



Potential Years of Life Lost and Its Implication on Economic Output: Assessment of OECD Members and Candidate Countries for the Period 1993-2018

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Abstract

Over the last 30 years, significant geopolitical, social, and economic changes have impacted the OECD members and candidates, which has led to a significant improvement in the quality of life and life expectancy, with the reduction of the potential years of life lost one of the indicators of reduced mortality observed across the group. On the geopolitical side, the admission of the Baltic countries and their standardization of the metrics to track demographics more aligned with the internationally accepted practices, on the social side; the increase in life expectancy poses challenges to the care of the elders but also the extension on the age within the labor force and lastly, on the economic changes; the ongoing increase of income and GDP has led to an expanded access of care including goods and services. This paper explores the use of mortality information and potential years of life lost as a beacon to point toward the economic burden of poor health and its related mortality.

Keywords: *potential years of life lost, burden of mortality, OECD, economic epidemiology*

JEL Classification: *I0, I15*

Introduction

The relationship between economic growth and population has been studied extensively, with some researchers predicting slower economic growth in high-income countries as a direct consequence of the negative trends in population growth [Sadigov, 2022]. Others believe that economic growth will continue to be problematic as the population growth remains high, and that must be matched with the inherent nature of finite resources, therefore posing a challenge only due to the scarcity of materials [Baker, 2005].

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Whilst most research in the field has focused on general demographic trends such as birth rate and life expectancy, limited evidence uses specific information about the

causality of life expectancy reduction and, more specifically, the cause of mortality and its impact on potential years of life lost [OECD, 2023] (PYLL). Moreover, the impact on human capital as a consequence of loss of human life is seldom addressed in research.

Although there are several tools available for economists to assess the impact of health and health outcomes that can be used to evaluate, compare, and draw conclusions about the performance of a healthcare system, its financing structure and overall, the risk a given population might be exposed; altogether defined as health status (OECD). The use of these tools is largely reliant on birth, life expectancy, and mortality, both crude and standardized. Is it the latter datasets that are most useful to draw conclusions around the causality of loss of life and its impact on the demographic composition of a country or group of countries?

Albeit there are many factors driving economic growth, like availability of qualified hand labor, effective productivity, access to technologies, and ever-so-increased productivity [OECD, 2023], the importance of human capital in economic growth is certainly relevant [Gardner, 2023]. This human capital can be increased or be significantly lost due multiple factors, but more notorious are the effectiveness of the educational systems, the succession strategies within specific areas of economic output (through apprenticeship programs) and the incorporation of qualified hand labor after tertiary education. The loss of life over an individual's direct external productivity brings negative impacts to the economic output broadly speaking, and the loss of paid and unpaid productivity at microeconomic level, which in turn may impact the inequalities of a given society.

To better understand the impact on productivity and economic output, this paper pursues an assessment of multiple subsets of data from OECD Economies and candidate countries that provide information about the mortality trends between 1993 and 2018. These data sets can extract specific information related to potential years of life lost, the cause of mortality (total mortality, non-communicable diseases mortality, cardiovascular diseases mortality) [OECD, 2023; WHO, 2023], and the cumulative mortality for the period. To draw adequate conclusions, the datasets have been assessed both from crude mortality (all causes) and standardized mortality (adjusted to non-communicable diseases and cardiovascular diseases related deaths) and standardized from a population perspective (deaths over 100,000 inhabitants) to reduce the distortion provided when comparing countries with significantly different populations.

The PYLL has been standardized for both genders, not keeping into consideration the significant differences in mortality based on genders (Female mortality range 70,6 – 87,7, median 81,3; Male mortality range 60,6-82,1, median 75,5).

Data and methodological aspects. General aspects of the data sets

This paper focuses on the analysis of data from 1993 to 2018 using datasets from WHO8 and OECD [OECD, 2023; WHO 2023] to assess the trends in mortality and its impact on potential years of life loss in the selected countries. The data sets were filtered to include the aforementioned period. This period was selected based on 2 criteria: a) obtain datasets for all the countries, b) ensure a sufficient period of data to draw conclusions by assessing trends. The datasets were separated based on source and criteria. The most relevant are all mortality data (crude), and additional data sets include total population (MM inhabitants), total GPD (MM current USD), and average income (MM USD adjusted) for

the period. These data sets estimated the annual loss of direct income for the overall population based on PYLL, and comparisons were drawn based on each country's GDP.

For the mortality data sets, these were obtained as crude death rates and were crossed with population information for each of the years included in the scope of this research to obtain standardized death rates for each indicator based on mortality over 100,000 inhabitants of the selected countries. This enables a better assessment of the distortion of net mortality for a larger or smaller population, allowing for an accurate and standardized comparison of the mortality information. The mortality datasets were collected for all mortality without differences based on gender. Although mortality and PYLL rates over 100,000 inhabitants are useful metrics and, moreover, commonly used in epidemiological assessments, the net number of deaths is required to estimate the actual economic output impact from the excess mortality attributed to PYLL.

A quartile assessment was conducted to better assess the data, categorized based on the quartiles associated with the PYLL standardized over 100,000 inhabitants. This assessment generated 4 clusters described on Table 1.

Potential years of life lost conversion.

To calculate the PYLL, the standard PYLL formula was utilized (Formula 1) to obtain the specific numbers of cumulative PYLL for each country, standardized for 100,000 inhabitants.

Equation 1: Potential years of life lost, standardized at 69 years of age.

$$\sum_{K:n}^{69} Di(L1)$$

Variables: 1: Age at death; L: Life expectancy
(Source: Author's Contribution, 2023)

This information provides the base for estimating the economic impact of the PYLL adjusted by the economies size, population, and specific mortality information. The assessment of the beforementioned datasets was done with Microsoft® Excel, version 16.71 and the data analysis were done using IBM SPSS Statistics Version 29.0.0.

Results and discussion

Trends in Potential years of life lost

A Pearson regression model was used to assess the trend in PYLL within the period 1993-2018. The results show a strong to less strong coefficient of determination, with a steep downward trend in the PYLL (N=38, R² M = .9375, SD .093 minimum 0.517 – maximum .989). Five countries (United States, Mexico, Costa Rica, Lithuania, and Latvia; 13.1% of the sample) show a less strong to strong coefficient of determination (R² M = .77, SD .11 minimum 0.517 – maximum .81) with only one of them on the lower end of the spectrum (Latvia, R² M = .52). These results are in line with general observations of mortality (for all causes) and increased in life expectancy, therefore reducing the potential years of life list. Table 1.

Table 1.

Coefficient of determination for PYLL

Country	R	R Square	Adjusted R Square	Std. Error of the Estimate	Sample Size
Latvia	0.72	0.52	0.5	6384.32	26
Lithuania	0.87	0.76	0.75	956.89	26
Costa Rica	0.88	0.77	0.76	345.26	26
Mexico	0.88	0.77	0.76	450.36	26
United States	0.9	0.81	0.8	297.28	26
Germany	0.97	0.93	0.93	243.49	26
Brazil (*)	0.97	0.94	0.93	328.78	25
Colombia	0.97	0.95	0.95	434.45	26
Luxemburg	0.98	0.95	0.95	290.9	26
Romania	0.98	0.95	0.95	489.74	26
Bulgaria (*)	0.98	0.96	0.96	253.81	26
Croatia (*)	0.98	0.96	0.96	309.06	25
Italy	0.98	0.96	0.96	191.3	26
Sweden	0.98	0.96	0.96	121.1	26
Australia	0.98	0.96	0.96	152.9	25
Austria	0.98	0.96	0.96	199.13	26
New Zealand	0.98	0.97	0.97	179.9	24
Ireland	0.98	0.97	0.97	201.55	24
Netherlands	0.98	0.97	0.97	152.76	26
Portugal	0.99	0.97	0.97	243.27	23
Slovenia	0.99	0.97	0.97	278.42	26
Switzerland	0.99	0.97	0.97	157.41	26
Chile	0.99	0.97	0.97	157.41	26
Poland	0.99	0.97	0.97	246.97	24
Korea	0.99	0.97	0.97	295.45	26
Hungary	0.99	0.98	0.98	348.68	26
Israel	0.99	0.98	0.97	143.22	26
Czechia	0.99	0.98	0.98	204.99	26
United Kingdom	0.99	0.98	0.98	114.98	26
Spain	0.99	0.98	0.98	139.3	26
Japan	0.99	0.98	0.98	80	26
Denmark	0.99	0.99	0.99	147.87	26
Finland	0.99	0.99	0.98	114	26
France	0.99	0.99	0.99	102.44	25
Slovakia	0.99	0.99	0.99	148.19	24
Belgium	1	0.99	0.99	91.72	26
Canada	1	0.99	0.99	91.72	26
Norway	1	0.99	0.99	87.3	24

(*) Candidates Countries. Created based on information from OECD (2023), Potential years of life.
(Source: Author's Contribution, 2023)

It is noteworthy to elaborate on the lower end of this list, with Latvia and Lithuania having the lowest coefficient of determination, which can be explained by a rather significant reduction in the PYLL from 1993 to 2018 (Latvia 39.584 in 1993 to 8.773 in 2018 and Lithuania 15.465 in 1993 to 9.326 in 2018). Moreover, this reduction faces a significant deceleration on the decline linked to both the small population of both countries and the asymptotic nature of reduction in mortality once this approaches OECD reference values.

In general, this downward trend is consistent with two primary drivers: the standardization of the methodology to calculate PYLL and the effectiveness of the public health programs to address risk factors among the general population (e.g., safe surgery programs, improvement to access to care, improvement of neonatal care, access to potable water). The current PYLL reduction programs are, therefore, in general, more structural in nature, which may be more difficult to address as they may require health policy changes, investment in infrastructure, addressing increased morbidities within the population, and improving access to care in both proximity and health care professionals availability.

Correlation assessment

A Pearson correlation coefficient was computed to assess several variables and describe their correlation. Table 2. As for the Annual Income and standardized PYLL, a moderate negative correlation between the two variables was found ($r_{969} = [-.619]$, $p = [.000]$). As for the Per capita GDP and standardized PYLL, a moderate negative correlation between the two variables was found ($r_{969} = [-.588]$, $p = [.000]$).

Table 2.

Correlation between variables

Variables	Pearson Correlation	P-Value	N	Degrees of freedom
Annual Income - Standardized PYLL	-.619**	0.0001	971	969
Per capita GDP – Standardized PYLL	-.588**	0.0001	971	969
**. Correlation is significant at the 0.01 level (2-tailed) (Source: Author's Contribution, 2023)				

These results suggest a strong negative correlation between income, GDP, and standardized PYLL. This can certainly be explained by some of the most prevalent variables around health care access and health inequality; with lower income/GDP countries taking a bigger toll in PYLL as part of structural deficiencies or lack of adequate public policies, yet it also has been attributable to the nature of resources allocation: with more resources available, populations tend to spend more in healthier habits including addressing risk factors but also periodic health screenings. The opposite can be said about the lower income populations where the resources allocation will lean towards subsistence rather than building and maintaining healthy habits.

This brings a discussion to the table: the role of public policy in addressing PYLL as a mean to reduce the GDP gap between middle- and high-income countries, both at GDP

level and household level. When translating the PYLL into the economic burden, this generates a significant impact in the shape of income loss, which can then be assessed as a function of the overall country GDP, which will prevent the natural buffer effect generated for lower income in specific countries.

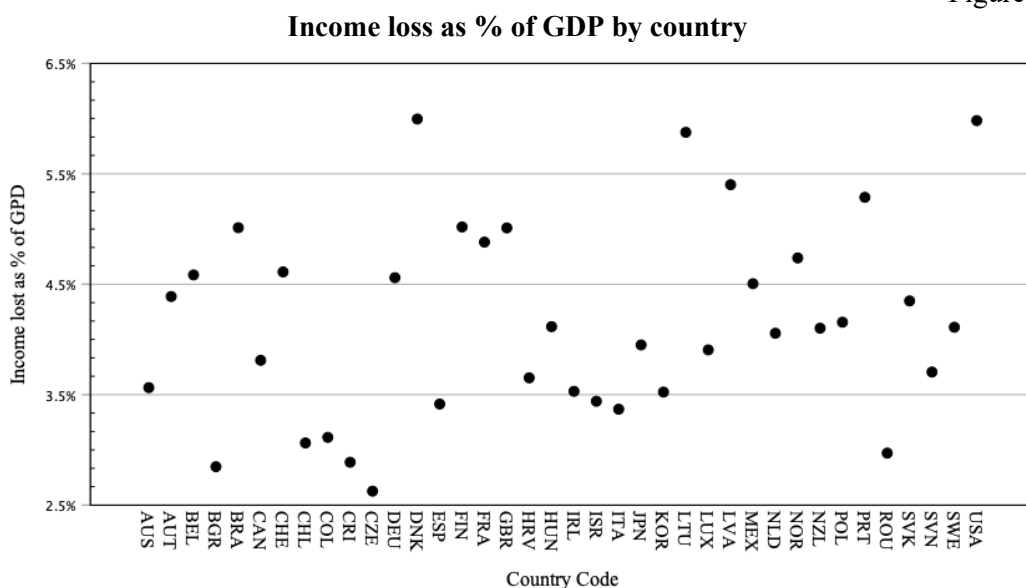
Table 3.

Income loss descriptive statistics	
Variables	Income lost as % of GDP
N	38
	0
Mean	4.16%
Median	4.11%
Std. Deviation	0.89%
Range	3.40%
Minimum	2.60%
Maximum	6.00%

(Source: Author's Contribution, 2023)

In general, the lower the average income, the lower the % of impact as a function of the GDP; nonetheless, the results show a significant impact for both developed and developing economies. On both the top end of the spectrum, Denmark, and the United States (6%), Lithuania (5.9%, and Latvia (5.4%) are in the top 10%, whilst Romania (3%), Costa Rica (2.9%), Bulgaria (2.8%) and Czechia (2.65) are in the bottom 10%.

Figure 1.



(Source: Author's Contribution, 2023)

Conclusions

Economic epidemiology, as a discipline, has largely focused on the reimbursement process of drugs, surgical procedures, and health care in general, having a reduced focus on the aspects around the macroeconomic impact of disease and mortality. While the former remains relevant due to the influence of medical device technology manufacturers and pharmaceutical companies alike, the latter remains as a potential opportunity to develop evidence to continue driving interventions through public health policies to continue reducing both mortality and health inequalities.

As part of this paper, the results point towards the significance of mortality as it impacts economic development. Moreover, the research points towards the significant toll lower-income countries face regarding the potential years of life lost and its impact on the overall economic output. From an absolute income loss point of view, the higher income and higher GDP countries will face, by large, a more significant impact on the income lost; income lost in lower-income countries is proportionally higher when considering the ability to spend and the overall impact of a reduced income on a lower income family.

Potential years of life lost constitute a powerful tool to determine the impact of a given cause of mortality and morbidity, and as an estimator of the cost of these factors, providing important information for policymakers to assess ways to reduce them while benefiting from a sustained income both at micro and macroeconomic level.

Public health interventions must be carefully planned, measured, and assessed continuously, as unfortunately; their results can only be perceived years after a public health intervention. Nevertheless, there is both an ethical component and a financial incentive to assess current public health trends, on the former to provide more equitable access to health care and better opportunities for economic development and social upward movements, and on the latter to harvest potential benefits of increase income at local level.

This paper sheds some light on one of the factors relevant to a generally less-studied field within economic epidemiology. Furthering the understanding of how mortality in all its shapes (in this case, as potential years of life lost) might be creating a burden to economic growth.

Limitation

This paper focuses on declared annual average income and excludes non-remunerated income like home labor, care of elders, children, and house chores. Due to the lack of completeness of data, six OECD members and candidates were excluded from this research, with member countries Estonia, Island, Greece, and Turkey and candidate countries Argentina and Peru not being included.

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References

- Baker D., Delong J. B., & Krugman P. R. (2005). Asset returns and economic growth. *Brookings Papers on Economic Activity*, 1, 289-330.
- Gardner JW, Sanborn JS. Years of potential life lost (YPLL)--what does it measure? *Epidemiology*. 1990 Jul;1(4):322-9. doi: 10.1097/00001648-199007000-00012. PMID: 2083312.
- Riley G. (2012), *Economic Growth - The Role of Human & Social Capital, Competition & Innovation*, <http://www.tutor2u.net/economics/revision-notes/a2-macro-economic-growth-capital.html>, Accessed April 16, 2014.
- Sadigov R. Rapid Growth of the World Population and Its Socioeconomic Results. *Scientific World Journal*. 2022 Mar 23;2022:8110229. doi: 10.1155/2022/8110229. PMID: 35370481; PMCID: PMC8967589.
- OECD (2023), Life expectancy at birth (indicator). doi: 10.1787/27e0fc9d-en (Accessed on 08 April 2023)
- OECD (2023), Gross domestic product (GDP) (indicator). doi: 10.1787/dc2f7aec-en (Accessed on 11 March 2023)
- OECD (2023), Average wages (indicator). doi: 10.1787/cc3e1387-en (Accessed on 13 April 2023)
- WHO Mortality Database <https://platform.who.int/mortality/themes/theme-details/MDB/all-causes> (accessed on March 7, 2023)