



Association of Gross Domestic Product with Under-Five Mortality Rate and Life Expectancy During 1990 - 2015 in Iran: An Ecological Study

Firooz Esmailzadeh¹, Manijeh Alimohammadi², Mojtaba Sepandi^{3,4}, Farzad Khodamoradi⁵ and Yousef Alimohammadi^{2,6,*}

¹Department of Public Health, School of Public Health, Maragheh University of Medical Sciences, Maragheh, Iran

²Pars Advanced and Minimally Invasive Medical Manners Research Center, Pars Hospital, Iran University of Medical Sciences Tehran, Iran

³Health Research Center, Life Style Institute, Baqiyatallah University of Medical Sciences, Tehran, Iran

⁴Department of Epidemiology and Biostatistics, Faculty of Health, Baqiyatallah University of Medical Sciences, Tehran, Iran

⁵Department of Community Medicine, School of Medicine, Dezfoul University of Medical Sciences, Dezfoul, Iran

⁶Department of Epidemiology and Biostatistics, School of Public Health, Tehran University of Medical Sciences, Tehran, Iran

*Corresponding author: Pars Advanced and Minimally Invasive Medical Manners Research Center, Pars Hospital, Iran University of Medical Sciences, Tehran, Iran. Email: yalimohammadi67@gmail.com

Received 2018 December 29; Revised 2019 April 10; Accepted 2019 April 14.

Abstract

Background: Under-five mortality and life expectancy are two important health indicators that may be associated with GDP. Thus, the evaluation of the relationship between these indicators can be important in health planning.

Objectives: Due to the lack of such study in Iran, the current study aimed to assess the correlation of under-five mortality and life expectancy with GDP in Iran during 1990 - 2015.

Methods: In this ecological study, all data were extracted from the Gapminder website. The data were analyzed by Pearson correlation coefficient at $\alpha = 0.05$ as the significance level. All analyses were done using Stata14 and Excel 2010 software.

Results: During the study period (1990 - 2015), the life expectancy and GDP were increasing and under-five mortality was decreasing. The correlation of GDP with life expectancy and under-five mortality resulted in $r = 0.94$ ($P < 0.001$) and $r = -0.95$ ($P < 0.001$), respectively.

Conclusions: Considering the correlation of GDP with life expectancy and under-five mortality, the share of GDP allocated to the health sector should be increased to improve these indices in Iran.

Keywords: GDP, Life Expectancy, Under-Five Mortality, Iran

1. Background

Life expectancy is an indicator commonly used to represent the overall development of a country. This indicator has increased steadily in most countries of the world over the past 10 years (1). Based on the World Health Organization's global report, the average global life expectancy at birth increased by 7 years between 1998 and 2025. There are 26 countries with life expectancy at birth of more than 80 years. The life expectancy increase is associated with improved access to safe water, medical progress, and children's vaccination; it directly reflects the levels of health, nutrition, and income and indirectly the stats of employment and shelter (2).

More than 60 million children die every year worldwide. There are many differences in the mortality of under-five children between high- and low-income countries (3). The under-five mortality rate in the Eastern Mediterranean

region was 57 per 1000 live births in 2012 that ranked second in the world after the African region. Iran with an under-five mortality rate of 18 per 1000 live births is ranked eleventh in the Eastern Mediterranean region (3). Reducing the mortality rate of under-five children has been recognized by the United Nations as one of the high-priority global goals. The fourth Millennium Development Goal (MDG4) could reduce under-five mortality by two-thirds between 1990 and 2015 (4, 5). Although progress has been made in reducing the under-five mortality, it is estimated that only 10 out of 67 countries with high mortality rates have achieved this goal (5). By controlling the socioeconomic and geographic factors, under-five mortality in developing countries has declined by 2.7% per year (6). In spite of population growth in developing countries, the under-five mortality rate declined overall from 12.7 million in 1990 to almost 6 million in 2015 (7).

There is an important relationship between the health

system and the economy in today's world (8). Gross domestic product (GDP) per capita is a criterion for measuring the economic performance of a community. Increasing GDP per capita is essential to achieve economic welfare (9). GDP per capita is one of the main predictors of country-level income and it has been used in health modeling outcomes, mortality trends, estimates of cause-specific mortality, finances, and health system implementation, among others (10). High life expectancy has a relationship with high income per capita in countries (11). Life expectancy and per capita income correlate across countries and at any time, especially at low levels of income (6). A study conducted in Brazil showed a positive correlation between GDP per capita and life expectancy (12). A study of life expectancy in the Middle East and Eastern Mediterranean region showed that GDP was a positive predictor of life expectancy (1). A meta-analysis study conducted to estimate the relationship between income and under-five mortality indicated that pooled estimate of the relationship between income and under-five mortality was 0.45 (0.11 - 0.79) before adjusting for covariates and 0.28 (0.19 - 0.37) after adjusting for covariates, which showed a meaningful relationship (13).

2. Objectives

Since life expectancy and under-five mortality are the important health indicators in any country and GDP is a very important indicator in relation to these indicators and due to the lack of such a comprehensive study in Iran, we conducted the current study to examine the correlation of life expectancy and under-five mortality with GDP in Iran during 1990 - 2015.

3. Methods

This was an ecological study.

3.1. Study Variables

The variables used in this study were life expectancy at birth, GDP (per capita, purchasing power parity (PPP) (current international \$), and under-five mortality rate (per 1,000 live births). The data for the period of 1990 - 2015 were extracted from the World Bank database available at <https://data.worldbank.org>.

3.2. Analysis Methods

To describe the data, we used descriptive statistics such as mean and standard deviation. The Pearson correlation coefficient was used to examine the correlation between

the variables under study after establishing the normalization condition by the Kolmogorov-Smirnov test. Furthermore, scatter plots were used for the schematic representation of the data correlation. All analyses were done using Stata 14 and Excel 2010 software. To examine the correlation between the variables, the significance level was set at $\alpha = 0.05$.

4. Results

The mean life expectancy, under-five mortality, and GDP per capita in Iran were 70.86 years (at birth), 31.98 per 1000 live births, and 12,734.35 current international \$, respectively, during 1990 - 2015 (Table 1). The mean life expectancy increased from 63.82 years in 1990 to 75.73 years in 2015. Moreover, under-five mortality declined from 56.1 per 1,000 live births in 1990 to 16 per 1,000 live births in 2015 (Figures 1 and 2). The GDP per capita increased from 7363.33 \$ in 1990 to 17571.2 \$ in 2015 (Figure 3).

Table 1. Mean and Standard Deviation of Life expectancy, GDP and Under-Five Mortality in 1990 - 2015 in Iran

Variables	1990	2015	Mean \pm SD (1990 to 2015)
Life expectancy (years)	63.82	75.73	70.86 \pm 3.25
GDP (per capita, current international \$)	7363.3	17571.2	12734.35 \pm 3710.89
Under-five mortality (per 1000 live births)	56.1	16	31.98 \pm 12.52

There was a significant positive correlation between GDP and life expectancy ($r = 0.94$, $P < 0.001$). It means that with increasing one of the variables, the other variable will also increase. The GDP had also a significant negative relationship with under-five mortality ($r = -0.95$, $P < 0.001$). Finally, a significant negative correlation was found between under-five mortality and life expectancy ($r = -0.99$, $P < 0.001$). The diagrams (scatterplots) of the correlation between life expectancy and GDP and between GDP and under-five mortality are shown in Figures 4 and 5, respectively.

5. Discussion

The results of this study showed that life expectancy had an increasing trend in Iran from 1990 to 2014, which was consistent with the trend of life expectancy in the United States, Western Europe, and Japan. In Eastern Europe and Russia, life expectancy had different trends and was declining in some years, possibly due to dangerous lifestyles and the high rate of smoking and alcohol consumption in eastern Europe and the collapse of the Soviet

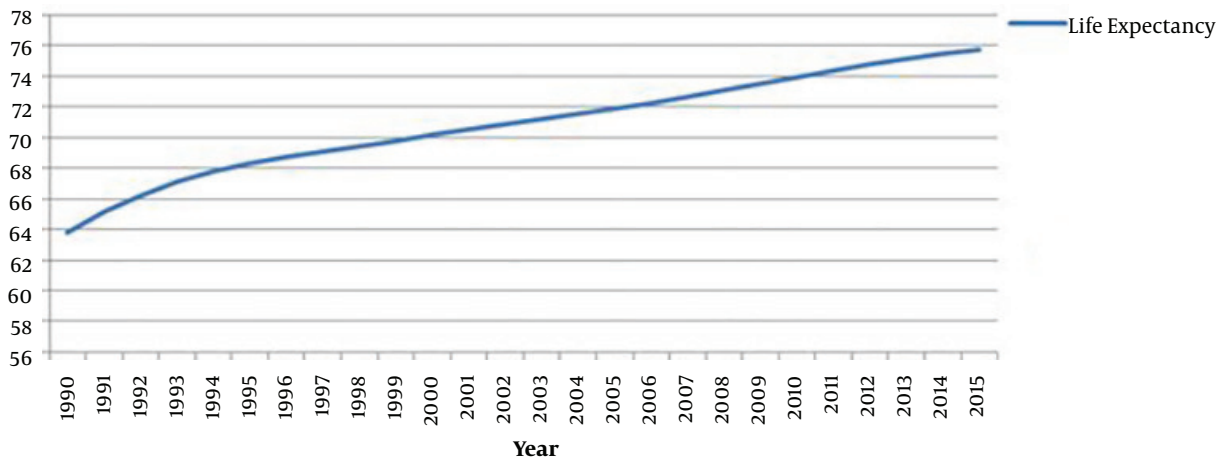


Figure 1. The trend of changes in life expectancy during 1990 - 2015 in Iran

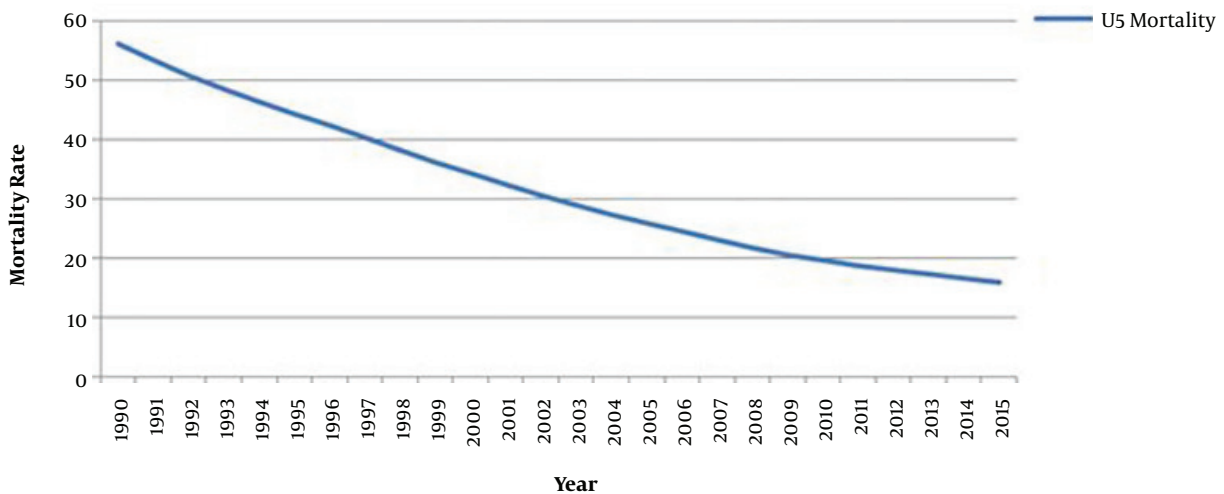


Figure 2. The trend of changes in under-five mortality rate (per 1000 live births) during 1990 - 2015 in Iran

Union and sudden political, economic, and social changes in Russia (14). Moreover, under-five mortality reduced by 72% in the years of conducting the present study. This rate was higher than the mean reduction in childhood mortality in the world (52%) (15) and indicated appropriate conditions in Iran in terms of medical and health indicators. The studies carried out in Bangladesh (16) and Hong Kong (17) also showed a declining trend of under-five mortality. However, this trend was increasing in Hong Kong within 2013 - 2015 and the researcher attributed it to increased birth asphyxia, pre-term delivery, congenital cardiovascular diseases, and immobility. If these factors are not controlled, they will appear to increase the under-five mortality rate in other countries in the near future.

Similar to studies by Aghion et al. (18) and Kennelly et al. (19), there was a strong positive correlation between GDP and life expectancy in the present study. Swift (20) showed that a one percent increase in life expectancy would increase the total GDP and the GDP per capita by 6% and 5%, respectively. Furthermore, the total GDP and the GDP per capita had dramatic effects on life expectancy in many countries (20). Thus, it could be concluded that the causal relationship between GDP and life expectancy might be positive and mutual so that an increase in each factor could lead to an increase in the other one, showing improved economic and health indicators and human development indices of countries. Of course, it should be noted that if the GDP growth is followed by an increase in

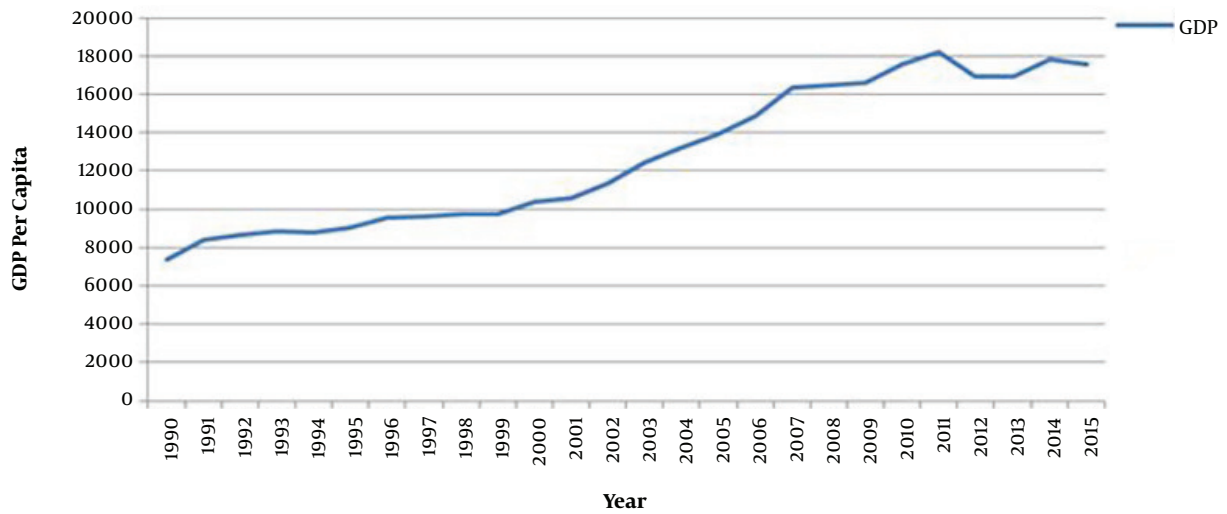


Figure 3. The trend of changes in GDP (per capita) during 1990 - 2015 in Iran

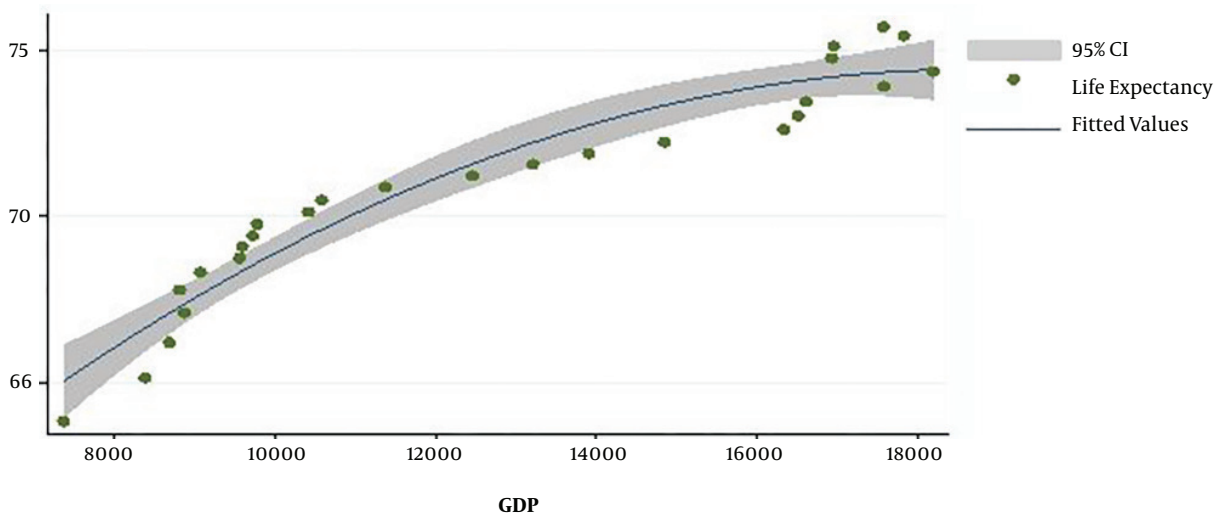


Figure 4. The diagram (scatterplot) of correlation between life expectancy and GDP during 1990 - 2015 in Iran

income inequalities, it can have negative effects on life expectancy in society (12). Therefore, policy-makers should not only focus on increasing incomes, but the fair distribution of incomes must always be considered by statesmen, as well. Another point to be noticed is the existence of a strong negative correlation between life expectancy and the under-five mortality rate. This strong correlation can be attributed to the fact that increased life expectancy in the past years was mainly due to the reduced under-five mortality rate and it is likely that life expectancy was not increased significantly in over-five age groups.

5.1. Conclusions

From 1990 to 2015, life expectancy and under-five mortality rate in Iran had increasing and decreasing trends, respectively, but the slopes have been gradually milder in recent years. Given the strong correlation between GDP and life expectancy and under-five mortality, and the declining growth of GDP in previous years and even declined GDP in some years, we suggest that the share of GDP allocated to the health sector be increased to maintain the increasing trend of life expectancy and reduce the under-five mortality rate. This is an investment that can, in turn, increase GDP in coming years.

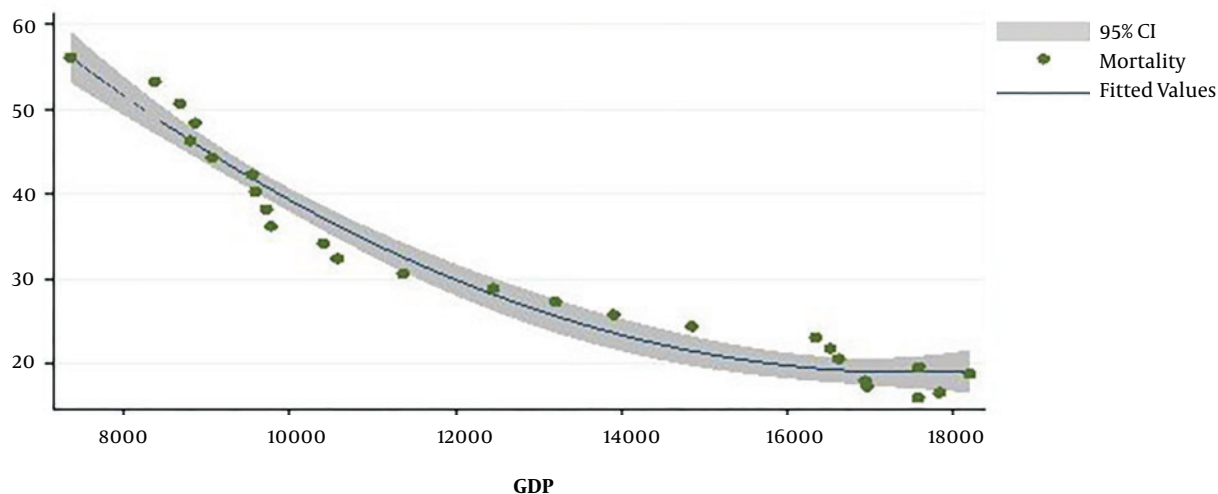


Figure 5. The diagram (scatterplot) of correlation between GDP and under-five mortality rate during 1990 - 2015 in Iran.

Footnotes

Authors' Contribution: Firooz Esmailzadeh: Study concept, data extraction, and manuscript preparation. Manijeh Alimohammadi, Mojtaba Sepandi, and Farzad Khodamoradi: Manuscript preparation and English editing; Yousef Alimohamadi: Study concept, data extraction, data analysis, and manuscript preparation.

Conflict of Interests: The authors have no conflict of interest.

Ethical Approval: Not necessary. All data used in this study are at the international level and are obtained from the open source.

Funding/Support: The current study did not have any funding source.

References

- Gilligan AM, Skrepnek GH. Determinants of life expectancy in the Eastern Mediterranean region. *Health Policy Plan.* 2015;**30**(5):624-37. doi: [10.1093/heapol/czu041](https://doi.org/10.1093/heapol/czu041). [PubMed: [24920217](https://pubmed.ncbi.nlm.nih.gov/24920217/)].
- Rahmani KH, Zokaei M, Bidarpoor F, Babahajani SH, Nessaei P, Moradi GH. Children mortality rate trend in Kurdistan province during 2007 to 2011. *Iran J Epidemiol.* 2014;**10**(1):65-72.
- Soori H, Rafiei E, Entezami N, Hasani J, Hossaini SM. A comparison study on rate and causes of under 5 years old deaths in Iran, Eastern Mediterranean region and the world. *Safe Promot Injury Prev.* 2016;**4**(1):1-8.
- Feng XL, Theodoratou E, Liu L, Chan KY, Hipgrave D, Scherpbier R, et al. Social, economic, political and health system and program determinants of child mortality reduction in China between 1990 and 2006: A systematic analysis. *J Glob Health.* 2012;**2**(1):10405. doi: [10.7189/jogh.02.010405](https://doi.org/10.7189/jogh.02.010405). [PubMed: [23198134](https://pubmed.ncbi.nlm.nih.gov/23198134/)]. [PubMed Central: [PMC3484751](https://pubmed.ncbi.nlm.nih.gov/PMC3484751/)].
- Maruthappu M, Ng KY, Williams C, Atun R, Zeltner T. Government health care spending and child mortality. *Pediatrics.* 2015;**135**(4):e887-94. doi: [10.1542/peds.2014-1600](https://doi.org/10.1542/peds.2014-1600). [PubMed: [25733755](https://pubmed.ncbi.nlm.nih.gov/25733755/)].
- Jamison DT, Murphy SM, Sandbu ME. Why has under-5 mortality decreased at such different rates in different countries? *J Health Econ.* 2016;**48**:16-25. doi: [10.1016/j.jhealeco.2016.03.002](https://doi.org/10.1016/j.jhealeco.2016.03.002). [PubMed: [27046447](https://pubmed.ncbi.nlm.nih.gov/27046447/)]. [PubMed Central: [PMC4921600](https://pubmed.ncbi.nlm.nih.gov/PMC4921600/)].
- Asumadu-Sarkodie S, Owusu PA, Zhang X. The casual nexus between child mortality rate, fertility rate, GDP, household final consumption expenditure, and food production index. *Cogent Econ Finance.* 2016;**4**(1). doi: [10.1080/23322039.2016.1191985](https://doi.org/10.1080/23322039.2016.1191985).
- Rezapour A, Arabloo J, Tofighi S, Alipour V, Sepandy M, Mokhtari P, et al. Determining equity in household's health care payments in Hamedan province, Iran. *Arch Iran Med.* 2016;**19**(7):480-7. [PubMed: [27362241](https://pubmed.ncbi.nlm.nih.gov/27362241/)].
- Sadeghi SK, Gharshasbi FS, Ranjipour R, Motafaker AMA. Evaluating the effect of cultural capital on GDP in provinces of Iran. *J Appl Econ Stud.* 2017;**6**(23):231-54.
- James SL, Gubbins P, Murray CJ, Gakidou E. Developing a comprehensive time series of GDP per capita for 210 countries from 1950 to 2015. *Popul Health Metr.* 2012;**10**(1):12. doi: [10.1186/1478-7954-10-12](https://doi.org/10.1186/1478-7954-10-12). [PubMed: [22846561](https://pubmed.ncbi.nlm.nih.gov/22846561/)]. [PubMed Central: [PMC3487911](https://pubmed.ncbi.nlm.nih.gov/PMC3487911/)].
- Cervellati M, Sunde U. Life expectancy and economic growth: The role of the demographic transition. *J Econ Growth.* 2011;**16**(2):99-133.
- Messias E. Income inequality, illiteracy rate, and life expectancy in Brazil. *Am J Public Health.* 2003;**93**(8):1294-6. doi: [10.2105/ajph.93.8.1294](https://doi.org/10.2105/ajph.93.8.1294). [PubMed: [12893617](https://pubmed.ncbi.nlm.nih.gov/12893617/)]. [PubMed Central: [PMC1447959](https://pubmed.ncbi.nlm.nih.gov/PMC1447959/)].
- O'Hare B, Makuta I, Chiwaula L, Bar-Zeev N. Income and child mortality in developing countries: A systematic review and meta-analysis. *J R Soc Med.* 2013;**106**(10):408-14. doi: [10.1177/0141076813489680](https://doi.org/10.1177/0141076813489680). [PubMed: [23824332](https://pubmed.ncbi.nlm.nih.gov/23824332/)]. [PubMed Central: [PMC3791093](https://pubmed.ncbi.nlm.nih.gov/PMC3791093/)].
- Leon DA. Trends in European life expectancy: A salutary view. *Int J Epidemiol.* 2011;**40**(2):271-7. doi: [10.1093/ije/dyr061](https://doi.org/10.1093/ije/dyr061). [PubMed: [21415000](https://pubmed.ncbi.nlm.nih.gov/21415000/)].
- G B D Child Mortality Collaborators. Global, regional, national, and selected subnational levels of stillbirths, neonatal, infant, and under-5 mortality, 1980-2015: A systematic analysis for the Global Burden of Disease Study 2015. *Lancet.* 2016;**388**(10053):1725-74. doi: [10.1016/S0140-6736\(16\)31575-6](https://doi.org/10.1016/S0140-6736(16)31575-6). [PubMed: [27733285](https://pubmed.ncbi.nlm.nih.gov/27733285/)]. [PubMed Central: [PMC5224696](https://pubmed.ncbi.nlm.nih.gov/PMC5224696/)].

16. Khan JR, Awan N. A comprehensive analysis on child mortality and its determinants in Bangladesh using frailty models. *Arch Public Health*. 2017;75:58. doi:10.1186/s13690-017-0224-6. [PubMed: 28912949]. [PubMed Central: PMC5588744].
17. Cao H, Wang J, Li Y, Li D, Guo J, Hu Y, et al. Trend analysis of mortality rates and causes of death in children under 5 years old in Beijing, China from 1992 to 2015 and forecast of mortality into the future: An entire population-based epidemiological study. *BMJ Open*. 2017;7(9). e015941. doi: 10.1136/bmjopen-2017-015941. [PubMed: 28928178]. [PubMed Central: PMC5623503].
18. Aghion P, Howitt P, Murtin F. The relationship between health and growth: When Lucas meets Nelson-Phelps. *Nat Bureau Econ Res*. 2010. doi:10.3386/w15813.
19. Kennelly B, O'Shea E, Garvey E. Social capital, life expectancy and mortality: A cross-national examination. *Soc Sci Med*. 2003;56(12):2367-77. doi:10.1016/s0277-9536(02)00241-1. [PubMed: 12742601].
20. Swift R. The relationship between health and GDP in OECD countries in the very long run. *Health Econ*. 2011;20(3):306-22. doi: 10.1002/hec.1590. [PubMed: 20217835].