COVID-19 Economic Costs and the Implicit Value of a Life-Year in Canada

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Canadian Health Policy, June 2020. ISSN 2562-9492 canadianhealthpolicy.com

ABSTRACT

Governments around the world use health technology assessment (HTA) to inform price negotiations between publicly funded drug plans and pharmaceutical manufacturers. HTA relies on pharmacoeconomic concepts like incremental cost effectiveness ratios (ICERs) which are derived from statistics like disability-adjusted life-years (DALYs) or quality-adjusted life-years (QALYs). The Canadian Agency for Drugs and Technology in Health (CADTH) conducts HTA of new medicines on behalf of federal, provincial and territorial publicly funded drug plans using such pharmacoeconomic methods. The federal government's drug price regulator known as the Patented Medicine Prices Review Board (PMPRB) also intends to introduce pharmacoeconomic factors into its price control guidelines later this year. The cost effectiveness thresholds used by CADTH and intended for use by the PMPRB are calculated from life-year valuations that are lower than the values assigned by other countries. Medications priced above the threshold are not eligible for reimbursement. CADTH and PMPRB have justified the cost effectiveness thresholds on the basis of their respective mandates to consider the affordability constraints of public payers. Yet, as of June 12, 2020, the total cost of COVID-19 pandemic related spending by the federal government and associated GDP losses resulting from public health measures imposed by Canadian governments could exceed $391 billion. This raises an important question about how many potential deaths were avoided by imposing mass quarantine on Canadians. The cost per life saved has implications for the economic value of a life-year when used as a tool to set Canadian public policies like the PMPRB's new price control guidelines. This brief analysis calculates the economic value of a life-year implied by the costs of the federal government's policy response to COVID-19 and compares this to the cost effectiveness thresholds used by CADTH and PMPRB.

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SUBMISSION DATE

June 15, 2020

PUBLICATION DATE

June 18, 2020 (Updated to incorporate new data released on June 18, 2020)

REVIEW STATUS

Expedited.

INTRODUCTION

Governments around the world use health technology assessment (HTA) to inform price negotiations between publicly funded drug plans and pharmaceutical manufacturers. HTA relies on pharmacoeconomic concepts like incremental cost effectiveness ratios (ICERs) which are derived from the notional economic value of a human life represented by statistics like disability-adjusted life-years (DALYs) or quality-adjusted life-years (QALYs). In Canada, the Canadian Agency for Drugs and Technology in Health (CADTH) conducts HTA of new medicines on behalf of federal, provincial and territorial publicly funded drug plans using such pharmacoeconomic methods. On the basis of these assessments CADTH makes recommendations regarding whether or not a new drug should be included on publicly funded drug plan formularies.

All patented medicines sold in Canada are also subject to price regulation by the federal government's quasi-judicial tribunal known as the Patented Medicine Prices Review Board (PMPRB). In January 2021, the PMPRB will implement revised regulatory guidelines governing price controls for innovative medicines (patented prescription drugs). The guidelines introduce several rule changes, one of which is the addition of pharmacoeconomic value assessment. According to the draft guidelines published by the PMPRB, "the Incremental Cost-Effectiveness Ratio ("ICER") measured in cost per quality-adjusted life-years ("QALYs") for each indication of a patented medicine will be identified from the cost-utility analyses filed by the patentee. The ICER will be compared against the applicable Pharmacoeconomic Value Threshold ("PVT") of $60,000 per QALY. The price at which the patented medicine's ICER would be equivalent to the PVT will be deemed the "Pharmacoeconomic Price" ("PEP"). The PEP will be enforced as a maximum ceiling price." (PMPRB 2019)

The cost effectiveness thresholds used by CADTH and intended for use by the PMPRB are substantially lower than the values assigned by other countries. A 2018 study reviewed the cost effectiveness (CE) thresholds used by the HTA process in 17 countries (Cameron et al 2018). CE thresholds ranged from 102% of per capita GDP in Sweden up to 391% of per capita GDP in Belgium. On average CE thresholds were 215% of per capita GDP. By contrast, the new guidelines proposed by the PMPRB will use a CE threshold of C$60,000, which is approximately 100% of Canada's GDP per capita in 2018 of C$60,555.

CADTH and PMPRB have justified the cost effectiveness thresholds on the basis of their respective mandates to consider the affordability constraints of public payers. However, the government response to the COVID-19 pandemic has exposed a double standard in regard to its willingness to spend on health. Federal and provincial governments imposed mass quarantine on the grounds that it was necessary to prevent the loss of human life from COVID-19. As of June 12, 2020, the total cost of pandemic related spending by the federal government and associated GDP losses resulting from public health measures imposed by Canadian governments could exceed $391 billion.

The enormous costs should raise an important question about how many potential deaths were avoided by imposing mass quarantine on Canadians. The cost per life saved has implications for the economic value of a life-year when used as a tool to set Canadian public policies like the PMPRB's new price control guidelines. This brief analysis calculates the economic value of a life-year implied by the costs of the federal government policy response to COVID-19 and compares this to the cost effectiveness thresholds used by CADTH and PMPRB.

The issue is important from a policy perspective because the use of pharmacoeconomic assessment and other rule changes will have a significant impact on the prices of patented drugs. The PMPRB estimated that the combined changes would reduce the price ceilings for new medicines by more than half. Independent research has shown that the changes could reduce the maximum list prices allowed for innovative medicines by as much as 84 percent from current levels (Rawson and Lawrence 2020). Empirical research suggests that a severe reduction in prices will discourage pharmaceutical companies from launching new products in Canada (Skinner 2019) and cause a decline of industry investment in clinical trials in Canada (Skinner 2018). Both of which would reduce the availability of new innovative therapies for Canadian patients.

METHOD

The most recent data on deaths from COVID-19 by country were obtained from Johns Hopkins University's COVID-19 website, which is widely considered to be an authoritative and accurate source. The data were current to June 12, 2020 (JHU 2020). Data were collected for Canada, the United States, Sweden and the United Kingdom. These countries were selected on the basis of geographic proximity, difference in policy response and relatively high rates of death from COVID-19 compared to Canada. CAN, USA, SWE and the UK all experienced their first case of COVID-19 near the end of January 2020.

The most recent comparable population data were obtained from the national statistical agencies for each country current to June 30, 2019 (StatCan 2020a, Census Bureau 2020, SCB 2020, ONS 2020) . Death rates were calculated as a percentage of the national population. The death rates associated with each country were used to project potential Canadian deaths if Canada had experienced the death rates associated with each country. These scenarios were used as a benchmark to measure avoidable deaths due to policy differences. (TABLE 1)

A benchmark representing the worst-case scenario was added based on research published by the Imperial College of London, UK at the beginning of the pandemic. Using data from the Chinese experience the study estimated that the death rate from COVID-19 was 0.9% of the infected population. (Ferguson et al 2020) For the worst-case scenario the 0.9% death rate was applied to the Canadian population to project maximum potential Canadian deaths. (TABLE 1)

Data on the Canadian age distribution of deaths from COVID-19 were not available from Johns Hopkins University. The Public Health Agency of Canada publishes a weekly detailed epidemiological report that contains the age distribution of deaths from COVID-19 (PHAC 2020). The most recent report was current to June 8, 2020. The data allowed for a projection of Canadian deaths by age group applied against the updated data from Johns Hopkins University for Canada under five scenarios: actual Canadian deaths, and potential Canadian deaths at the respective rates experienced by the USA, SWE and the UK; and a worst-case scenario (WC). (TABLE 2)

The most recent estimates of average life expectancy for each age group were calculated from data obtained from the 2016-2018 Life-Year tables published by Statistics Canada (StatCan 2020b). These data were multiplied by the number of deaths in each age group projected under each of the scenarios to estimate the number of life-years lost in each age group. (TABLE 3) The number of deaths avoided by Canada's policy response to COVID-19 was calculated as the difference between actual Canadian deaths and potential deaths projected at the rates experienced by the USA, SWE, the UK and the WC. The same calculation was applied to estimate the number of potential life-years saved by Canada's policy response to COVID-19. (TABLE 4)

Data on government spending and GDP losses associated with COVID-19 were obtained from the Parliamentary Budget Officer (PBO 2020) current to June 12, 2020. The total economic cost was divided by the number of deaths avoided under each scenario to produce an estimate of the cost per death avoided. The same calculation was performed to estimate the cost per life-year saved. (TABLE 5)

The most recent data on the leading causes of death in Canada were obtained from Statistics Canada. (TABLE 6) The data were used to compare the number of deaths from COVID-19 to other leading causes of death.

RESULTS

The first confirmed case of COVID-19 occurred at the end of January 2020 in CAN (January 25), the USA (January 22), SWE (January 31) and the UK (January 30). The analysis therefore covers roughly the same period of time in each country.

TABLE 1 shows that death rates were 0.02% of the population in CAN, 0.035% in the USA, 0.047% in SWE, 0.062% in the UK and 0.900% for the WC scenario. The death rates were used to project scenarios representing potential deaths in Canada if the country had experienced the same death rate experienced in the USA, SWE, the UK and the WC. As of June 12, 2020, actual Canadian deaths from COVID-19 numbered 8,124. If

Canada had experienced the death rates that occurred in the USA, SWE and the UK the corresponding number of deaths would have been 13,109, 17,747 and 23,391 respectively. Under the WC scenario the number of deaths could have reached 338,303. (TABLE 1)

TABLE 1. COVID-19 DEATHS BY COUNTRY JUNE 12, 2020; PROJECTED CAN DEATHS AT USA, SWE AND UK RATES; AND WORST-CASE RATE.

COUNTRY	POPULATION	DEATHS	RATE	PROJECTED CAN DEATHS
CAN	37,589,262	8,124	0.022%	8,124
USA	328,234,721	114,469	0.035%	13,109
SWE	10,281,189	4,854	0.047%	17,747
UK	66,796,807	41,566	0.062%	23,391
WC			0.900%	338,303

The most recent data available on the distribution of COVID-19 deaths by age in Canada were current to June 8, 2020. Assuming that the distribution remained constant between June 8 and June 12 the age distribution of COVID-19 deaths were projected for each scenario shown in TABLE 2. The data indicate that the highest percentage of deaths occur among older populations. Over 97% of COVID-19 deaths affected people age 60 years or older. No deaths were reported for people aged 19 years or younger.

TABLE 2. CANADA COVID-19 DEATHS ACTUAL VS POTENTIAL.

DISTRIBUTION BY AGE JUNE 8, 2020			DISTRIBUTION BY POTENTIAL RATE				
AGE GROUP	DEATHS	% TOTAL	0.022%	0.035%	0.047%	0.062%	0.900%
0-19	-	0.0%	-	-	-	-	-
20-39	22	0.3%	23	37	50	66	949
40-59	208	2.7%	215	348	471	620	8,971
60-79	1,959	25.0%	2,029	3,274	4,432	5,842	84,490
80+	5,655	72.1%	5,857	9,451	12,794	16,863	243,894
TOTAL	7,844	100.0%	8,124	13,109	17,747	23,391	338,303

The age distribution of COVID-19 deaths is important for the calculation of life-years lost shown in TABLE 3. Life expectancy varies by age group. For people aged 19 years or younger life expectancy averaged 72.9 years. For people aged 80 years or older life expectancy averaged 4.4 years. Total life-years lost due to COVID-19 under each scenario were estimated as follows: actual death rate 0.022% = 69,919.9 LY, potential death rates 0.035% = 112,823.1 LY, 0.047% = 152,739.3 LY and 0.062% = 201,315.4 LY. Under the WC scenario: 0.900% = 2,911,635 LY.

TABLE 3. CANADA COVID-19 LIFE-YEARS LOST ACTUAL VS POTENTIAL.

AGE GROUP	AVG LIFE EXP YRS	LYs 0.022%	LYs 0.035%	LYs 0.047%	LYs 0.062%	LYs 0.900%
0-19	72.9	-	-	-	-	-
20-39	53.5	1,218	1,965	2,660	3,507	50,715
40-59	34.5	7,436	12,000	16,245	21,411	309,673
60-79	17.5	35,476	57,244	77,497	102,143	1,477,300
80+	4.4	25,790	41,614	56,337	74,255	1,073,947
	TOTAL	69,920	112,823	152,739	201,315	2,911,635

TABLE 4 shows the number of deaths avoided and life-years saved, calculated as the difference between Canada's actual experience and the potential experience represented by the other scenarios. There were 4,985 deaths avoided and 42,903 life-years saved compared to scenario 2 (0.035% death rate); 9,623 deaths avoided and 82,819 life-years saved compared to scenario 3 (0.047% death rate); 15,267 deaths avoided and 131,396 life-years saved compared to scenario 4 (0.062%); and 330,179 deaths avoided and 2,841,716 life-years saved compared to the WC scenario (0.900%).

TABLE 4. CANADA DEATHS AVOIDED AND LIFE-YEARS SAVED VS POTENTIAL.

DEATH RATE	TOTAL DEATHS	TOTAL LY LOST	DEATHS AVOIDED	LY SAVED
0.022%	8,124	69,919.9	-	-
0.035%	13,109	112,823.1	4,985	42,903
0.047%	17,747	152,739.3	9,623	82,819
0.062%	23,391	201,315.4	15,267	131,396
0.900%	338,303	2,911,635	330,179	2,841,716

TABLE 5 shows the cost per potential death avoided and the cost per life-year saved based on the COVID-19 related government spending and GDP losses reported on June 18, 2020 by the Parliamentary Budget Officer citing data current to June 12, 2020. To date, federal government spending alone (excluding provincial government expenditures related to COVID-19) totals more than $169.2 billion. In addition, according to the PBO, "Relative to a counterfactual scenario in which the COVID-19 pandemic and oil price shocks did not occur, nominal GDP in 2020 would be $222 billion (9.3 per cent) lower." (PBO 2020) Total costs to date could be more than $391 billion.

The cost per death avoided was more than $78 million versus scenario 2 (0.035% death rate), almost $41 million versus scenario 3 (0.047% death rate), over $25 million versus scenario 4 and nearly $1.2 million versus the WC scenario. Cost per life-year saved was $9.1 million versus scenario 2, over $4.7 million versus scenario 3, almost $3 million versus scenario 4 and nearly $138,000 versus the WC scenario.

TABLE 5. CANADA COVID-19 COST PER POTENTIAL DEATH AVOIDED AND PER LIFE-YEAR SAVED.

Government Spending	$	169,200,000,000
GDP Loss	$	222,000,000,000
Total Costs	$	391,200,000,000
Cost Per Death Avoided: By Potential Death Rate		
0.035%	$	78,476,564
0.047%	$	40,653,418
0.062%	$	25,624,117
0.900%	$	1,184,812
Cost Per Life-Year Saved: By Potential Death Rate		
0.035%	$	9,118,204
0.047%	$	4,723,527
0.062%	$	2,977,270
0.900%	$	137,663

TABLE 6 shows the most recent available data on the number of deaths in 2018 from the leading causes in Canada for comparison to the number of deaths from COVID-19 to date. As of June 12, 2020, deaths from COVID-19 totaled 8,124 over the nearly five months since Canada's first confirmed case on January 25. This is roughly the same period of time for the typical flu season. By comparison, over 12 months in 2018 there were almost 80,000 deaths due to cancer (malignant neoplasms), over 66,000 deaths due to heart disease and stroke (cardiovascular, cerebrovascular), over 13,000 deaths due to accidents, almost 13,000 deaths due to chronic respiratory diseases and over 8,500 deaths due to influenza and pneumonia.

TABLE 6. LEADING CAUSES OF DEATH (ICD-10) 2018.

Malignant neoplasms [C00-C97]	79,536
Diseases of heart [I00-I09, I11, I13, I20-I51]	53,134
Cerebrovascular diseases [I60-I69]	13,480
Accidents (unintentional injuries) [V01-X59, Y85-Y86]	13,290
Chronic lower respiratory diseases [J40-J47]	12,998
Influenza and pneumonia [J09-J18]	8,511
Diabetes mellitus [E10-E14]	6,794
Alzheimer's disease [G30]	6,429
Intentional self-harm (suicide) [X60-X84, Y87.0]	3,811
Nephritis, nephrotic syndrome and nephrosis [N00-N07, N17-N19, N25-N27]	3,615
Chronic liver disease and cirrhosis [K70, K73-K74]	3,514
Assault (homicide) [X85-Y09, Y87.1]	373

POLICY DISCUSSION

A fair assessment of government policy responses to the COVID-19 pandemic must acknowledge the context regarding information available at the time (mid-March) when the decision was made to impose mass quarantine. Governments in China, Italy, Spain and France had also imposed society wide lockdowns to contain the virus. The best available science was based on the study published by the Imperial College of London, which estimated that if COVID-19 was left unchecked by mass quarantine it would result in a potential death rate of 0.9% of the population based on the Chinese experience prior to its lockdown. A 0.9% death rate would have resulted in more than 338,000 Canadian fatalities due to COVID-19.

It is perhaps too early to conduct a definitive analysis because the pandemic is not yet over. However, Canadian daily case counts peaked in early May and have since declined steadily (JHU 2020). Unless Canada experiences a massive increase in a second wave, it is very unlikely that the country will come anywhere near a 0.9% death rate from COVID-19. The actual death rate so far in Canada of 0.022% is 41 times smaller than the death rate predicted by the Imperial College study. Even the UK's death rate of 0.062% is 14 times smaller.

Countries took different approaches regarding the use and timing of mass quarantine policy responses. Canada moved into a full lockdown. Some US states moved into lockdown, while others have not locked down at all. Some states were also quicker to lift the lockdown. The UK government at first seemed reluctant to impose a national lockdown but under public pressure subsequently moved to mass quarantine. By contrast, Sweden did not impose mass quarantine but instead chose a more targeted approach focused on protecting vulnerable populations. Interestingly, Sweden's daily case count has remained relatively flat during the entire course of the pandemic so far and its death rate of 0.047% is almost 20 times smaller than the death rate predicted by the Imperial College study.

Furthermore, to date the number of deaths due to COVID-19 are roughly the same as the annual number of deaths from influenza and pneumonia in Canada and is vastly exceeded by annual deaths attributable to cancer or heart disease and stroke. Again, COVID-19 death rates in Canada would have to grow exponentially for the remainder of the year to come close to matching deaths due to several other leading causes.

All of this raises the question about whether it was necessary for the government of Canada and its provincial counterparts to impose mass quarantine. The data analyzed in this study suggest the Swedish approach could have doubled the number of deaths experienced in Canada to date. However, Sweden might avoid a second wave as its policy response will likely allow it to reach ‘herd immunity’ (Fine 2011) quicker than Canada, the United States and the UK which will likely see a spike in the number of cases as they reopen their societies. This could result in the convergence of death rates across countries.

Other countries not included in this study like Taiwan and South Korea did not impose mass quarantine and avoided the enormous economic damage caused by such measures taken in other countries like Canada, the UK, Italy, Spain, France and even partly in the USA. Importantly, Taiwan and South Korea both report much lower numbers for cases and deaths from COVID-19 relative to Canada. Both countries took a more targeted approach focused on mass testing, contact tracing, isolating positive cases and focusing resources on vulnerable populations. To date neither country’s healthcare system has been overwhelmed by caseloads.

Nevertheless, federal and provincial policy responses to COVID-19 imply a much higher willingness-to-pay for the preservation of human life than is currently applied to the cost effectiveness thresholds used by CADTH and PMPRB to assess the value of new medicines in Canada. CADTH does not publish an official cost effectiveness threshold but has cited $50,000 in some of its documents (CADTH 2017). PMPRB proposes to use a cost effectiveness threshold of $60,000 under the new guidelines to be implemented in January 2021.

By comparison, the value of a life-year implied by the costs associated with the federal government policy response to COVID-19 could range from almost $3 million to $9.1 million depending on the three real-world scenarios presented in this paper. Even the worst-case scenario implies a life-year value of almost $138,000. The findings of the study suggest that CADTH and PMPRB cost effectiveness thresholds do not reflect the actual willingness-to-pay for the preservation of human life implied by Canada's COVID-19 policy response.

LIMITATIONS

GDP losses attributed to the policy responses of governments to COVID-19 are partly attributable to oil price shocks. The PBO did not report the COVID-19 impact separately from the oil price shock. This study overestimates GDP losses directly attributable to government policy responses to COVID-19, by the portion of those costs attributable to the oil price shock.

However, the analysis excludes COVID-19 related expenditures of provincial and territorial governments and also excludes expenditures of municipal governments. If these costs were included it would increase the total costs estimated by this study.

Further, the estimate of the cost per death avoided and per life-year saved could be as much as 20% higher because research suggests that herd immunity is achieved when 80% of the population has been exposed to a virus. This means that the worst-case scenario death rate should only apply to 80% of the population. If so, the number of deaths avoided and life-years saved would be reduced, thereby increasing the cost per each variable.

Finally, the estimate of deaths avoided and life-years saved attributes the results entirely to differences in policy responses to COVID-19 between countries. There might in fact be other explanations for the differences observed. In which case, the cost per death avoided and life-year saved would increase.

REFERENCES

CADTH (2017). Guidelines for the economic evaluation of health technologies: Canada. 4th ed. Appendix — worked example. Ottawa: CADTH; 2017 Jul. https://www.cadth.ca/sites/default/files/pdf/economic_guidelines_worked_example.pdf

Cameron, David et al (2018). On what basis are medical cost-effectiveness thresholds set? Clashing opinions and an absence of data: a systematic review. GLOBAL HEALTH ACTION, 2018. VOL. 11, 1447828. https://doi.org/10.1080/16549716.2018.1447828.

Ferguson, Neil M et al (2020). Impact of non-pharmaceutical interventions (NPIs) to reduce COVID-19 mortality and healthcare demand. Imperial College COVID-19 Response Team. WHO Collaborating Centre for Infectious Disease Modelling MRC Centre for Global Infectious Disease Analysis Abdul Latif Jameel Institute for Disease and Emergency Analytics Imperial College London. 16 March 2020. https://doi.org/10.25561/77482

Fine, Paul et al (2011). "Herd Immunity": A Rough Guide, Clinical Infectious Diseases, Volume 52, Issue 7, 1 April 2011, Pages 911–916, https://doi.org/10.1093/cid/cir007

Johns Hopkins University (2020). COVID-19 Dashboard by the Center for Systems Science and Engineering (CSSE). https://coronavirus.jhu.edu/data/mortality

Parliamentary Budget Officer (2020). Scenario Analysis Update: COVID-19 Pandemic and Oil Price Shocks. June 18, 2020. https://www.pbo-dpb.gc.ca/web/default/files/Documents/Reports/RP-2021-009-S/RP-2021-009-S_en.pdf

PMPRB (2019). Guidelines. https://www.canada.ca/content/dam/pmprb-cepmb/documents/consultations/draft-guidelines/draft-guidelines-en.pdf

Public Health Agency of Canada (2020). Coronavirus Disease 2019 (COVID-19). Weekly Epidemiology Update (4-10 June, 2020). Published: 12 June 2020. https://www.canada.ca/content/dam/phac-aspc/documents/services/diseases/2019-novel-coronavirus-infection/surv-covid19-epi-update-eng-20200406.pdf

Rawson, Nigel SB; Lawrence, Donna (2020). New Patented Medicine Regulations in Canada: Updated Case Study of a Manufacturer's Decision-Making about a Regulatory Submission for a Rare Disorder Treatment. Canadian Health Policy, January 2020. https://www.canadianhealthpolicy.com/products/new-patented-medicine-regulations-in-canada--updated-case-study---en-fr-.html

Sanche S et al (2020). High contagiousness and rapid spread of severe acute respiratory syndrome coronavirus 2. Emerg Infect Dis. 2020 July. https://doi.org/10.3201/eid2607.200282

Skinner, Brett J (2018). Consequences of over-regulating the prices of new drugs in Canada. *Canadian Health Policy*, March 27, 2018. https://www.canadianhealthpolicy.com/products/consequences-of-over-regulating-the-prices-of-new-drugs-in-canada.html

Skinner, Brett J (2019). Patented drug prices and clinical trials in 31 OECD countries 2017: implications for Canada's PMPRB. *Canadian Health Policy*, August 2019. https://www.canadianhealthpolicy.com/products/patented-drug-prices-and-clinical-trials-in-31-oecd-countries-2017--implications-for-canada---s-pmprb-.html

Statistics Canada (2020a). Table 17-10-0005-01. Population estimates on July 1st, by age and sex. National population at July 1, 2019. https://doi.org/10.25318/1710000501-eng.

Statistics Canada (2020b). Life tables, Canada, provinces and territories, catalogue no. 84-537-X. 2016/18. https://www150.statcan.gc.ca/n1/en/catalogue/84-537-X

Statistics Canada (2020c). Table 13-10-0394-01. Leading causes of death, total population, by age group. https://doi.org/10.25318/1310039401-eng

Statistics Sweden SCB (2020). National population at June 30, 2019. https://www.scb.se/en/finding-statistics/statistics-by-subject-area/population/population-composition/population-statistics/pong/tables-and-graphs/quarterly-population-statistics--municipalities-counties-and-the-whole-country/quarter-2-2019-/

UK Office for National Statistics (2020). National population at June 30, 2019. https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates

US Census Bureau (2020). National population at June 30, 2019. https://www.census.gov/popclock/