.org

Valuation of human life losses associated with COVID-19 in Germany: A human capital approach

JosesMuthuriKiriga[1], Rose Nabi Deborah Karimi[2]
[1](*African Sustainable Development Research Consortium, Kenya)*
[2](*Faculty of Health Sciences, University of Pretoria, South Africa)*

Abstract:
Background*:The specific aim of this study was to estimate the total discounted value of human life losses associated with COVID-19 in Germany as of 8 November 2020 (*$TVHL_{GERMANY}$ *).*
Materials and Methods*: The human capital approach (HKA) model was applied in calculating the total value of the 11,435 human lives losses associated with COVID-19 in Germany as of 8 November 2020. The model was rerun five times. First, using a discount rate of 3% and the German mean life expectancy of 81.88 years. Second, using a discount rate of 5% instead of 3%, while holding Germany's mean life expectancy constant. Third, employing a discount rate of 10%, while holding Germany's mean life expectancy constant. Fourth, applying the global mean life expectancy of 73.2 years, while holding the discount rate constant at 3%. Fifth, utilizing the world's highest mean life expectancy of 88.17 years, while holding the discount rate constant at 3%.*
Results*: The human lives lost to COVID-19 had a total discounted monetary value of International Dollars (Int$)1,916,725,559 and amean of Int$167,619 per human life lost. The application of discount rates of 5% and 10% diminished the*$TVHL_{GERMANY}$ *byInt$262,270,279 (13.7%) and Int$691,050,968 (36.1 %), respectively. Use of the world highest mean life expectancy boosted the* $TVHL_{GERMANY}$ *by Int$1,727,165,543 (90.1 %).*
Conclusion:*The estimated monetary value per human life loss associated with COVID-19 of Int$167,619 was three-fold the GDP per capita for Germany. Thus, COVID-19 has a significantly negative effect on both the health and wealth of Germany.*
Key Word*:Coronavirus Disease; COVID-19; Gross Domestic Product; Value of Human Life*

Date of Submission: 08-11-2020 Date of Acceptance: 21-11-2020

I. INTRODUCTION

Germany had a population of 83.9 million people [1], a total gross domestic product (GDP) of International Dollars (Int$) 4,454.498 billion, and a GDP per person of Int$53,571.191 in 2020 [2]. The country has the largest economy in Europe; and the third among the G7 countries, i.e. after the USA and Japan. Germany had a very high inequality-adjusted human development index of 0.861in 2018, and a Gini Coefficient of 31.7 in 2017 [3]. The readers will recall that the Gini coefficient varies from 0 (where national income is equally distributed among all persons in a population) to 100 (where the entire national income belongs to one person). About 22% of the population are at a relative risk of poverty [4]. These positive economic indicators are at the risk of being eroded by the ongoing coronavirus disease (COVID-19) pandemic. For instance, according to Nicola *et al.*[5]review, COVID-19 has adversely impacted on the primary sectors (agriculture and petroleum), secondary sectors (manufacturing industries), and tertiary sectors (education; finance food; health care; sports industry; hospitality, tourism and aviation; information technology, media, and research and development; and real estate and housing).Also, according to the IMF [6], the Germany economy (real GDP) is projected to contract by 7.0% in 2020due to the COVID-19 pandemic.

By 8 November 2020, globally, there were 50,278,656 COVID-19 cases, including 35,556,537 recovered cases, 13,465,561 active cases, and 1,256,558 deaths [1]. As of that date, Germany had conducted cumulatively 23,393,311 tests, revealing a total of 658,481 COVID-19 cases, which included 412,000 (62.6%) recovered cases, 235,046 active cases (35.7%), and 11,435 deaths (1.7%) [1]. The densities in Germany were 278,893 COVID-19 total tests per million population, 7,850 cases per million population, and 136 deaths per million population. About 86.5% of the deaths occurred among persons aged 70 years and above. Around 55.53% and 44.47% of the dead were male and female, respectively [7].

Despite having the largest population in Europe, Germany has had a relatively low number of COVID-19 deaths, probably, due to four factors. First, in 2019, Germany had an average of 13 International Health Regulations (IHR) capacities score of 88 (on a scale of 0 to the target of 100), which was higher than the WHO European Region (WER)average IHR score of 75 (Figure 1)[8].

Table 1: International Health Regulations (IHR) core capacity scores for Germany compared to the averages for the WHO European Region (WER)		
IHR capacity	**Germany in 2019**	**WER in 2019**
Legislation and financing	100	70
Coordination and IHR national focal point functions	100	78
Laboratory	100	73
Surveillance	100	74
Human resources	80	71
National health emergency framework	100	70
Health service provision	100	73
Risk communication	60	66
Points of entry	60	59
Chemical events	80	69
Radiation emergencies	100	77
Food safety	80	77
Zoonotic events and the human-animal interface	100	80
Average of 13 IHR core capacity scores	**88**	**75**

Source: WHO [8].

Before the COVID-19 pandemic, as depicted in Figure 1, Germany's IHR legislation and financing, coordination and national focal point functions, laboratory, surveillance, national health emergency framework, health service provision, radiation emergencies, and zoonotic events and the human-animal interface capacities were optimal, i.e. had a target score of 100. Only IHR human resources, chemical events, food safety, risk communication, and point of entry capacities had gaps of 20%, 20%, 20%, 40%, and 40%, respectively [8]. Twelve IHR core capacities scores for Germany were higher than those of the WER. Only score of risk communication in Germany was 10% lower than an average of 66 in the WER. Therefore, it is not surprising that the German integrated national disease surveillance and response system performed better than other European countries in containing the transmission of the pandemic, and managing the infected persons.

Second, as shown in Table 2, all the indicators of the national health system and other systems that tackle social determinants of health in Germany are better than averages of the WER. For example, the Universal Health Coverage Service Index (UHSCI) for Germany of 83 was 7.23% higher than the WER average of 77[9]. Thus, whereas European gap in the coverage of essential health services was 23, Germany's was 17. Also, in Germany, only 0.1% of the population had households spending over 25% of their income on health care compared to the European average of 1.2% [10].

Table 2: The health system and social determinants of health indicators of Germany compared to the averages for the WHO European Region (WER)		
Health workforce indicators (2018) [10,11]	**Value in Germany**	**WHO European Region**
Medical doctors per 10,000 population	42.5	34.1
Nursing and midwifery personnel per 10,000 population	132.4	81.3
Dentists per 10,000 population	8.5	5.7
Pharmacists per 10,000 population	6.5	6.8
Medical devices indicators [11,12]		
Linear accelerators per million population	6.21	N/A
Telecobalt units per million population	0.23	N/A
Radiotherapy units per million population	6.44	3.9
Infrastructure indicator [13]		
Hospital beds per 10,000 population	80	N/A
Essential health service coverage indicators [9]		
UHC index of service coverage (SCI)	**83**	**77**
UHC SCI components: Reproductive, maternal, newborn and child health	94	86
UHC SCI components: Infectious diseases	79	73
UHC SCI components: Noncommunicable diseases	64	61
UHC SCI components: Service capacity and access	99	94

Catastrophic out-of-pocket health spending (SDG indicator 3.8.2)		
Population with household expenditures on health greater than 10% of total household expenditure or income (SDG 3.8.2) (%) [10]	1.7	6.27
Population with household expenditures on health greater than 25% of total household expenditure or income (SDG indicator 3.8.2) (%) [10]	0.1	1.15
Current Health Expenditure (CHE) per Capita in PPP [14]	5922.64	2923
Domestic General Government Health Expenditure as % of CHE [14]	77.66	65.0
Domestic Private Health Expenditure as % of CHE [14]	22.34	35.0
Out-of-Pocket Expenditure (OOPS) as % of CHE [14]	12.67	30.4
Current Health Expenditure (CHE) as % Gross Domestic Product (GDP) [14]	11.25	7.78
Domestic general government health expenditure as percentage of GDP (%)[14]	8.73	4.92
Social Determinants of Health		
Population using safely managed drinking water services (%) [10]	>99	92
Population using safely managed sanitation services (%) [10]	97	68
Relative poverty rate (%) [4]	16.1	16.9
Unemployment rate (%) [2]	4.267	7.6

Source: European Commission [4], IMF [2], WHO [9-14]. Note: N/A means not available.

Third, the German health system is also better resourced than in other European countries. For instance, the densities of medical doctors and nursing (and midwifery) of 42.5 and 132.4 per 10,000 population in Germany were respectively 19.8% and 38.6% higher than WER averages of 34.1 and 81.3 per 10,000 [10,11].

Fourth, the performance of systems that tackle social determinants of health is better in Germany than the averages for WER. For example, whereas over 99% and 97% of the German population use safely managed drinking water and sanitation services, the WER population using the same services were 92% and 68% [10].

Notwithstanding higher IHR capacities scores, UHC service index, health worker densities, and coverage of safely managed water and sanitation in Germany compared to European region averages, there is need for increased investments in health-related sectors to sustain the health gains and bridge extant health-related services gaps.

Rice [15] underscored that monetary valuation of statistical human lives lost is essential for defining the magnitude of disease burden in dollar terms, and justifying investments in health research, health system, disease surveillance and response system, and other systems that address social determinants of health.Since COVID-19, caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), was first reported in December 2019 in Wuhan Province of China [16],some studies have applied the human capital approach to estimate the value of human life losses associated with the disease in Africa [17], Brazil [18], Canada [19], China [20], France [21], Germany [22], India [23], Iran [24], Italy [25], Japan [26], Mauritius [27], Spain [28], Turkey [29], the United Kingdom (UK) [30], and the United States of America [31]. Globally, there is a paucity of health economics literature on various aspects of the pandemic [32], and especially on the value of human life losses associated with COVID-19.The first estimationof the dollar value of human life losses associated with COVID-19 in Germany was conducted in May 2020 by the authors of this paper [22]. Given the rapidly evolving pandemic situation, there isneed for an update for use in sustaining advocacy for increased investment into the ongoing laudable fight against COVID-19.The specific aim of this study was to estimate the total discounted financial value of human life losses associated with COVID-19 in Germany as of 8 November 2020($TVHL_{GERMANY}$).

II. MATERIAL AND METHODS

Study Design, Location and Subjects

This is a cross-sectional study of the value of human life losses associated with COVID-19 in the sixteen states of the Federal Republic of Germany, i.e.Baden-Württemberg, Bavaria (Bayern),Berlin, Brandenburg, Bremen, Hamburg, Hesse (Hessen),Lower Saxony (Niedersachsen), Mecklenburg-Vorpommern, North Rhine-Westphalia (Nordrhein-Westfalen), Rhineland-Palatinate (Rheinland-Pfalz),Saarland, Saxony (Sachsen), Saxony-Anhalt (Sachsen-Anhalt),Schleswig-Holstein, and Thuringia (Thüringen)[33]. The study spans from 27 January 2020 (when the first COVID-19 case was confirmed in Germany near Munich, Bavaria [34]) to 8 November 2020. The analysis included all the 11,435 persons deceased from COVID-19 within the study period, and thus, sampling was not applicable.

Analytical framework

The human capital approach (HKA) was applied in calculating the$TVHL_{GERMANY}$. Cambridge dictionary defines human capital as "*employees, and all of the knowledge, skills, and experience that they have, which makes them valuable to a company or economy*" [35]. According to Rice [15], HKA views a person "*...as producing a stream of output that is valued at market earnings and the value of life is the discounted future earnings stream*" (p.177). According to Weisbrod [36], the present value of a person is equal to "*…his/her discounted expected future earnings stream net of his consumption*" (p.427). In the current study, net GDP per person is used in the valuation of human lives lost to COVID-19, which is because as explained in other studies [17-31], individuals do not derive utility (pleasure or happiness) from consumption of health services (or expenditures on health services [37,38].

The $TVHL_{GERMANY}$ is the sum of the discounted financial value of human lives lost (VHL_{δ})among people of age 0-9 years, 10-19 years, 20-29 years, 30-39 years, 40-49 years, 50-59 years, 60-69 years, 70-79 years, 80-89 years, 90-99 years, and 100 years and older [14]. Formally [17-31]:

$$TVHL_{GERMANY} = \sum_{\delta=1}^{\delta=11} VHL_{\delta} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (1)$$

Where: VHL_{δ} is the discounted financial value of human lives lost due to COVID-19 in δ^{th} age bracket: δ =1 is age 0-9 years, δ=2 is age 10-19 years, δ=3 is age 20-29 years, δ=4 is age 30-39 years, δ=5 is age 40-49 years, δ=6 is age 50-59 years, δ=7 is age 60-69 years, δ=8 is age 70-79 years, δ =9 is age 80-89 years, δ=10 is age 90-99 years, δ=11 is age 100 years and older; $\sum_{\delta=1}^{\delta=11}$ is the sum of VHL_{δ} the across age brackets 1 to 11.

Equation (2) was applied in estimating the VHL_{δ} for each of the eleven age brackets [17-31]:

$$VHL_{\delta} = \sum_{\alpha=1}^{\alpha=m} \left(\frac{1}{(1+r)^{\alpha}}\right) \times (K_1 - K_2) \times (K_3 - K_4) \times (K_5 \times K_6) \dots\dots (2)$$

Where: $\sum_{\alpha=1}^{\alpha=n}$ is the addition from year one (α=1) of life lost to the final year of life lost (α=m); r is the discount rate of 3%; K_1 is the GDP per person of Germany; K_2 is the per capita current health expenditure in Germany; K_3 is the mean life expectancy at birth of Germany; K_4 is the mean life expectancy at death in the δ^{th} age bracket; K_5 is the cumulative number of human lives lost to COVID-19 in Germany as of 18 May 2020; K_6 is the proportion of total human lives losses from COVID-19 accruing to the δ^{th} age bracket.

The HKA model was rerun four times to gauge the sensitivity of the $TVHL_{GERMANY}$. First, using a discount rate of 5% instead of 3%, while holding Germany's mean life expectancy constant. Second, employing a discount rate of 10%, while Germany's mean life expectancy was held constant. Third, applying the global mean life expectancy of 73.2 years, while holding the discount rate constant at 3%. Fourth, utilizing the world's highest mean life expectancy of 88.17 years (that of Hong Kong Females), while holding a discount rate constant at 3%.

Data and data sources

Excel software (Microsoft Corporation, Washington, D.C.) was used in estimating equations 1 and 2, assuming 2020 as the base year.The sources of data used to estimate the two equations are as follows:

a) GDP per person in Germany of Int$53,571.191 was from the IMF World Economic Outlook Database [2].
b) The 11,435 deaths due to COVID-19 in Germany by 8 November 2020 was obtained from WorldometerCOVID-19 pandemic database [1].
c) Proportion of deaths from COVID-19 per age bracket in Germany (0-9 years = 0.000187864; 10-19 years = 0.000281796; 20-29 years = 0.001315048; 30-39 years = 0.00281796; 40-49 years = 0.008453879; 50-59 years = 0.036351681; 60-69 years = 0.094871313 years; 70-79 years = 0.222524892; 80-89 years = 0.4415743; 90-99 years = 0.186079279; 100 years and above = 0.005541988) were obtained from the Statista [7].
d) Proportion of deaths from COVID-19 per state in the Federal Republic of Germany from Statista:Bavaria = 0.260003605; Baden-Wuerttemberg = 0.18853641; North Rhine Westphalia = 0.207011536; Lower Saxony = 0.072278298; Hesse = 0.065699351; Hamburg = 0.026856525; Rhineland-Palatinate = 0.027937996; Saxony = 0.034787311; Berlin = 0.025865177; Brandenburg = 0.018745494; Saarland = 0.017844268; Thuringa = 0.019556597; Schleswig-Holstein = 0.017483778; Saxony-Anhalt = 0.007930786; Bremen = 0.007299928; Mecklenburg-West Pomerania = 0.002162942[40].

e) Germany average life expectancy at birth (ALE) of 81.88 years; global ALE of 73.2 years; Hong Kong Females ALE (world highest) of 88.17 years were from the Worldometerdemographics database [39].
f) Discount rates of 3%, 5% and 10% from past studies were used [17-30].
g) The current health expenditure per person of Int$5,922.63818359 in Germany in 2017 was obtained from the WHO Global Health Expenditure Database [14]. Between 2016 and 2017, the CHE per capita grew from Int$5,568.27001953 to Int$5,922.63818359, implying a growth rate of 6.36406213809852%. Thus, assuming that growth rate remains constant, CHE per capita grows to Int$7,126.88822274587 by 2020. We used the projected CHE per capita of Int$7126.88822274587for 2020 in the monetary valuation of human life model.

III. RESULTS

Findings from analysis assuming Germany's mean life expectancy of 81.88 years

The 11,435 human lives lost to COVID-19 had a $TVHL_{GERMANY}$ of Int$1,916,725,559 and an average of Int$167,619 per human life lost (Table 3).Out of the $TVHL_{GERMANY}$, 0.16% accrued to 0-9 year-olds, 0.22% to 10-19 year-olds, 0.99% to 20-29 year-olds, 1.95% to 30-39 year-olds, 5.19% to 40-49 year-olds, 18.5% to 50-59 year-olds, 34.6% to 60-69 year-olds, 38.39% to 70-79 year-olds, 0.0% to 80-89 year-olds, 0.0% to 90-99 year-olds, and 0.0% to 100 year-olds and above. About 61.23% of the $TVHL_{GERMANY}$ accrued to persons aged between 20 and 69 years. Since 7,241 (63.3%) of the human life losses were above the average life expectancy of Germany of 81.88 years, they were valued at zero.

The average financial value per human life lost decreases significantly as the age of onset of death increases. For example, the average financial value per human life lost at age 0-9 years of Int$1,389,163 was five-fold that of a person who died at age 70-79 years.

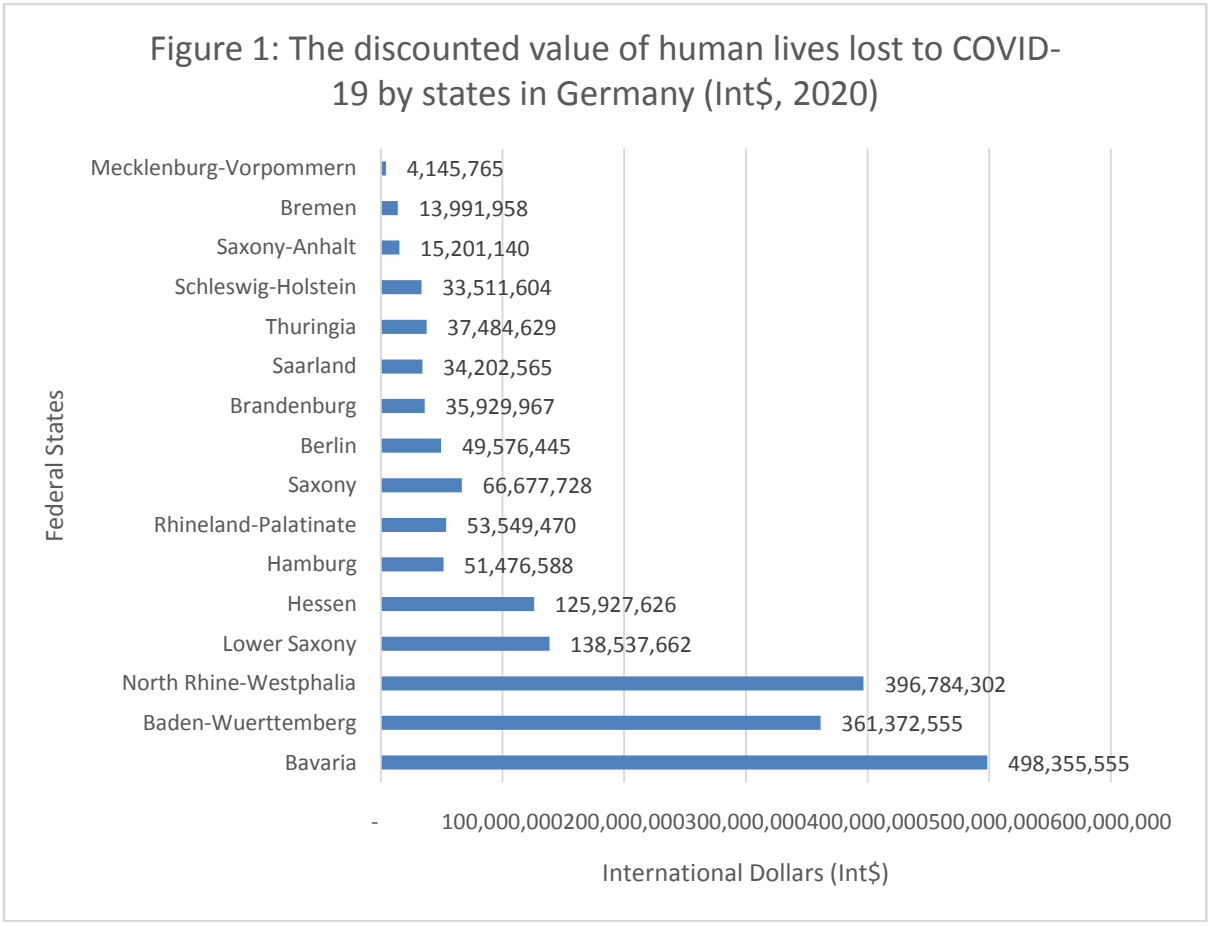
Table 3: The total and average discounted financial value of human lives lost from COVID-19 in Germany – assuming the national mean life expectancy and a 3% discount rate (in 2020 Int$)

Age bracket in years	Discounted financial value of human lives lost at 3% discount rate (Int$)	Average discounted financial value per human life lost in an age bracket (Int$)
0-9	2,984,233	1,389,163
10-19	4,300,165	1,334,486
20-29	18,962,474	1,261,006
30-39	37,451,777	1,162,255
40-49	99,525,919	1,029,542
50-59	353,822,336	851,186
60-69	663,378,340	611,491
70-79	736,300,315	289,361
80-89	0	0
90-99	0	0
100 and older	0	0
TOTAL	**1,916,725,559**	**167,619**

Source: Authors estimates.

Distribution of the $TVHL_{GERMANY}$ by federal states in Germany

Figure 1 portrays the distribution of the $TVHL_{GERMANY}$ due to COVID-19 across the 16 Federal States in Germany.



Source: Authors estimates.

Out of the $TVHL_{GERMANY}$ of Int$1,916,725,559, 26% accrued to Bavaria, 18.8% to Baden-Wuerttemberg, 20.7% to North Rhine-Westphalia, 7.2% to Lower Saxony, 6.6% to Hessen, 2.7% to Hamburg, 2.8% to Rhineland-Palatinate, 3.5% to Saxony, 2.6% to Berlin, 1.9% to Brandenburg, 1.8% to Saarland, 2.0% to Thuringia, 1.7% to Schleswig-Holstein, 0.8% to Saxony-Anhalt, 0.7% to Bremen, and 0.2% to Mecklenburg-Vorpommern. About 72.7% of the $TVHL_{GERMANY}$ was for the States of Bavaria, Baden-Wuerttemberg, North Rhine-Westphalia, and Lower Saxony.

The sensitivity of $TVHL_{GERMANY}$ to changes in the discount rate

Rerun of the economic model with discount rates of 5% and 10% yielded $TVHL_{GERMANY}$ of Int$1,654,455,280 and Int$1,225,674,591, respectively (Table 4).

Table 4: The discounted financial value of human lives lost from COVID-19 in Germany – assuming 5% and 10% discount rates (in 2020 Int$)

Age bracket in years	Discounted financial value of human lives lost at 5% discount rate (Int$)	Discounted financial value of human lives lost at 10% discount rate (Int$)
0-9	1,948,847	997,080
10-19	2,879,303	1,494,070
20-29	13,102,526	6,953,566
30-39	26,910,244	14,796,233

40-49	75,029,935	43,577,390
50-59	282,698,939	178,334,166
60-69	568,046,791	404,168,072
70-79	683,838,694	575,354,015
80-89	0	0
90-99	0	0
100 and older	0	0
TOTAL	**1,654,455,280**	**1,225,674,591**
Discounted financial value per human life lost	**144,683**	**107,186**

Source: Authors estimates.

Application of 5% and 10% discount rates diminished the $TVHL_{GERMANY}$ by Int$262,270,279 (13.7 %) and Int$691,050,968 (36.1 %), respectively. Correspondingly, application of the 5% and 10% discount rates caused a decline in the average discounted financial value of human life by Int$22,936 and Int$60,433, respectively. Therefore, the magnitude of $TVHL_{GERMANY}$ is, to a great extent, dependent on the discount rate used.

The sensitivity of $TVHL_{GERMANY}$ to changes in the average life expectancy

Reanalysis of the economic model using the average global and world's highest life expectancies resulted in the $TVHL_{GERMANY}$ of Int$813,947,610and Int$3,643,891,102, respectively (Table 5).

Table 3: Discounted financial value of human lives lost from COVID-19 in Germany – assuming average global and world's highest life expectancies (in 2020 Int$)

Age bracket in years	**Discounted financial value of human lives lost at 3% discount rate and global mean life expectancy of 73.2 years (Int$)**	**Discounted financial value of human lives lost at 3% discount rate and the world's highest life expectancy of 88.17 years (Int$)**
0-9	2,893,124	3,048,068
10-19	4,116,501	4,428,847
20-29	17,810,602	19,769,516
30-39	34,134,592	39,775,913
40-49	86,151,861	108,896,254
50-59	276,535,786	407,972,007
60-69	392,305,145	853,301,741
70-79	0	1,334,979,852
80-89	0	871,718,904
90-99	0	0
100 and older	0	0
TOTAL	**813,947,610**	**3,643,891,102**
Discounted financial value per human life lost	**71,180**	**318,661**

Source: Authors estimates.

The substitution of Germany average life expectancy of 81.88 years with the global mean life expectancy of 73.2 years in the HKA model led to a reduction in the $TVHL_{GERMANY}$ of Int$1,102,777,950 (57.5%). On the contrary, a rerun of the model with the Hong Kong female mean life expectancy of 88.17 years (the world's highest mean life expectancy) boosted the $TVHL_{GERMANY}$ by Int$1,727,165,543 (90.1 %). Similarly, utilization of the global mean life expectancy caused a reduction in the average $TVHL_{GERMANY}$ of Int$96,439; and a growth in the average $TVHL_{GERMANY}$ of Int$151,042 when the world's highest mean life expectancy was applied. Thus, the magnitude of $TVHL_{GERMANY}$ is also dependent on the size of average life expectancy used.

IV. DISCUSSION

Recap of the key findings

- The 11,435 human lives lost to COVID-19 had a $TVHL_{GERMANY}$ of Int$1,916,725,559, which was equivalent to 0.038% of Germany's total GDP in 2020.
- The average of discounted value per human life lost was Int$167,619, which was three-fold the GDP per capita for Germany.
- Application of 5% and 10% discount rates, respectively, diminished the $TVHL_{GERMANY}$ by 13.7 % and 36.1%.
- The substitution of Germany average life expectancy of 81.88 years with the global mean life expectancy of 73.2 years in the HKA model reduced the $TVHL_{GERMANY}$ by 57.5%.
- A rerun of the HKA model with the world's highest mean life expectancy of 88.17 years boosted the $TVHL_{GERMANY}$ by 90.1 %.

How does the average discounted value per human life lost ($ATVHL_{GERMANY}$) due to COVID-19 compare with those of similar studies?

Globally, a number of studies have attempted to estimate the macroeconomic impact of COVID-19 for various countries around the world [41-45]. However, our search in PubMed revealed only a relatively few studies that estimate the average discounted value per human life lost from COVID-19($ATVHL_{GERMANY}$). A comparison with those studies revealed that Germany's 8 November 2020 $ATVHL_{GERMANY}$ of Int$167,619 was lower than that of Spain of Int$470,798 by 181% [28]; Italy of Int$369,088 by 120% [25]; China of Int$356,203 by 113% [20]; France of Int$339,381 by 102% [21];Mauritius of Int$312,069 by 86% [27]; the USA of Int$292,889 by 75% [31]; Japan of Int$286,973 by 71% [26]; Canada of Int$231,217 by 38% [19]; Turkey of Int$228,514 by 36% [29]; and the UK of Int$225,104 by 34% [30]. However, the 8 November 2020 $ATVHL_{GERMANY}$ of Germany was higher than Germany's May 2020 estimate of Int$132,960 by 21% [22]. Also, the 8 November 2020 Germany's $ATVHL_{GERMANY}$ was higher than that of Iran of Int$165,187 by one percent [24]; Brazil of Int$99,629 by 41% [18]; Africa of Int$87,442 by 48% [17]; and India of Int$80,928 by 52% [23].

The study limitations

First, the HKA has been criticized for presuming that the only object of saving lives is to grow GDP; omitting non-market societal contributions, such as, those of full-time homemakers; and ignoring intangible psychic costs (e.g. pain of losing loved ones, stigma) [15,36,46]. In this study, 7,241 (63.32%) of the human lives lost to COVID-19 were above the average life expectancy of Germany, and thus, following the HKA were valued at zero. Valuation of lives lost above the national average life expectancy at zero may have led to a massive underestimation of the $TVHL_{GERMANY}$ .Moreover, the zero valuation of lives lost among those aged over 81.88 years and above is, according to WHO [47] *"...stereotyping of and discrimination against individuals or groups based on their age"* (p.11), and could be viewed as immoral because the society attaches social value to every life, including the lives of the very old [48].According to the WHO world report on ageing and health, the elderly contribute to society "… *by direct participation in the formal or informal workforce, through taxes and consumption, through transfers of cash and property to younger generations and through a myriad of less tangible benefits that accrue to their families and communities*" (p.16). They also contribute in transmission of social and cultural norms and values, reconciliation in family disputes, and social cohesion. The current study did not capture the loss of these contributions due COVID-19, especially among deceased persons above the national average life expectancy.

Second, the per capita GDP, which is used in the valuation of human life, has been castigated for ignoring the distribution of income and wealth; omitting adverse effects (e.g. global warming/climate change, pollution)of output production processes; and for ignoring society's quality of life or wellbeing [49].

Third, in the process of testing, contact tracing, isolation/quarantine, treatment and care for COVID-19 cases various resources are consumed, including suspected patients time, political leaders time, health workers time, multi-sectoral COVID-19 committee members time, ambulance (and other transport), hospital space, food, and media [17-31]. Also, resources used during the post-mortem and burial of those who die from COVID-19,

were not included in the analysis. Those health system and multi-sectoral costs were not within the scope of the study reported in this paper.

V. CONCLUSION

The estimated average discounted value per human life loss associated with COVID-19 of Int$167,619 was three-fold the GDP per capita for Germany in 2020. Thus, despite the limited scope of this study, it has demonstrated that the potential attrition of current and future labor force occasioned by the COVID-19 has a significant negative impact on the German economy. The human and financial losses from the ongoing and future public health emergencies can be mitigated through sustained investment in the reinforcement of the disease surveillance and response system (through optimization of all the IHR capacities); enhanced resilience of the State and Federal health systems; optimization of coverage of water and sanitation services (and systems that address other social determinants of health); and bolstering of the national health research, innovation and development system(s).

ACKNOWLEDGEMENT

We owe profound gratitude to *El Shaddai* for meeting all our needs during these challenging times of COVID-19 pandemic. We thank Lenity Honesty KainyuNkanata for care, moral support and goading us to be creative. The paper is dedicated to all health workers, political leaders at all levels in the Federal Republic of Germany, and essential non-health workers for their priceless contributions in the inexorable fight against COVID-19.

CONFLICT OF INTEREST

The authors declared that they had no actual or potential conflict of interest on any aspect of this study.

FUNDING

The study reported in this article did not receive funding from any public or private source.

REFERENCES

[1]. Worldometer. COVID-19 coronavirus pandemic. [Last updated: November 08, 2020, 06:58 GMT]. [Internet]. Available from: https://www.worldometers.info/coronavirus/. Accessed 8 November 2020.
[2]. International Monetary Fund [MF]. IMF World Economic Outlook Database. [October 2020 Edition]. [Internet].Available from: https://www.imf.org/en/Publications/WEO/weo-database/2020/October. Accessed 8 November 2020.
[3]. United Nations Development Programme [UNDP]. Human Development Report 2019: Beyond income, beyond averages, beyond today: inequalities in human development in the 21st century empowered lives. New York: UNDP; 2019.
[4]. European Commission. State of health in the EU: Germany country health profile 2019. Brussels: European Union; 2019. Available from: http://www.oecd.org/publications/germany-country-health-profile-2019-36e21650-en.htm. Accessed 8 November 2020.
[5]. Nicola M, Alsafi Z, Sohrabi C, Kerwan A, Al-Jabir A, Iosifidis C, Agha M, Agha R. The Socio-Economic Implications of the Coronavirus and COVID-19 Pandemic: A Review. *International Journal of Surgery*. 2020; **78**: 185-193. Doi: https://doi.org/10.1016/j.ijsu.2020.04.018.
[6]. International Monetary Fund (IMF). G-20 surveillance note. COVID-19—Impact and Policy Considerations. G-20 Finance Ministers and Central Bank Governors' Meetings, April 15, 2020 Virtual Meeting. Washington, D.C.: IMF; 2020.
[7]. Statista. Number of coronavirus (COVID-19) deaths in Germany in 2020, by gender and age. [Update: 4 November 2020]. [Internet].Available from https://www.statista.com/statistics/1105512/coronavirus-covid-19-deaths-by-gender-germany/. Accessed 8 November 2020.
[8]. World Health Organization (WHO). Global Health Observatory data repository. International Health Regulations (2005) monitoring framework, SPAR. All capacities data by country. [Internet].Available from https://www.who.int/data/gho/data/themes/topics/indicator-groups/indicator-group-details/GHO/ihr---all-capacities. Accessed 8 November 2020.
[9]. WHO. Global Health Observatory data repository. Index of service coverage Data by country. [Internet]. Available from: https://apps.who.int/gho/data/view.main.INDEXOFESSENTIALSERVICECOVERAGEv?lang=en.Accessed 8 November 2020.
[10]. WHO. World Health Statistics 2020: Monitoring health for the SDGs. Geneva: WHO; 2020.
[11]. WHO. World Health Statistics 2015. Geneva: WHO; 2015.
[12]. WHO. Global Health Observatory. Medical devices. [Internet]. Available from: https://www.who.int/data/gho/data/themes/topics/indicator-groups/indicator-group-details/GHO/medical-equipment. Accessed 8 November 2020.
[13]. WHO. Global Health Observatory data repository. Hospital bed density data by country. [Internet]. Available from: https://apps.who.int/gho/data/node.main.UHCHOSPITALACCESS?lang=en. Accessed 9 November 2020.
[14]. WHO. Global Health Expenditure Database. [Internet]. Available from:https://apps.who.int/nha/database/ViewData/Indicators/en. Accessed 8 November 2020.
[15]. Rice DP. Cost of illness studies: what is good about them? *Injury Prevention*. 2000;**6**: 177–179.
[16]. WHO. Timeline: WHO's COVID-19 response. [Internet]. Available from: https://www.who.int/emergencies/diseases/novel-coronavirus-2019/interactive-timeline#!. Accessed 9 November 2020.
[17]. Kirigia JM, Muthuri RNDK, Nkanata LHK, Muthuri NG. The present value of human life losses associated with coronavirus disease in Africa. *Open Journal of Business & Management*. 2020; 8: 2371-2395. doi: https://doi.org/10.4236/ojbm.2020.86146
[18]. Kirigia JM, Muthuri RNDK, Nkanata LHK, Muthuri NG. The pecuniary value of human life losses associated with COVID-19 in Brazil. *IOSR Journal of Pharmacy*. 2020; **10**(8), 45-51. URL: http://iosrphr.org/papers/vol10-issue8/E1008014551.pdf

[19]. Kirigia JM, Muthuri RDKM. The dollar value of human life losses associated with COVID-19 in Canada. *Pharmaceutical and Biomedical Research*. 2020; **6**(0). URL:http://pbr.mazums.ac.ir/article-1-351-en.html
[20]. Kirigia JM, Muthuri RNDK. The fiscal value of human lives lost from coronavirus disease (COVID-19) in China. *BMC Research Notes*. 2020; **13**(198). Doi: https://doi.org/10.1186/s13104-020-05044-y
[21]. Kirigia JM, Muthuri RNDK, Nkanata LHK, Muthuri NG. The discounted value of human lives lost due to COVID-19 in France. F*1000Research*. 2020; **9**:1247. doi: https://doi.org/10.12688/f1000research.26975.1
[22]. Kirigia JM, Muthuri RNDK. The financial value of human life losses associated with coronavirus disease in Germany. *Academic Journal of Economic Studies*. 2020.(in press).
[23]. Kirigia JM, Muthuri RNDK, Nkanata LHK, MuthuriNG.The present value of human life losses from Coronavirus Disease (COVID-19) in India. *IOSR Journal of Dental and Medical Sciences*. 2020; **19**(11): 54-64. URL: https://www.iosrphr.org/iosr-jdms/papers/Vol19-issue11/Series-4/I1911045464.pdf
[24]. Kirigia JM, Muthuri RNDK, Muthuri NG. The present value of human lives lost due to coronavirus disease (COVID-19) in the Islamic Republic of Iran. *IOSR Journal of Dental and Medical Sciences*. 2020; **19**(9), 45-53. URL: https://www.iosrphr.org/iosr-jdms/papers/Vol19-issue9/Series-4/H1909044553.pdf
[25]. Kirigia JM, Muthuri RNDK, Nkanata LHK, Muthuri NG. The discounted financial worth of human lives lost from COVID-19 in Italy. *IOSR Journal of Economics and Finance*. 2020; 11(5): 15-24. URL: https://www.iosrjournals.org/iosr-jef/papers/Vol11-Issue5/Series-5/B1105051524.pdf
[26]. Kirigia JM, Muthuri RNDK, Nkanata LHK, Muthuri GN. The present value of human life losses associated with COVID-19 in Japan**.***IOSR Journal of Economics & Finance*. 2020; **11**(6): 6-16. URL:http://www.iosrjournals.org/iosr-jef/papers/Vol11-Issue6/Series-2/B1106020716.pdf
[27]. Musango L, Nundoochan A, Kirigia JM. The discounted money value of human life losses associated with COVID-19 in Mauritius.*Frontiers Public Health*. 2020; **8**:604394.doi: http://doi.org/10.3389/fpubh.2020.604394.
[28]. Kirigia JM, Muthuri RNDK. The discounted money value of human lives lost due to COVID-19 in Spain. *Journal of Health Research*. 2020; **34**(5): 455-460. doi:https://doi.org/10.1108/JHR-04-2020-0116
[29]. Kirigia JM, Muthuri RNDK, Nkanata LHK. The monetary value of human life losses associated with COVID-19 in Turkey. *Emerald Open Research*. 2020; **2**:44. doi: https://doi.org/10.35241/emeraldopenres.13822.1
[30]. Kirigia JM, Muthuri RDKM. The present value of human lives lost due to COVID-19 in the United Kingdom (UK). *Pharmaceutical and Biomedical Research*. 2020; 6(3). URL: http://pbr.mazums.ac.ir/index.php?sid=1&slc_lang=en
[31]. Kirigia JM, Muthuri RNDK. Discounted monetary value of human lives lost due to COVID-19 in the USA as of 3 May 2020. *IOSR Journal of Dental and Medical Sciences*. 2020; **19**(5): 51-54. doi: https://www.iosrjournals.org/iosr-jdms/papers/Vol19-issue5/Series-10/K1905105154.pdf
[32]. Donaldson C, Mitton C. Coronavirus: where has all the health economics gone? *International Journal of Health Policy and Management*. 2020;9(11):466–468. doi:10.34172/ijhpm.2020.108
[33]. Wikipedia. States of Germany. [Internet]. Available from: https://en.wikipedia.org/wiki/States_of_Germany#List. Accessed 9 November 2020.
[34]. Wikipedia. COVID-19 pandemic in Germany. [Internet]. Available from: https://en.wikipedia.org/wiki/COVID-19_pandemic_in_Germany.Accessed 9 November 2020.
[35]. Cambridge University Press. (2020). Cambridge English dictionary [Internet]. Available from:https://dictionary.cambridge.org/dictionary/english/human-capital. Accessed 18 May 2020.
[36]. Weisbrod BA. The Valuation of Human Capital. *Journal of Political Economy. 1961;***69**(5), 425-436.
[37]. Grossman M. On the concept of health capital and the demand for health. *Journal of Political Economy*. 1972; **80**(2): 223-255. DOI:https://doi.org/10.1086/259880
[38]. WHO. WHO guide to identifying the economic consequences of disease and injury. Geneva: WHO; 2009.
[39]. Worldometer. Demographics. Life Expectancy of the World Population. [Internet]. Available from: https://www.worldometers.info/demographics/life-expectancy/. Accessed 10 November 2020.
[40]. Statista. Coronavirus (COVID-19) case numbers in Germany in 2020, by federal state. [Updated: 6 November 2020]. [Internet].https://www.statista.com/statistics/1105274/coronavirus-covid-19-case-numbers-by-federal-state-germany/ . Accessed 11 November 2020.
[41]. International Monetary Fund [IMF]. World Economic Outlook: The Great Lockdown. Washington, D.C.: IMF; 2020. https://www.imf.org/en/Publications/WEO/Issues/2020/04/14/weo-april-2020. Accessed 14 November 2020.
[42]. Ayittey FK, Ayittey MK, Chiwero NB, Kamasah JS, Dzuvor C. (2020). Economic impacts of Wuhan 2019-nCoV on China and the world. *Journal of Medical Virology*. 2020;**9**2(5): 473- 475.
[43]. Açikgöz Ö, Günay A. The early impact of the Covid-19 pandemic on the global and Turkish economy. *Turkish Journal of Medical Sciences*. 2020;**50**(SI-1):520- 526.doi:https://doi.org/10.3906/sag-2004-6
[44]. Zouari A. What are the economic implications of COVID-19? *La TunisieMédicale*. 2020;**98**(4), 312- 313.
[45]. Wagner AF. What the stock market tells us about the post-COVID-19 world. *Nature Human Behaviou*r.2020; **4**(5): 440. doi: https://doi.org/10.1038/s41562-020-0869-y
[46]. Rice DP, Cooper BS. The economic value of human life. *American Journal of Public Health*.1967; **57**(11): 1954–1966.
[47]. WHO. World report on ageing and health. Geneva: WHO; 2015.
[48]. Mooney GH. *The Valuation of Human Life.* London: Palgrave; 1977.
[49]. Sen A, Fitoussi JP, Stiglitz J. *Mismeasuring Our Lives: Why GDP Doesn't Add Up.* New York.: The New Press; 2010.

JosesMuthuriKiriga, et. al. "Valuation of human life losses associated with COVID-19 in Germany: A human capital approach". *IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)*, 19(11), 2020, pp. 56-65.