Short Communication:
The Dollar Value of Human Life Losses Associated With COVID-19 in Canada

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Article info:
Received: 19 May 2020
Accepted: 25 Jul 2020

Keywords:
Coronavirus, Gross domestic product, Value of life, Canada

ABSTRACT

Background: The coronavirus disease 2019 (COVID-19) pandemic continues to cause morbidity and premature mortality and ravage the socio-economic sectors in Canada.

Objectives: The study aimed to appraise the Total Dollar Value of Human Life Losses (TDVHL) associated with COVID-19 in Canada.

Methods: The net output approach was applied in the dollar valuation of the 8810 human life losses associated with COVID-19 in Canada as of July 16, 2020. The economic model was rerun assuming 3%, 5%, and 10% discount rates with Canada's life expectancy of 83 years, the world's average life expectancy of 73 years, the world's highest average life expectancy of 88 years, and a 3% discount rate.

Results: The human lives lost to COVID-19 had an estimated value of the international dollar (Int$) 2037021173 and an average of Int$ 231217 per human life lost. Quebec and Ontario provinces alone accounted for 94.99% of the TDVHL. Reanalysis of the economic model with discount rates of 5% and 10% resulted in declines in TDVHL of Int$ 192721390 (9%) and Int$ 530132423 (26%), respectively. Substitution of the nation with the word's average life expectancy shrank the TDVHL by Int$ 1754972473 (86%) while applying the world's highest life expectancy triggered a growth in the TDVHL of Int$ 498674987 (24%).

Conclusion: The average value of human life lost is 4-fold the gross domestic product per capita for Canada.

1. Introduction

Canada is one of the member states of WHO Region of the Americas (ROA) and a member of the 7 advanced economies in the world, i.e. the G-7 countries (Canada, France, Germany, Italy, Japan, the United Kingdom, the United States of America). It had an estimated population of 37.814 million, a gross domestic product of Int$ 1971.8 billion, and a Gross Domestic Product (GDP) per capita of Int$ 52144.4 in 2020 [1]. In 2019, the inequality-adjusted human development index was 0.841,

Citation Muthuri Kirigia J, Nabi Deborah Karimi Muthuri. The Dollar Value of Human Life Losses Associated With COVID-19 in Canada. Pharmaceutical and Biomedical Research. 2020; 6 (Special Issue on COVID-19):93-104. http://dx.doi.org/10.18502/pbr.v6i(S2).5660

doi: http://dx.doi.org/10.18502/pbr.v6i(S2).5660

and the Gini coefficient was 34.0. The lowest 40% held about 18.9% of the national income in Canada compared to 25.3% and 13.6% held by the wealthiest 10% and 1% [2]. The International Monetary Fund (IMF) predicts that Canada's real GDP growth would decline by 6.2% in 2020 due to the adverse impact of the ongoing Coronavirus Disease 2019 (COVID-19) pandemic [3].

As of July 16, 2020, 13699621 COVID-19 cases have been reported in the world, including 8157677 (58.2%) recoveries, 4954970 (37.4%) currently infected patients (active cases), and 586974 (4.3%) deaths [4]. Canada had 108829 COVID-19 cases that included 8810 (8.1%) deaths, 72485 (66.4%) recovered cases, and 27534 (25.4%) active cases [5]. Of the total COVID-19 cases in Canada, Quebec bore 52.35%, Ontario 34.06%, Alberta 8.16%, British Columbia 2.88%, Nova Scotia 1%, Saskatchewan 0.81%, Manitoba 0.3%, Newfoundland and Labrador 0.24%, New Brunswick 0.15%, Prince Edward Island 0.03%, Yukon 0.01%, Northwest territories 0.005%, Nunavut 0%, and repatriated traveller cases 0.01% [6].

Approximately 64.03% of the deaths in Canada occurred in Quebec, 30.96% in Ontario, 2.15% in British Columbia, 1.83% in Alberta, 0.73% in Nova Scotia, 0.17 in Saskatchewan, 0.08% in Manitoba, 0.03% in Newfoundland and Labrador, and 0.02% in New Brunswick Province [6]. The remaining provinces of Prince Edward Island and the territories of Yukon, Northwest Territories, and Nunavut had not reported any deaths at the time.

In 2017, Canada had a UnitedHealthcare (UHC) service coverage index of 89%, which was higher than the average of 79% in the ROA [7]. However, with a gap of 11% in the coverage of essential health services, Canada cannot be complacent. Around 0.5% of the Canadian population had household expenditures on health greater than 25% of total household income, which was lower than the average of 1.8% for the ROA.

In Canada, domestic general government health expenditure forms 19.3% of the general government expenditure, which is higher than an average of 13.2% in the ROA. Even in terms of current health expenditure (CHE) per capita, Canada had US$ 4755 CHE compared to an average of US$ 1019 in the ROA [8].

Canada's health workforce densities of 23.1 medical doctors and 99.2 nursing and midwifery personnel per 10000 population were generally comparable to the average of 24.0 medical doctors and 83.3 nursing personnel in the ROA [7]. Canada's average of the 13 International Health Regulations (IHR) core capacities score of 99% was higher than the mean of 71% for the ROA in 2019 [7].

Approximately 99% and 82% of Canada's population use safely-managed drinking-water and sanitation, which was significantly higher than the mean of 79% and 49% in the ROA [7]. Even though the indicators mentioned above are better than the averages for the ROA, some limited coverage gaps still lurk in Canada; therefore, the government is much aware that there is no room for complacency.

The COVID-19 pandemic had a substantial negative impact on agriculture [9], education [10, 11], wholesale trade [12], gig economy [13], small businesses [14], manufacturing and service industries [15], and labor force and work [16]. As explained in Canada's COVID-19 economic response plan, the government of Canada is taking significant measures to mitigate the negative impact of the global pandemic on individuals, businesses, and sectors [17]. Information on the dollar value of human lives lost due to COVID-19 in Canada is missing so far.

The objective of the study was to appraise the dollar value of human life losses associated with COVID-19 in Canada.

2. Materials and Methods

Study location and subjects

The study focuses on the 8810 people in Canada who died from COVID-19 as of July 16, 2020. The analysis was done separately on the 8 Canadian provinces that had notified deaths associated with COVID-19.

Conceptual framework

The net output approach (also known as the human capital approach) was applied in the dollar valuation of human life losses associated with COVID-19 in Canada. The standard measure of national output is the GDP. A country's GDP is the sum of total spending on consumer goods and services, investment, government, and net exports, i.e. exports minus imports. Premature death associated with COVID-19 erodes these GDP components. Death from COVID-19 (or any other cause) terminates the stock of human capital, which is the "knowledge, skills, competencies and attributes (including physical, emotional and mental health) embodied in individuals that facilitate the creation of personal, social and economic wellbeing" [18]. Following every loss of life as-

Table 1. Data and resources used in the Canada analysis

Variables	Data	Data Sources
Per capita Gross Domestic Product (GDP) in Canada	International dollar (Int$) 52144.4	International Monetary Fund (IMF) [1]
Cumulative number of deaths due to COVID-19 in Canada by July 16, 2020	8810	Worldometer [5]
Proportion of deaths from COVID-19 per age group in Canada	0-19 years=0.000114982; 20-29 years=0.00103484; 30-39 years=0.001724733 years; 40-49 years=0.00528918; 50-59 years=0.022996436; 60-69 years=0.070829022; 70-79 years=0.180637001; and 80 years and older=0.717373807	Statistics Canada [6]
Share of COVID-19 deaths by Canadian 10 provinces and 3 territories	Provinces and territories: Newfoundland and Labrador=0.000341297; Nova Scotia=0.007167235; New Brunswick=0.000227531; Quebec=0.640273038; Ontario=0.30967008; Manitoba=0.000796359; Saskatchewan=0.001706485; Alberta=0.018316268; British Columbia=0.021501706; Prince=Edward Island=0; Yukon=0; Northwest Territories=0; Nunavut=0	Government of Canada [6]
Average Life Expectancy at birth in years (ALE)	Canada ALE =82.96 years; global ALE=73.2 years; Japanese Females ALE (world highest)=88.09 years [25].	Wordometer [26]
Discount rate	3%, 5%, 10%	Kirigia and Muthuri [21, 22, 24, 25]; Kirigia, Muthuri, and Nkanata [23]
Canada's per capita current health expenditure in International Dollars (Int$) or Purchasing Power Parity (PPP)	Int$ 4929	World Health Organization (WHO) [8]

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sociated with COVID-19, such embodied capabilities that hitherto enabled victims to make a positive contribution to GDP, family, and community are permanently lost.

In line with past studies [19-25], the total dollar value of human life lost due to COVID-19 in Canada equals the addition of dollar values of human life lost at the age groups of 0-19 years old, 20-29 years old, 30-39 years old, 40-49 years old, 50-59 years old, 60-69 years old, 70-79 years old, and 80 years and older. In the algebraic form [21-25] (Formula 1):

1. $TDVHL_{CANADA}=\sum_{\varepsilon=1}^{\varepsilon=8} DVHL_{\varepsilon}$

, where $\sum_{\varepsilon=1}^{\varepsilon=8}$ is the addition from group 1 to 8, is age group, =1 is 0-19 years old, =2 is 20-29 years old, =3 is 30-39 years old, =4 is 40-49 years old, =5 is 50-59 years old, =6 is 60-69 years old, =7 is 70-79 years old, and =8 is 80 years and older (Formula 2).

2. $DVHL_{\varepsilon}=\sum_{\tau=1}^{\tau=n}(1/_{(1+r)}\tau)\times(K_1-K_2)\times(K_3-K_4)\times(K_5\times K_6)$

The dollar value of human life lost per age group was estimated using the following formula [21-25]:

, where: is the discount factor, r refers to the 3% discount rate, denotes the year of life lost, =1 is the first and =n is the last year of life lost in the age group , is Canada's per capita GDP, refres to the per capita current health expenditure of Canada; is the average life expectancy at birth of Canada, is the average age at onset of death in age group , is the number of deaths associated with COVID-19 in Canada, and is the proportion of deaths from COVID-19 borne by age group. The year 2020 was taken as the base year for the analysis [21-25]. The equations were estimated using Microsoft Excel software.

Data and resources

Table 1 contains the data and data sources used in the Canada analysis.

3. Results

Findings from analysis assuming Canada's average life expectancy of 82.96 years and 3% discount rate

A total of 8810 human lives lost to COVID-19 had an estimated value of Int$ 2037021173 and an average of Int$ 231217 per human life lost. Of the TDVHL, 0.1% occurred to 0-19 years old, 0.6% to 20-29 years old, 0.9% to 30-39 years old, 2.4% to 40-49 years old, 8.8% to 50-59 years old, 19.9% to 60-69 years old, 25.9% to 70-79 years old, and 41.4% to 80 years old and older. About 54.6% of the TDVHL was among persons aged 50 to 79 years. The dollar value per human life lost decreased substantially with an increase in age. For example, the dollar value per human lost in the age group 80 years and above was 9.7 times lower than 20-29 years old (Table 2).

Table 2. The dollar value of human lives lost from COVID-19 in Canada using the national average life expectancy and a 3% discount rate

Age Group	The Dollar Value of Human Lives Lost at a 3% Discount Rate (Int$ or PPP)	Average Discounted Dollar Value per Human Life Lost per Age Group (Int$ or PPP)
0-19 years	1410028	1391943
20-29 years	11764911	1290446
30-39 years	18127188	1192979
40-49 years	49486342	1061992
50-59 years	179493390	885956
60-69 years	405214420	649378
70-79 years	527454241	331438
80 years and older	844070653	133554
Total	2037021173	231217

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Distribution of the TDVHL by provinces and territories of Canada

Figure 1 shows the share of TDVHL across 9 Canadian provinces that had recorded COVID-19 deaths by July 16, 2020.

Out of Int$ 2037021173 TDVHL, 64.03% occurred in Quebec, 30.97% in Ontario, 2.15% in British Columbia, 1.83% in Alberta, 0.72% in Nova Scotia, 0.08% in Manitoba, 0.17% in Saskatchewan, 0.03% in Newfoundland and Labrador, and 0.02% in New Brunswick Canadian provinces. The provinces of Quebec and Ontario alone bore Int$ 1935054243 (94.99%) of TDVHL. The remaining province of Prince Edward Island and the three Canadian territories (Yukon, Northwest, and Nunavut) had not recorded any loss of lives associated with COVID-19 by July 16, 2020.

The sensitivity of TDVHL to changes in the discount rate

As shown in Table 3, a reanalysis of the economic model with a discount rate of 5% resulted in a decline in TDVHL of Int$ 192721390 (9%), and the average dollar value per human life lost decreased by Int$ 21875. Use a discount rate of 10% reduced TDVHL by Int$ 530132423 (26%) and the average value per human life of Int$ 60174.

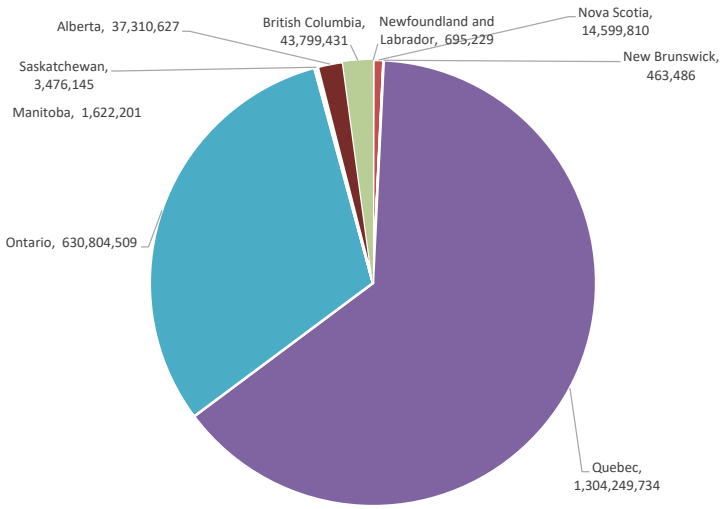

Figure 1. The discounted value of human lives lost to COVID-19 by provinces in Canada (Int$ 2020)

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Table 3. The discounted dollar value of human lives lost from COVID-19 in Canada holding national life expectancy constant and using 5% and 10% discount rates

Age Group	The Dollar Value of Human Lives Lost at a 5% Discount Rate (Int$ or PPP)	The Dollar Value of Human Lives Lost at a 10% Discount Rate (Int$ or PPP)
0-19 years	929420	477834
20-29 years	8101064	4287496
30-39 years	12969163	7100388
40-49 years	37111559	21413099
50-59 years	142512254	89024597
60-69 years	344405764	241635023
70-79 years	485640807	400862228
80 years and older	812629752	742088085
Total	1844299783	1506888750
Dollar value per human life lost	209342	171043

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Table 4. The discounted dollar value of human lives lost from COVID-19 in Canada using the average world and the world's highest life expectancies

Age Group	The Dollar Value of Human Lives Lost at a 3% Discount Rate and Global Mean Life Expectancy Of 73.2 Years (Int$)	The Dollar Value of Human Lives Lost at a 3% Discount Rate And the World's Highest Life Expectancy Of 88.09 Years (Int$)
0-19 years	477216	478032
20-29 years	4264267	4294946
30-39 years	6999969	7132595
40-49 years	20614352	21669277
50-59 years	80017011	91913543
60-69 years	169675884	264714027
70-79 years	0	553527197
80 years and older	0	1591966543
Total	282048700	2535696161
Dollar value per human life lost	32015	287820

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The sensitivity of TDVHL to variations in life expectancy

As portrayed in Table 4, re-calculation of the model with the world's average life expectancy induced a contraction in the TDVHL of Int$ 1754972473 (86%) and a decrease in the average value per human life of Int$ 199202. Replacement of the national life expectancy with the world highest life expectancy triggered a growth in the TDVHL of Int$ 498674987 (24%) and an Int$ 56603 increase in the average dollar value per human life lost.

4. Discussion

The main findings of this study are as follows: The 8810 human lives losses associated with COVID-19 had an estimated value of Int$ 2037021173, which equiva-

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Table 4. A comparison of Canada's cumulative COVID-19 cases (as of July 16, 2020) with those of other major advanced economies (G-7 countries)

COVID-19	Canada	France	Germany	Italy	Japan	The UK	The USA
(A). Total cases	108829	173304	201252	243506	22508	291911	3617040
(B). Deaths	8810	30120	9148	34997	984	45053	140150
(C). Recovered cases	72485	78820	186000	196016	18545	N/A	1645966
(D). Active cases (currently infected patients)	27534	64364	6104	12493	2979	N/A	1830924
(E). Cases which had an outcome [E=B+C]	81295	108940	195148	231013	19529	N/A	1786116
(F). Percentage of dead [F=(B/E)x100]	10.8	27.6	4.7	15.1	5.0	N/A	7.8
(G). Percentage of recovered [G=(C/E)x100]	89.2	72.4	95.3	84.9	95.0	N/A	92.2
(H). Total cases per million population	2882	2655	2402	4028	178	4299	10925
(I). Deaths per million population	233	461	109	579	8	664	423
Tests per million population	88515	38790	76091	100120	4639	183531	135459

Source: Worldometer [4].

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lent to 0.10% of the total GDP of Canada. The dollar value per human life lost due to COVID-19 is Int$ 231217. The dollar value per human life lost in the age group 80 years and above was 9.7 times lower than that of 20-29 years old. Application of discount rates of 5% and 10% led to contractions in the TDVHL of Int$ 192721390 (9%) and Int$ 530132423 (26%), respectively. The higher the discount rate, the lower the TDVHL, indicating an inverse relationship. Use of the world's average life expectancy of 73 years decreased the TDVHL by Int$ 1754972473 (86%), while application of the world's highest life expectancy of 88 years grew the TDVHL by Int$ 498674987 (24%). The higher the life expectancy assumed, the higher the estimated TDVHL, which denotes a positive relationship.

Comparison with other studies

What does value per human life lost from COVID-19 in Canada compare with those of other countries? The estimated discounted money value per human life lost due to COVID-19 was Int$ 356203 [21] in China, Int$ 292889 [22] in the USA, Int$ 228514 in Turkey [23], Int$ 470798 in Spain [24], and Int$ 225104 in the UK [25]. Thus, the estimated dollar value per human life lost due to COVID-19 in Canada of Int$ 231217 was lower than those of China, the USA, and Spain by Int$ 124986, Int$ 61672, and Int$ 239581, respectively. However, the value per human life lost for Canada was Int$ 2703 and Int$ 6113 higher than that of Turkey and the UK, respectively.

Comparison of Canada's COVID-19 morbidity and mortality against 6 other G-7 countries

Table 4 provides a comparison of Canada's total COVID-19 cases, deaths, recovered cases, active cases, total cases per million population, deaths per million population, and tests per million population with those of the other 6 G-7 countries (also called the major advanced economies).

Among the G-7 countries, Canada has the fourth-highest total cases of COVID-19 per million population, i.e. after Italy, the UK, and the USA. The total cases per million population in Canada are 16-fold more than those of Japan but 4-fold lower than those of the USA.

Contrastingly, Canada had the third-lowest number of deaths per million population, after Germany and Japan. The percentage of deaths among cases with an outcome in Canada of 11% was 6 points, 6 points, and 3 percentage points higher than those of Germany, Japan, and the USA. However, 17 and 4 percentage points lower than those of France and Italy. The percentage of recoveries from COVID-19 was higher in Germany, Japan, and the USA than in Canada.

Why was the number of deaths per million population in Canada about 2-fold and 29-fold those of Germany and Japan, respectively? Could the variance be due to underlying variations in the Universal Health Coverage (UHC), the International Health Regulations (IHR), and social determinants of health?

Table 5. A comparison of the health system, water, sanitation, and secondary education indicators in Canada with those of other G-7 countries

Health System, Water, Sanitation, And Secondary Education Indicators		Canada	France	Germany	Italy	Japan	The UK	The USA
Medical doctors per 10000 population [7]		23.1	32.7	42.5	39.8	24.1	28.1	26.1
Nursing and midwifery personnel per 10000 population [7]		99.4	114.7	132.4	57.4	121.5	81.7	145.5
Dentists per 10000 population [7]		6.4	6.7	8.5	8.2	8.0	5.2	5.8
Pharmacists per 10000 population [7]		11.2	10.6	6.5	10.9	18.0	8.9	9.2
Psychologists working in mental health sector per 100000 population [27]		48.7	48.74	49.55	3.8	3.04	N/A	29.86
Psychiatrists working in mental health sector per 100000 population [27]		14.68	20.91	13.2	5.98	11.87	N/A	10.54
Nurses working in mental health sector per 100000 population [27]		68.66	98.02	N/A	23.49	83.81	N/A	4.28
Social workers working in the mental health sector per 100000 population [27]		145.4	N/A	N/A	2.59	8.33	N/A	60.34
Skilled health professionals per 10000 population [27]		123.8	138	179.8	97.39	136.1	112.5	117.3
Radiotherapy units per million population [28]		8.1	7.5	6.4	6.4	7.2	5.0	12.4
Hospital beds (per 10000 population) [28]		27	64.77	82.78	34.22	134	27.58	29
Current health expenditure as % gross domestic product [8]		10.6	11.3	11.2	8.8	10.9	9.6	17.1
Domestic general government health expenditure as % current health expenditure [8]		73.7	77.1	77.7	73.9	84.1	79.4	50.1
Out-of-pocket as % of current health expenditure [8]		14.2	9.4	12.7	23.5	12.8	16.0	11.0
Out-of-pocket expenditure per capita in international dollars (Int$) or purchasing power parity PPP [8]		700.8	470.3	750.6	850.1	586.3	692.3	1,126.3
Current health expenditure (CHE) per capita in (PPP) [8]		4929	5011	5923	3620	4563	4338	10246
Percentage of population with household expenditure on health greater 25% of income [29]		0.5	0.22	0.11	1.08	0.6	0.48	0.78
Universal health coverage index [29]		89	78	83	82	83	87	84
Proportion of population using safely-managed drinking-water services (%) [7]		99	98	>99	95	98	>99	>99
Proportion of population using safely-managed sanitation services (%) [7]		82	88	97	96	99	98	90
Population with at least some secondary education (% ages 25 and older) [2]	Female	100	81.0	96.0	76.6	95.2	82.9	95.7
	Male	100	86.3	96.6	83.0	92.2	85.7	95.5

Source: UNDP [2], WHO [7, 8, 26, 27, 28, 29].

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Comparing the health system and social determinants of health indicators in Canada with those of the other 6 G-7 countries. Table 5 compares the health system, water, sanitation, and secondary indicators in Canada with those of the other 6 G-7 countries.

Human resources for health

Regarding human resources for health, Canada has a lower density of skilled health professionals per 10000 population than those for France, Germany, and Japan [27]. Also, the country has lower densities of medical doctors and nursing personnel compared to France, Germany, Japan, and the USA [7]. The lower densities of key health workforce cadres may have reduced, albeit slightly, Canada's capacity to provide optimal care for COVID-19 patients in serious or critical condition, leading to a higher number of deaths compared to Germany and Japan. On the other hand, Canada's higher ratio of psychiatrists and social workers (per 100000 population) practicing in the mental health sector might enable the country to manage better (than most other G-7 countries) the recovered COVID-19 patients with mental disorders.

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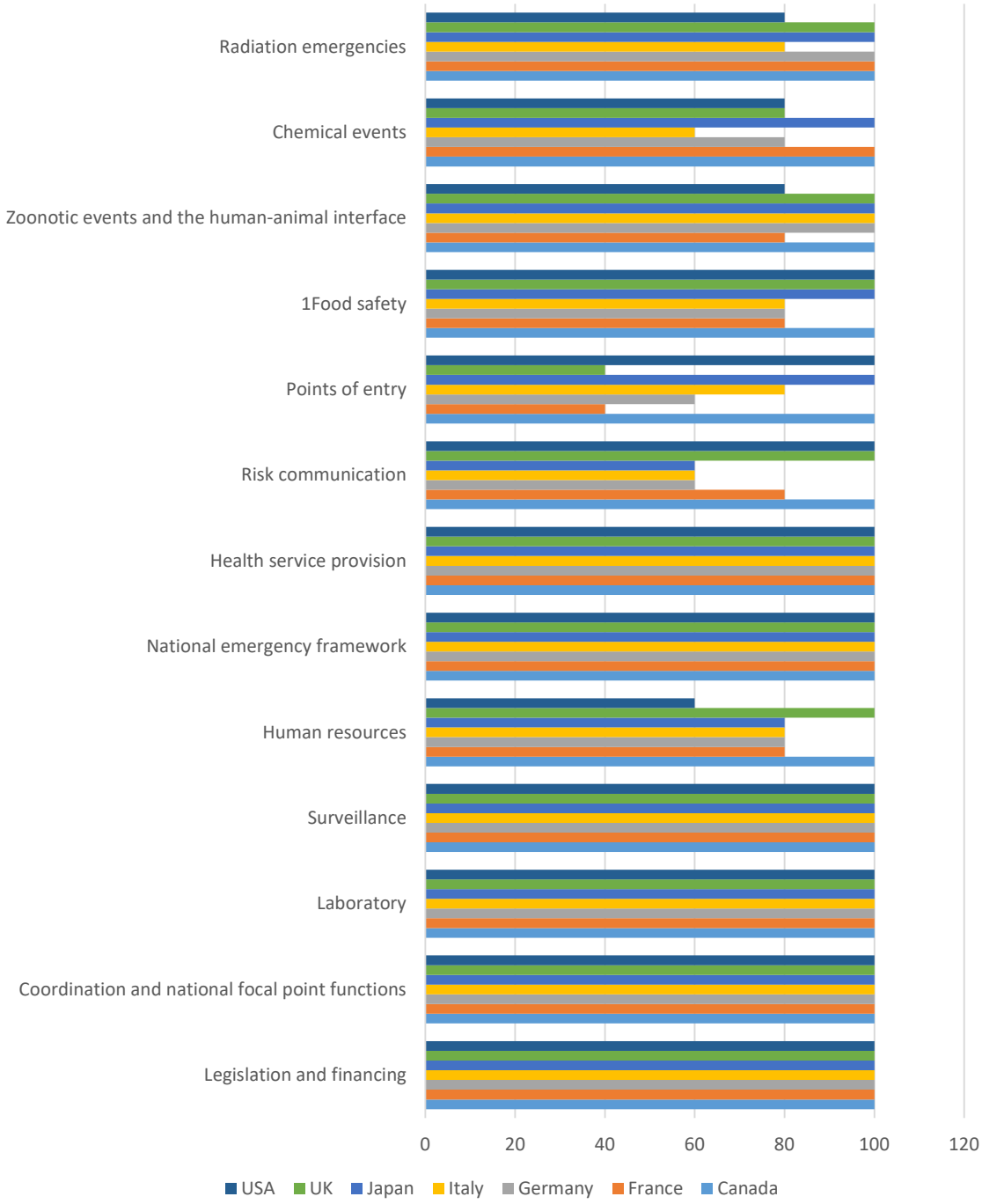

Figure 2. A comparison of Canada's and the other G-7 countries IHR core capacities

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Infrastructure and medical devices

Concerning health infrastructure, Canada has a lower number of hospital beds per 10000 population than all the other G-7 countries [29]. For instance, the ratios of hospital beds in France, Germany, and Japan were 2-fold, 3-fold, and 5-fold, respectively. Hospitals are crucial for the provision of hospital-based emergency care services [30, 31], strengthening of capacities and supervision of other levels of care, and efficient functions of the referral system. Concerning medical devices, Canada had a higher density of radiotherapy units (per million population) than France, Germany, Italy, Japan, and the UK [28]. The density of health infrastructure may be a proxy (albeit imperfect) for the capacity to accommodate and provide hotel services for COVID-19 cases in need of inpatient care.

Service delivery

In the Declaration of Astana [32], the WHO Member States and stakeholders are committed to these issues:

"… strengthen health systems by investing in Primary Health Care (PHC) [to] provide a comprehensive range of services and care, including but not limited to vaccination; screenings; prevention, control and management of non-communicable and communicable diseases; care and services that promote, maintain and improve maternal, newborn, child and adolescent health; and mental health and sexual and reproductive health" (operative paragraph V).

According to the Declaration of Alma Ata [33], PHC also encompasses health education about current health challenges (such as COVID-19) and how to prevent and control them, improve food security and healthy diet, and safe water and basic sanitation. The PHC strategy is vitally important for preventing, diagnosing, contact tracing, containing the spread/transmission, and managing mild and moderate COVID-19 cases [34]. The Declaration of Astana views PHC as a cornerstone of a sustainable health system for the attainment of Universal Health Coverage (UHC) and health-related Sustainable Development Goals (SDG) [32].

The UN SDG 3, target 3.8, is about achieving UHC, which encompasses "financial risk protection, access to quality essential healthcare services and access to safe, effective, quality and affordable essential medicines and vaccines for all (p.16)" [35]. According to the WHO and the World Bank [36], the SDG indicator 3.8.1 is about coverage of essential health services, which is defined as the "… average coverage of essential services based on tracer interventions that include reproductive, maternal, newborn and child health; infectious diseases; noncommunicable diseases; and service capacity and access" (p. xiii). The SDG indicator 3.8.1 is tracked using the UHC service coverage index presented on a scale of 0% to 100% (target). As shown in Table 5, by subtracting the actual score from the target (100%), we realize that 11%, 22%, 17%, 18%, 17%, 13%, and 16% of people in need of essential health services in Canada, France, Germany, Italy, Japan, the UK, and the USA did not have access.

Health financing

As portrayed in Table 5, the portion of GDP (total output) spent on health in Canada of 10.6% was lower than those of France, Germany, Japan, and the USA. McIntyre, Meheus, and Røttingen [37] recommended: "… a target of government spending on health of at least 5% of GDP for progressing towards UHC" (p. 125). The government spending on health as a proportion of GDP was 7.8% in Canada, 8.7% in France, 8.7% in Germany, 6.5% in Italy, 9.2% in Japan, 7.6% in the UK, and 8.6% in the USA. Thus, all G-7 countries governments surpassed the threshold of spending 5% of GDP on health. It is worth noting that government spending as a percentage of GDP in France, Germany, Japan, and the USA is higher than Canada's.

Also, Canada's current health expenditure of Int$ 4929 per person was less than those of France, Germany, and the USA by Int$ 82, Int$ 994, and Int$ 5317 (Table 5). Canada's spending on PHC as a percentage of total health spending in Canada of 47% was reasonably comparable to 48% in Germany [38]. Thus, the PHC spending per person is almost Int$ 2,317 in Canada.

According to WHO [39], "It is only when the reliance on direct payments falls to less than 15%–20% of total health expenditures that the incidence of financial catastrophe routinely falls to negligible levels." Among the G-7 countries, only Italy whose out-of-pocket spending on health as a percentage of current health expenditure is higher than the threshold mentioned above. Canada and the other 5 G-7 countries have achieved those levels (Table 5). Nevertheless, 189070 (0.5%) Canadians with household expenditure on health greater than 25% of income are exposed to a high incidence of financial catastrophe and impoverishment [39].

Comparison of Canada's IHR core capacities with those of the other 6 G-7 countries

The 58 World Health Assembly adopted the revised International Health Regulations (IHR) [40] in 2005 through Resolution WHA58.3 [41]. The Resolution WH58.3 [41], operative paragraph 5(1), called upon the Member States to "to build, strengthen and maintain the capacities (to detect, assess, notify and report public health events/emergencies) required under the IHR, and to mobilize the resources necessary for that purpose" (p. 4).

According to WHO [42], there are 13 IHR core capacities: national legislation, policy and financing; coordination and national focal point functions; national emergency framework; surveillance; response; preparedness (public health emergency response plans, mapping of potential hazards and hazard sites, development of appropriate national stockpiles of resources); risk communication (establish communication policies and procedures, develop communication plans, dissemination of health risk information to the public); human resources (skills

and competencies of public health personnel); laboratory (for reliable and timely laboratory identification of infectious agents and other hazards); zoonotic events; food safety events; chemical events; and radiological and nuclear emergencies. Each member state self-assesses on a scale of 0 (non-existent) to 100 (target) each of the abovementioned IHR core capacities, and then an average score is calculated. Figure 2 provides a comparison of the G-7 countries IHR core capacity scores.

Source: Generated by authors using data from WHO [43]

In 2019, Canada self-assessed the 13 core capacities in Figure 2 to be on target or optimal (100) [43]. The average of 13 IHR core capacities score for Canada of 99% was higher than 82% in France, 88% in Germany, 85% in Italy, 95% in Japan, 93% in the UK, and 92% in the USA [6]. However, how come that the total COVID-19 cases and deaths per million population in Canada are higher compared to those of, for example, Germany and Japan. According to Althubaiti [44], "… self-reported data are often argued to be unreliable and threatened by self-reporting bias. … bias can arise from social desirability, recall period, sampling approach, or selective recall".

Study limitations

There are some study limitations. First, the current study excluded the resources used in COVID-19 testing, contact tracing and quarantine, transportation, hospitalization (bed, food, water, soap, towels), treatment (time on ventilators, medicines), interment [21, 22], and psychological effects on the dead (fear, anxiety, and pain before death) and family members (grief and social stigma) [45].

Second, per capita GDP ignores the contribution of economic production processes to environmental degradation, improvements of ozone layer following COVID-related economic lockdown, inequalities in the distribution of income and wealth within society, and quality of life [46, 47].

Third, some critics may take issue with the approach taken by the researchers to value the years of life lost among the elderly (60 years and older) at the same net GDP per capita as the younger folk. The same net GDP per capita was used even for the elderly because they contribute to society through consumption of goods and services, participation in the formal (or informal) workforce, payment of taxes, cash and asset transfer to younger generations, entrepreneurship and investment, innovation, social and cultural contribution, and social cohesion [48, 49].

5. Conclusion

The study succeeded in assessing the dollar value of human life losses associated with COVID-19 in Canada. The average value of human life lost is 4-fold the GDP per person in Canada. Therefore, to prevent human life and economic losses from the ongoing and future pandemics, Canada needs to grow its investments into the national health system to bridge the existing gap of 11% in the UHC service coverage index; the 1% gap in IHR capacities; and the 1% and 18% gaps coverage gaps of Canada's population without access to safely-managed drinking-water and sanitation [7]. It is vital that Canada bridges the remaining gaps in coverage of essential health services and safely managed drinking water and sanitation services not only for economic reasons but also because those services are human rights [50].

Ethical Considerations

Compliance with ethical guidelines

The ethical approval was unnecessary because the study analyzed data from the Canada Government, Worldometer, IMF, and WHO databases. Those databases are freely available to the public.

Funding

This research did not receive any grant from funding agencies in the public, commercial, or non-profit sectors.

Authors' contributions

Conceptualization and supervision, and writing – original draft: Joses Muthuri Kirigia; Writing – original draft, writing – review & editing: Rose Nabi Deborah Karimi Muthur; Methodology, data collection, data analysis: Both authors.

Conflict of interest

The authors declared no conflict of interest.

Acknowledgments

We are grateful to Lenity Honesty Kainyu Nkanata for creating an enabling living and working environment. The Pharmaceutical and Biomedical Research Editor-in-Chief and anonymous peer reviewers' valuable suggestions helped improve this paper's quality.

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