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The present value of human lives lost due to coronavirus disease (COVID-19) in the Islamic Republic of Iran

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Abstract:
Background*: As of 28 August 2020, there was a total of 369,911 Coronavirus Disease (COVID-19) cases reported in the Islamic Republic of Iran that consisted of 21,249 deaths, 318,270 recovered cases, and 30,392 active cases. This study aimed to estimate the total present value of human lives lost due to COVID-19 in Iran as of 28 August 2020 (TPVHLL).*
Materials and Methods*: TPVHLL of the 21,249 human lives lost in Iran was estimated using the human capital approach (HCA), assuming the national life expectancy at birth of 77.33 years and a 3% discount rate. Subsequently, the HCA model was re-calculated with 5% and 10% discount rates, and the world average and highest life expectancies of 73.2 years and 88.17 years, holding all other parameters constant, to determine the impact on the TPVHLL.*
Results*: The 21,249 human lives lost had a TPVHLL of Int$3,510,063,043, and an average present value per human life of Int$165,187. Re-analysis of the HCA model with 5% and 10% discount rates reduced $TPVHLL_{IRAN}$ by 17% and 46%, respectively. Re-appraisal of the HCA model with the world average life expectancy of 73.2 years shrank the $TPVHLL_{IRAN}$ by 13%; whereas application of the world highest life expectancy of 88.17 years amplified the $TPVHLL_{IRAN}$ by 62%.*
Conclusion:*The average present value per human life loss associated with COVID-19 was nine-fold per capita GDP for Iran in 2020. Therefore, COVID-19 had a substantial negative impact on not only patients' health (health-related quality and length of life) but also on the economic production of Iran.*
Key Word*:Coronavirus Disease; COVID-19; Iran; Gross domestic product; Value of life.*

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I. Introduction

The Islamic Republic of Iran, an upper-middle-income economy, is one of the twenty-one Member States of the World Health Organization (WHO) Eastern Mediterranean Region (EMR) [1]. The country had a population of 84,159,305 million persons [2], a gross domestic product (GDP) of Int$1,500.5 billion, and a per capita GDP of Int$17,832 in 2020 [3]. Iran had an inequality-adjusted human development index of 0.706; and a Gini index of 40% (where zero percent depicts perfect equality and 100% signifies maximal inequality). The poorest 40%, the richest 10%, and the richest 1% of the population held 16.6%, 30.9%, and 16.3% of the national income in 2019, respectively [4].

As of 28 August 2020, globally, there were 24,665,281 reported cases of COVID-19, which included 836,475 deaths, 17,120,071 recovered cases, and 6,708,735 active cases [2]. By the same date, Iran had carried out a total of 3,161,894 COVID-19 tests (37,570 tests per million population) which revealed 369,911 cases that consisted of 21,249 deaths, 318,270 recovered cases, and 30,392 active cases [2]. The Iranian densities of 4,395 cases per million population and 252 deaths per million population were higher than the World's 3,164.9 cases per million population and 107.3 deaths per million population [2].

The relatively high density of COVID-19 cases and deaths borne by Iran might be due to gaps in the Universal Health Coverage (UHC), International Health Regulations (IHR), and coverage of water and sanitation. UHC, which means Iranians receive the essential health services they need without suffering financial hardship, can be viewed as a proxy indicator of the strength and resilience of the underlying national health system [5].

Table 1 presents a comparison of health system health indicators in Iran with the EMR averages.Iran's density of skilled health professionals of 30.42 per 10,000 population was 17.19% higher than the average for EMR.

Table 1: Comparison of the health system and social determinants of health indicators in Iran with the WHO Eastern Mediterranean Region (EMR) averages		
Health workforce indicators (2017) [6]	**Value in Iran**	**Average value in EMR**
Medical doctors per 10,000 population	15.84	10.1
Nursing and midwifery personnel per 10,000 population	4.43	14.5
Dentists per 10,000 population	4.47	N/A
Pharmacists per 10,000 population	2.93	N/A
Psychiatrists working in mental health sector per 10,000 population	2.02	N/A
Skilled health professionals per 10,000 population	30.42	25.19
Essential health service coverage indicators (2017) [6]		
Universal Health Coverage (UHC) index of service coverage (SCI)	72	57
UHC SCI components: Reproductive, maternal, newborn and child health (RMNCH)	85	66
UHC SCI components: Infectious diseases (IDS)	49	45
UHC SCI components: Noncommunicable diseases (NCD)	72	61
UHC SCI components: Service capacity and access (SCA)	88	60
Catastrophic out-of-pocket health spending (SDG indicator 3.8.2) [6]		
Population with household expenditures on health greater than 10% of total household expenditure or income (SDG 3.8.2) (%)	15.81	12.36
Population with household expenditures on health greater than 25% of total household expenditure or income (SDG indicator 3.8.2) (%) (2015)	3.76	1.87
Current Health Expenditure (CHE) per Capita in US$	475.5	555.6
Domestic Private Health Expenditure as % of CHE (2017)	48.73	45.49
Out-of-Pocket Expenditure (OOPS) as % of CHE	41.76	39.31
Current Health Expenditure (CHE) as % Gross Domestic Product (GDP)	8.66	5.69
Domestic general government health expenditure as percentage of GDP (%)	4.44	2.6
Total health expenditure on health as a % of GDP [2014]	17.53	4.75
Social Determinants of Health [7]		
Proportion of population using improved drinking water sources in 2015 (%)	96	91
Proportion of population using improved sanitation in 2015 (%)	90	78

Source: WHO [6,7] Note: N/A means data not available.

Iran has a UHC service coverage index of 65, implying a 35 gap in the coverage of essential health services. The UHC index component scores of 85 for reproductive, maternal, new-born and child health (RMNCH), 49 for infectious diseases (such as COVID-19) (IDS), 72 for non-communicable diseases (NCD), and 88 for service capacity and access (SCA) denote service coverage gaps of 15, 51, 28, and 12, respectively. About 3,198,054 (3.8%) and 13,305,586 (15.81%) of the population spent above the catastrophic (impoverishing) thresholds of 10% and 25% of their income on health care, respectively [6].

The coverage of basic water and sanitation services are proxy indicators for the performance of systems that tackle social determinants of health. In 2015, 90% of the Iranian proportion of population used improved sanitation, implying that 8,415,931 (10%) were not [1,6]. In the same year, 96% of the population were using safely managed drinking-water services, implying that 3,366,372 (4%) were not [1,6].

The IHR capacities are a proxy of the vibrancy of the national disease surveillance system [8]. As depicted in Table 2, in 2018, the Iran IHR capacities of legislation and financing, national health emergency framework, laboratory, health service provision, and chemical events had a rating of 100 (target capacity) [9].

Table 2: A comparison of the International Health Regulations scores for Iran with the averages for the WHO Eastern Mediterranean Region (EMR) in 2018		
IHR core capacity	**Iran IHR scores**	**Average EMR scores**
Legislation and Financing	100	61
IHR Coordination and National IHR Focal Point Functions	80	73

Laboratory	100	71
Surveillance	80	77
Human Resources	80	71
National Health Emergency Framework	100	68
Health Service Provision	100	64
Risk Communication	80	60
Points of Entry	60	55
Zoonotic Events and the Human-animal Interface	60	74
Food Safety	80	64
Chemical Events	100	53
Radiation Emergencies	80	60
Average 13 IHR capacity score	***85***	***66***

Source: WHO [9].

The IHR coordination and national focal point functions, surveillance, human resources, risk communication, food safety, and radiation emergencies had a rating of 80, implying a 20 gap. While the points of entry (a passage for international entry or exit of travellers and goods) and the zoonotic events and the human-animal interface IHR capacities had a rating of 60, implying a gap of 40 [9]. The average of 13 IHR core capacity scores in Iran was 85, implying an overall gap of 15 in IHR capacities. The Iran average IHR capacity score was 22.35% higher than the EMR average IHR capacity score of 66 [9].

Iran's current health expenditure per capita of US$475.5 in 2017 [6], although within the range of US$ 297 (minimum) to US$984 (maximum) required for attaining United Nations Sustainable Development Goal 3 on health, it was lower than the upper-middle-income countries recommended population-weighted mean of US$536 per person [10]. The current health expenditure per capita for Iran was also 16.85 % lower than the EMR average of US$555.6.

Card and Mooney [11] and Rice [12] make a compelling case for explicit monetary valuation of human life for use in advocacy with decision-makers and decision analysis models. A few countries studies have attempted to value human life losses associated with COVID-19, for example, Brazil [13], Canada [14], China [15], Germany [16], Spain [17], Turkey [18], the United Kingdom (UK) [19], and the United States of America (USA) [20]. To the best of our knowledge, no other study has estimated the present value of human life losses associated with COVID-19 in Iran. There is a need for evidence on the present value of human lives for use in advocacy for increased investments in health-related systems to attain UHC of essential health services, safely managed water and sanitation services, and optimal IHR capacities. This study aimed to estimate the present value of human life losses associated with COVID-19 in Iran as of 28 August 2020.

II. Material And Methods

Study Location: This health economics study was undertaken on persons who died of COVID-19 as of 28 August 2020 in the Islamic Republic of Iran.

Study Design: The study was a cross-sectional human capital valuation of human life losses associated with COVID-19.

Study Duration: The study spanned from 19 February 2020 (when first COVID-19 case was reported in Iran) to 28 August 2020.

Sample size: There was no need for sampling becausethe study included the entire population of the 21,249 patients reported to have died from COVID-19 by 28August 2020 in Iran.

Empirical framework for estimating the present value of human life

Mooney [21] provides a critical treatise of the three methods for monetary valuation of human life, i.e. the human capital, the implicit values, and the willingness-to-pay (WTP) approaches. The current study used the human capital approach (HCA) pioneered Petty [22] in the 17th Century and further refined by Farr [23] in the 19th Century. Fein [24], Mushkin and Collings [25], Landefeld and Seskin [26], Linnerooth [27], and Weisbrod [28] provides the theoretical foundations for applications of HCA to value human life.

According to Weisbrod [28], "..the value of a person to others is measured by any excess of his contribution to production over what he consumes from production…The present value of a man at any given age may be defined operationally as his discounted expected future earnings stream (net of his consumption)"

(pp.426-427). Also, the WHO guide to identifying the economic consequences of disease recommends that the expenditures on health should be deducted from GDP per capita in the valuation of human life [19]. This study followed the advice of Weisbrod [28] and WHO [29] to estimate the present value of human life losses associated with COVID-19 in Iran.

Premature death from COVID-19 results in potential years of life lost (YLL), which equals Iran's national life expectancy at birth minus the average age of onset of death. In the current study, YLL are valued using net GDP per capita, i.e. GDP per capita minus current health expenditure per capita for Iran [13-20].

The current study replicates the HCA model applied in recent studies to estimate the total present value of human life losses associated with COVID-19 in Iran ($TPVHLL_{IRAN}$) [13-20]. $TPVHLL_{IRAN}$ is the sum of present value of the human lives lost (PVHLL) by eight age groups, including the 0-9-year-old ($PVHLL_{0-9}$), 10-19-year-old ($PVHLL_{10-19}$), 20-29-year-old ($PVHLL_{20-29}$), 30-39-year-old ($PVHLL_{30-39}$), 40-49-year-old ($PVHLL_{40-49}$), 50-59-year-old ($PVHLL_{50-59}$), 60-69-year old ($PVHLL_{60-69}$), and 70-year-old and above $\left(PVHLL_{\geq 70}\right)$. Algebraically:

$$TPVHLL_{IRAN} = \sum_{i=1}^{i=8} PVHLL_i \dots\dots\dots\dots\dots (1).$$

The i[th] age group $PVHLL_i$ was estimated by multiplying discount factor, YLL, net GDP per person, and COVID-19 deaths in the i[th] age group [13-20]. Formulaically:

$$PVHLL_i = \sum_{t=1}^{t=n} \{(M_1) \times (M_2 - M_3) \times (M_4 - M_5) \times (M_6 \times M_7)\} \dots\dots\dots (2)$$

Where: $M_1 = 1/(1+r)^t$ is the discount factor; r is the discount rate of 3% [13-20]; $\sum_{t=1}^{t=n}$ is the total aggregation from year $t=1$ to $t=n$; $t=1$ is the first YLL due to COVID-19 and n is the final year of the total of YLL per COVID-19 human life lost within an age group; M_2 is the average life expectancy at birth for Iran; M_3 is the average age at onset of death from COVID-19 for i[th] age group; M_4 is the GDP per capita for Iran expressed in International Dollars (Int$) or purchasing power parity (PPP); M_5 is the current health expenditure per person expressed in Int$ for Iran; M_6 is the total number of COVID-19 associated deaths reported in Iran as of 28 August 2020; and M_7 is the proportion COVID-19 deaths accruing to the i[th] age group [13-20]. The baseline year for the analysis was 2020.

Data and data sources

The data and sources are contained in Table 3.

Table 3: Data and data sources

Variable	Data value	Source
Average life expectancy at birth (ALE) in 2020 (M_2)	Iran ALE = 77.33 years; world ALE = 73.2 years; world highest ALE = 88.17 years	Worldometer [3]
Average age of onset of death per age group (M_3)	0-9 years = 4.5 years; 10-19 years = 14.5 years; 20-29 years = 24.5 years; 30-39 years = 34.5 years; 40-49 years = 44.5 years; 50-59 years = 54.5 years; 60-69 years = 64.5 years; 70-79 years = 74.5 years	Ghafari*et al*. [30]
GDP per capita for Iran (M_4)	Int$17,832	International Monetary Fund (IMF) [2]
Current health expenditure per person in Iran (M_5)	Int$1,748	WHO [6]
Number of COVID-19 deaths for Iran as of 28 August 2020 (M_6)	21,249	Worldometer [3]
Distribution of COVID-19 deaths by age group in Iran (M_7)	0-9 years = 0.001945525; 10-19 years = 0.005836576; 20-29 years = 0.019455253; 30-39 years = 0.050583658; 40-49 years = 0.079766537; 50-59 years = 0.159533074; 60-69 years = 0.270428016; 70 years and older = 0.412451362.	Ghafari*et al*. [30]

Statistical analysis

The economic model was estimated using Excel Software (Microsoft, New York) in the following steps. *Step 1*: The undiscounted YLL for equals average life expectancy at birth for Iran(M_2) minus average age at onset of death from COVID-19 for ith age group (M_3). For example, the YLL for a person in age group 0-9 years = $(M_2 - M_3)$ = (77.33 years − 4.5 years) = 72.83 years. Table 4 presents the undiscounted YLL for the eight age groups.

Table 4: Undiscounted years of life lost per person due to COVID-19 by 28 August 2020

Age group (years)	Average life expectancy at birth in years for Iran (A)	Average age at onset of death (B)	Undiscounted years of life lost per person in age group (C) = (A) – (B)
0-9	77.33	4.5	72.83
10-19	77.33	14.5	62.83
20-29	77.33	24.5	52.83
30-39	77.33	34.5	42.83
40-49	77.33	44.5	32.83
50-59	77.33	54.5	22.83
60-69	77.33	64.5	12.83
70-79	77.33	74.5	2.83

Step 2: The discount factors (M_1) were calculated at a discount rate of 3% using the standard formula: $1/(1+r)^t$. For example, the M_1 for the first YLL = $1/(1+0.03)^1$ = 0.970874; the M_1 for the second YLL = $1/(1+0.03)^2$ = 0.942596; the M_1 for the fiftieth YLL = $1/(1+0.03)^{50}$ = 0.228107; the M_1 for the seventy-third year of life = $1/(1+0.03)^{73}$ = 0.115579975. The discount factors decrease as the YLL increase. Table 5 shows the discount YLL due to COVID-19 by 28 August 2020.

Table 5: Discounted years of life lost per person due to COVID-19 by 28 August 2020

Age group (years)	Discounted years of life lost per life lost in age group
0-9	29.4806675
10-19	28.15567261
20-29	26.37499028
30-39	23.98190213
40-49	20.76579178
50-59	16.44360839
60-69	10.63495533
70 -79	2.828611355

Step 3: The net GDP per capita equals GDP per capita (M_4) minus current health expenditure per person (M_5) expressed in Int$ for Iran. Since M_4 and M_5 were Int$17,832 and Int$1,748, respectively; the net GDP per capita equals Int$16,084, i.e. Int$17,832 minus Int$1,748.

Step 4: Calculate the distribution of COVID-19 deaths by age groups through the multiplication of total number of the COVID-19 deaths (M_6) by the proportions for age groups (M_7). The calculation in this step yielded the values in Table 6.

Table 6: Number of COVID-19 deaths per age group as of 28 August 2020

Age group (years)	COVID-19 deaths in Iran (A)	Proportion for age group (B)	Number of deaths per person in age group (C) = (A x B)
0-9	21,249	0.001945525	41
10-19	21,249	0.005836576	124
20-29	21,249	0.019455253	413
30-39	21,249	0.050583658	1,075
40-49	21,249	0.079766537	1,695
50-59	21,249	0.159533074	3,390
60-69	21,249	0.270428016	5,746
70-79	21,249	0.412451362	8,764

Step 5: This stage entailed calculating the present value (PVHLL) for each of the eight age groups. We can illustrate the calculation of PVHLL using the 0-9 age group. The discounted YLL for a person in age group 0-9 years = 29.4806674970713 years; net GDP per capita = Int$160,84; and COVID-19 deaths in 0-9 age group = 41.34046692607. $PVHLL_{0-9} = 29.4806674970713 \times 17832 \times 41.34046692607 = Int\$19{,}602{,}287.$

Step 6: In health economics, it is common practice to conduct sensitivity analysis to gauge the impact of uncertainty on the results of an economic appraisal [31,32,33]. In this study, there was uncertainty regarding the effects of the discount rate and the life expectancy assumed. The model was reanalysed four times to test the

impact of changes in the discount rate and average life expectancy on $TPVHLL_{IRAN}$. First, with a 5% discount rate holding all other parameters constant [13-20]. Second, with a 10% discount rate holding all other parameters constant [13-20]. Third, with the world average life expectancy at birth of 73.2 years instead of Iran's average life expectancy of 77.33 years [13]. Finally, with the world highest life expectancy of 88.17 years, i.e. the Hong Kong female average life expectancy [13].

III. Result

The present value of human life losses assuming Iran's average life expectancy of 77.33 years and a 3% discount rate

As depicted in Table 7, the 21,249 human life losses incurred by Iran had a total present value of Int$3,510,063,043 and an average of Int$165,187 per human life.

Table 7: The present value of human life losses associated with COVID-19 in Iran – assuming the national average life expectancy of 77.33 years and a 3% discount rate (in 2020 Int$)

Age group in years	Present value of human life losses at 3% discount rate (Int$)	Average present value per human life lost in an age group (Int$)
0-9	19,602,287	474,167
10-19	56,163,815	452,856
20-29	175,372,604	424,215
30-39	414,597,249	385,725
40-49	566,111,261	333,997
50-59	896,562,190	264,479
60-69	982,923,939	171,053
70 and older	398,729,698	45,495
TOTAL	**3,510,063,043**	**165,187**

Approximately, 0.6% of the $TPVHLL_{IRAN}$ accrued to 0-9-year-olds, 1.6% to 10-19-year-olds, 5.0% to 20-29-year-olds, 11.8% to 30-39-year-olds, 16.1% to 40-49-year-olds, 25.5% to 50-59-year-olds, 28.0% to 60-69-year-olds, and 11.4% to 70-year-olds and above. Thus, 64.9% of the $TPVHLL_{IRAN}$ accrued to lives lost among persons of age 50 years and above. The average present value per human life lost decreased with increase in age. For example, the present value per human life lost among 0-9-year-olds of Int$474,167 was ten-fold higher than that of a person aged 70-year-old and above.

The present value of human life losses assuming 5% and 10% discount rates holding Iran's average life expectancy of 77.33 years' constant

Table 8 shows that reanalysis of the HCA model with 5% and 10% discount rates reduced $TPVHLL_{IRAN}$ by Int$609,024,781 (17%) and Int$1,601,056,631 (46%), respectively. The corresponding decreases in average present value per human life lost due to COVID-19 were Int$28,661 and Int$75,347.

Table 8: A comparison of the present value of human lives lost from COVID-19 in Iran (in 2020 Int$) – at 5% and 10% discount rates

Age group in years	Present value of human life losses at 5% discount rate (Int$)	Present value of human life losses at 10% discount rate (Int$)
0-9	12,920,846	6,642,875
10-19	38,050,211	19,898,381
20-29	122,966,347	66,066,451
30-39	303,332,355	170,009,381
40-49	436,257,062	260,879,213

50-59	735,443,526	484,343,678
60-69	868,190,554	656519810.4
70 and older	383,877,361	244,646,624
TOTAL	**2,901,038,262**	**1,909,006,412**
Average present value of human life	**136,526**	**89,840**

The present value of human life losses assuming world average life expectancy of 73.2 years and the world highest life expectancy of 88.17 years holding discount rate constant at 3%

As portrayed in Table 9, re-appraisal of the HCA model assuming the world average life expectancy at birth of 73.2 years, resulted in a total present value of Int$3,060,465,966 and an average present value of Int$144,029 per human life lost. Thus, the use of a lower average life expectancy reduced the total present value by Int$449,597,077 (13%), and the average present value per human life by Int$21,159.

Table 9: A comparison of the present value of human lives lost from COVID-19 in Iran (in 2020 Int$): assuming world average life expectancy and world highest life expectancy

Age group in years	Present value of human lives lost at 3% discount rate and assuming the global average life expectancy of 73.2 years (Int$)	Present value of human lives lost at 3% discount rate and assuming the global average life expectancy of 88.17 years (Int$)
0-9	19,280,770	20,313,365
10-19	54,867,536	59,030,702
20-29	169,565,635	188,215,455
30-39	394,306,640	459,472,516
40-49	523,110,331	661,213,294
50-59	780,982,883	1,152,180,550
60-69	719,622,472	1,565,248,678
70 and older	398,729,698	1,592,328,978
TOTAL	**3,060,465,966**	**5,698,003,538**
Average present value of human life	**144,029**	**268,154**

Re-calculation of the HCA model using the highest life expectancy in the world (i.e., that of the Hong Kong Females) increased the total present value to Int$5,698,003,538 and the average present value to Int$268,154. Therefore, the use of the highest average life expectancy in the world amplified the total present value by Int$2,187,940,495 (62%), and the average by Int$102,967.

IV. Discussion

Key findings and implications

- The 21,249 human life losses incurred by Iran due to COVID-19 had a total present value of Int$3,510,063,043, i.e. 0.234% of the total GDP in 2020.
- The average present value per human life was Int$165,187, which is nine-fold per capita GDP in 2020.
- Re-analysis of the HCA model with 5% and 10% discount rates reduced $TPVHLL_{IRAN}$ by 17% and 46%, respectively.
- Re-appraisal of the HCA model with the world average life expectancy 73.2 years shrank the $TPVHLL_{IRAN}$ by 13%; whereas application of the world highest life expectancy of 88.17 years amplified the $TPVHLL_{IRAN}$ by 62%.

Therefore, sensitivity analysis revealed that the larger the discount rate, the lower the estimated total present value of human life lost; and the higher the life expectancy at birth the greater the number of YLL, and hence, the total present value of human life lost.

Comparison with similar studies

According to Donaldson and Mitton [34] "...health economics seems to have been absent from important debates based on its lifeblood of resource scarcity, and consequent trade-offs, each of which has been laid bare in the current crisis" (p. 1). There is indeed a paucity of studies worldwide that monetarily value human life losses associated with the COVID-19. In this subsection, we compare the average present value per human life lost from COVID-19 in Iran with those estimated using the human capital approach in eight other countries around the world. Iran's average present value per human life lost from COVID-19 of Int$165,187 is higher than those of Germany (Int$132,960) [16] and Brazil (Int$99,629) [13] by 19.5% and 39.7%, respectively. Whereas, Iran's average present value per human life is lower than those of Canada (Int$231,217) [14], China (Int$356,203) [15], Spain (Int$470,798) [17], Turkey (Int$228,514) [18], the UK (Int$225,104) [19], and the USA (Int$292,889) [20] by 40.0%, 115.6%, 185%, 38.3%, 36.3%, and 77.3%, respectively. The differences have been attributed to variations in the total number of YLL at younger age groups [13-20].

Limitations of the study

First, according to the WHO World Health Statistics Report 2019, the completeness of cause-of-death data was 90% in Iran compared to 32% in the EMR in 2017 [35]. The cause-of-death for about 10% of deaths in Iran is not recorded. Therefore, the number of notified COVID-19 cases (including deaths) are likely to be an underestimate. Should that be the case, the total present value of human lives lost reported in this paper would also be an underestimate.

Second, our study omits the COVID-19 health system costs related to prevention (water, soap, sanitizers, personal protective equipment), testing (diagnosis), contact tracing, quarantine, and hospitalization of critically ill patients, and post-mortem [13-20]. We also did not take into account funeral-related costs, including the purchase of caskets, hiring of a hearse, transport of the bodies (and family and friends), funeral ceremonies, and time of family and friends preparing and attending the funerals [13-20].

Third, given the limited scope, this study did not take into account the macroeconomic impact of COVID-19 pandemic on agriculture, education, financial services (e.g., banking and stock exchange), hydrocarbon (oil and gas), international trade and commerce, tourism and travel, and manufacturing sectors [36].

Finally, when austerely applied, the human capital approach employed in the current study would value the contributions of housewives, the elderly, the handicapped (physically and mentally), and children at zero [11-20]. To avoid human rights and ethical issues, we valued all the years of life lost, irrespective of age, gender, and economic status, using the same numeraire, i.e., net GDP per capita [13-20].

V. Conclusion

The average present value per human life loss associated with COVID-19 of Int$165,187 was nine-fold per capita GDP for Iran in 2020. Therefore, COVID-19 had a substantial negative impact on not only patients' health (health-related quality and length of life) but also on the economic production of Iran. This economic evidence, plus the human rights considerations (Universal Declaration of Human Rights Articles 03 on the right to life and Article 25 on the right to a standard of living adequate for the health and well-being) [37], urgently calls for strengthening of the Iranian national health-related systems to attain universal coverage of essential health services (SDG3) [38], and safely managed water and sanitation services (SDG6) [38], and target IHR capacities.

Even though economic evidence reported in this article is pivotal for public health advocacy [11,12,39], as articulated by Shiell, Gerard and Donaldson [40] it is not an aid to COVID-19 prevention and control public health decision-making. Public health decision-making requires evidence on both cost and consequences of alternative interventions for preventing and controlling COVID-19 [31,33,34].

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