Research Article

Correlation Between Human Development Index and Infant Mortality Rate Worldwide

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Abstract

Background: Infant mortality rate (per 1000 live births) is a vital index to monitor the standard of health and social inequality which is related to human development dimensions worldwide. Human development index (HDI) includes basic social indicators such as life expectancy, education and income.

Objectives: The current study aimed to find the correlation between human development index and infant mortality rate.

Patients and Methods: This descriptive study that represents the relationship of infant mortality rate with human development index and human development index dimensions was performed on the profiles of 135 countries worldwide [Africa (35 countries), America (26 countries), Asia (30 countries), the Pacific (2 countries) and Europe (42 countries)]. Two databases were used in the study: the world health organization (WHO) database (2010) and human development database (2010). Data were analyzed using Pearson correlation test by SPSS software.

Results: The study found that socio-economic factors or human development dimensions are significantly correlated with risk of chance mortality in the world. The per capita income (r = -0.625), life expectancy (r = -0.925) and education (r = -0.843) were negatively correlated with the infant mortality rate; human development index (r = -0.844) was also negatively correlated with the infant mortality rate (P < 0.01).

Conclusions: Human development index is one of the best indicators and predictors to perceive healthcare inequities. Worldwide improvement of these indicators, especially the education level, might promote infant life expectancy and decrease infant mortality.

Keywords: Infant Mortality Rate, Education, Income, Life Expectancy, Human Development Index

1. Background

Infant mortality rate, the most important measure in millennium development goals, should be considered in the process and performance of national development. Developed countries reduced infant mortality significantly, while the developing countries should try harder to reduce infant mortality. Infant mortality rate (IMR) (per 1000 live births) is a vital index to monitor the standard of health and medical services and social inequity (1, 2).

Infant mortality is a sensitive indicator of inequity; human development index (HDI) is a comprehensive indicator of overall development of countries including education, income and gross domestic products (GDP) per capita. The human development index is an important indicator to prove human development and promotion standard of life in the countries (3). Since it was first introduced by the united nation development program (UNDP), it distilled various concepts raised in earlier development discussions into a unified theme of human development. The

HDI includes socio-economic variables that affect people's health and national development indicators such as economic condition, political rights, people mortality rate, education level and civil liberties. Therefore, the effects of the abovementioned variables are tested in the framework of the HDI analyses. The HDI is then calculated as a simple arithmetic mean of the three indexes (4). The HDI formula includes three indicators: human development index = 1/3 (education index + GDP index + life expectancy index). Several studies confirmed links between infant mortality rate and socio-economic variables and showed correlation clearly; studies demonstrated that the promotion of socio-economic variables is very effective in improving the health status, and leads to improved human development index. Also, the infant mortality rate is one of the most important indicators used to judge the prevalence of health status and evaluate the socio-economic welfare of a country (5, 6)

A high infant mortality rate is determined as a monitoring factor to access the consequences of problems of the

primary health care services and lack of proper economic conditions and lead to many differences in mortality and inequalities in different countries. The current study compared the cross-sectional data and found that countries with higher national income have lower mortality rate and developed economy can help to reduce mortality largely due to improvements in immunization programs, considering the maternal status, education level in society, medical technology and the availability of maternal and infant health care services. In other words, improvement in declining infant mortality rate worldwide in the 20$_{th}$ century was associated with improved education, income and public health (7, 8).

The human development index was defined by the united nation development programme to measure the mean achievements in a country in three basic indices as long and healthy life, access to knowledge and awareness, and decent standard of living and promotion in life expectancy (9). These three dimension indices are computed on some basic parameters such as life expectancy at childbearing, access to knowledge measured in terms of adult literacy rate and gross enrolment ratios and finally income dimension that is assumed to capture the state of life other than health, and education is measured in terms of per capita income. The geometric mean of the three indices is the value of HDI. The methodology of computing HDI, as defined by UNDP, is primarily to construct the dimension index (10). Lack of enough attention to infant mortality and the importance of socioeconomic factors motivated the authors to conduct this research.

2. Objectives

The current study aimed to compute the correlation between human development index and infant mortality rate.

3. Patients and Methods

3.1. Subjects

This descriptive, correlational study was performed in 135 countries since their profiles were fulfilled. Five regions of the world were included, the united nation macro regions: Africa (35 countries), America (26 countries), Asia (30 countries), Oceania (2 countries) and Europe (42 countries). The study aimed to determine the correlation between human development index and infant mortality rate in these countries. The study represents the relationship of infant mortality rate with human development index and human development dimensions; also GDP per capita and social and health factors such as education and life expectancy.

3.2. Data Collection

Two databases were used in this study; the WHO database (11) and human development database (12).

3.3. Data Analysis

Pearson correlation test was used to examine the relationship between infant mortality rate and other indicators including education, income and life expectancy and human development indices. P < 0.01 were considered statistically significant.

4. Results

From 2000 to 2010, there was a 30% decline in infant mortality worldwide. However, there was a notable decrease during the eleven years: from 37 cases in 2000 to 26 cases in 2010, per 1000 live births. In fact, during these eleven years, there was a notable decrease in the infant mortality rate (Figure 1).

From 2000 to 2010, an 8% increase in human development index was observed, during the eleven years: from 0.545 in 2000 to 0.588 in 2010. In fact, during the eleven years, there was a little increase in the human development index (Figure 2).

Education, income and life expectancy trend average across the world are indicated in Table 1; annual increase in indicators is evident (Table 1). The lowest level of human development index was evident in the Africa (Table 2). The results showed that the per capita income, life expectancy and education were negatively correlated with the infant mortality rate. HDI was also negatively correlated with the infant mortality. Results showed that the per capita income affects the infant mortality rate but not as much as education and life expectancy due to lower correlation between per capita and human development index. The current study results represents the negative correlation between infant mortality rate with HDI (r = -0.844), education (r = -0.843), income per capita (r = -0.625) and life expectancy (r = -0.925) (P < 0.01) (Table 3).

5. Discussion

The study utilized data from 135 countries over 11 years, from 2000 to 2010, and investigated whether increases in human development index had led to reductions in infant mortality rates and increase in infant life expectancy. The obtained results represent the correlation between HDI dimension and mortality rate.

Infant mortality rate is defined as the number of infant deaths occurring between birth and first birthday in a particular calendar year divided by the number of live

Table 1. The Mean of Socio-Economic Determinants in the World 2000 - 2010

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Education, 0 - 100	77.8	78.4	79	79.6	80	80.5	80.9	81.3	81.7	81.9	82.1
Income per capita, USA $	12220	12363	12547	12850	13362	13782	14309	14840	15045	14646	14943
Life expectancy, y	67.1	67.3	67.6	67.8	68	68.3	68.6	68.8	69.1	69.4	69.6

Table 2. The Mean of Important Indicators in the Selected Continents, 2000 - 2010

	Education	Income Per Capita	Life Expectancy	HDI[a]	IMR
ASIA	79	15995	70	0.58	30
EUROPE	93	22654	76	0.72	10
AFRICA	60	2541	54	0.34	68
AMERICA	86	10319	72	0.59	21
OCEANIA	100	31744	80	0.81	5

Abbreviations: HDI, human development index; IMRb, infant mortality rate.
[a] 0 - 1 per 1000 live birth.

Table 3. The Correlation Between the Mean of Infant Mortality Rate and the Mean of Other Indicators, 2000 - 2010[a]

Pearson Correlation	Mean of HDI	Mean of Education	Mean of Income	Mean of Life Expectancy
Mean of IMR	-0.844	-0.843	-0.625	-0.925
P Value	< 0.01	< 0.01	< 0.01	< 0.01

Abbreviations: HDI, human development index; IMRb, infant mortality rate.
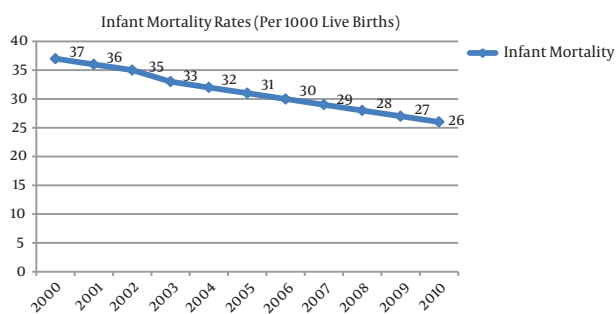[a] Correlation is significant at 0.01.

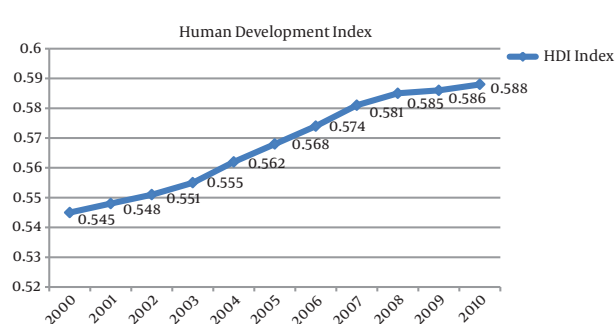**Figure 1.** Trend in the Infant Mortality Rate in the World 2000 - 2010 (Per 1000 Live Birth)

Figure 2. Trend in the Human Development Index Rate in the World 2000 - 2010

births in that calendar year. It is generally considered as one of the best mortality indicators reflecting overall socioeconomic development (13). IMR is sensitive to policy measures that directly or indirectly affect the health of infants; for instance policies directed towards the access and availability to child and mother health services and the ones directed towards the education of females (14). IMR, also the mortality rate of children under five, are therefore included as one of the 60 millennium development goal indicators used to assess progress in socioeconomic development and health targets set for the year 2015 (15). Result of the study showed that the cause of 19.4 infants' mortality per 100,000 was at pregnancy termination (16). The study by Demombynes reported that the decrease of malaria prevalence in Kenia reduced annual infant mortality rate 7.6% (17). Perin (18) reported that infant mortality rate is associated with birth interval. Also the study by

Ghahiri reported that the mean of natural delivery is clear but cesarean is better than natural delivery in emergency situations (19).

Empowering and training health professionals and their interaction with people can improve the health system and promote sustainable development in the countries (20). Several studies indicate that existence of higher levels of human resources in health systems, especially for health, typically lead to better health and decrease the infant mortality rate (21, 22); geographic location also has a purely exogenous effect on mortality rate (23).

Correlation between poverty and infant mortality is obvious. Razmi believed that poverty was associated with the most common causes of infant death. He also explained that spending on education and training will promote labor productivity and increases the work force and finally leads to decreased infant mortality rate (24). Also, the capacity of human resources for health system in a country, including nurses, dentists, physicians, midwives and other health professionals is proportional to the dimension of education and GDP per capita. There is a direct relationship between the rate of deliveries assisted by skilled birth attendants and the proportion of children fully immunized and negatively correlated with maternal, infant, and under-five mortality rates (25). The study by Patrick showed that changing economic status in the United States was associated with infant mortality rate (26).

Education is a vital and critical determinant of an individual's work and economic condition, and these are in turn correlated with health and survival status through specific work conditions and levels of consumption. Education is also associated with health and survival status through its connections with health risk behaviors such as smoking, addiction, and psychosocial conditions; since the higher the level of education is, the more likely it is that a person engages in health-enhancing self-maintenance activities, and avoids or feels confident to successfully modify adverse health risk behaviors (27). The study by Cutler showed a direct positive effect of education on health (28). Susumans indicated in his study that maternal literacy can be related to decreased mortality rate in infants (29); also life expectancy at birth is an important indicator to measure people's health especially for infants (30).

From 1990 to 2008, the highest mean of HDI was reported for the Pacific (0.882) and the lowest was reported for Africa with the value of 0.430 (31). HDI is the government target output as it is believed that this index is a better measure than a mere economic indicator, such as GDP growth. It is a standard means of measuring well-being. It is used to indicate and determine whether a country is a developed, developing or underdeveloped one and also to measure the impact of social, economic and policies on quality of life (32). HDI is suitable for ranking a country's development and it is the most important index to forecast infant mortality rate (33). Equity is an important criterion to reduce infant mortality rate in the countries; HDI also has negative correlation with infant mortality rate (34).

The HDI is a composite measure of health, education and income that was introduced in the first human development report in 1990. The scores for the three HDI dimension indices are then aggregated into a composite index using geometric mean. Human development index is one of the best indicators especially to estimate infant mortality rates and a predictor to understand health inequity in different countries. Improving these indicators might promote infant health and decrease infant mortality in the world. According to these results, policy makers must focus on socio-economic indicators such as the level of social literacy and family income to reduce mortality.

Acknowledgments

Footnotes

References

1. Arntzen A, Samuelsen SO, Bakketeig LS, Stoltenberg C. Socioeconomic status and risk of infant death. A population-based study of trends in Norway, 1967-1998. *Int J Epidemiol.* 2004;**33**(2):279–88. doi: 10.1093/ije/dyh054. [PubMed: 15082627].

2. Hakobyan M, Mkrtchyan A, Yepiskoposyan L. Infant mortality in Armenia, 1992-2003. *Econ Hum Biol.* 2006;**4**(3):351–8. doi: 10.1016/j.ehb.2006.04.002. [PubMed: 16798126].

3. Jha R, Murthy KVB. An inverse global environmental Kuznets curve. *J Comp Econ.* 2003;**31**(2):352–68. doi: 10.1016/s0147-5967(03)00042-8.

4. UNDP . Human development report. United Nations Development Program Official Web Page; 2008.

5. Gutierrez JP, Bertozzi SM. La brecha en salud en México, medida a través de la mortalidad infantil. *Salud Publica de Mexico.* 2003;**45**(2):102–9. doi: 10.1590/s0036-36342003000200006.

6. Aguilera N, Montesinos A, Marrufo GM. Desigualdad en salud en México: los factores determinantes. *Comercio Exterior.* 2006;**56**(2):106–13.

7. Hakobyan M, Yepiskoposyan L. Infant mortality decline in Armenia: Why with uneven rates?. *Econ Hum Biol.* 2010;**8**(1):134–7. doi: 10.1016/j.ehb.2009.07.001. [PubMed: 19647498].

8. Akachi Y, Canning D. Health trends in Sub-Saharan Africa: conflicting evidence from infant mortality rates and adult heights. *Econ Hum Biol.* 2010;**8**(2):273–88. doi: 10.1016/j.ehb.2010.05.015. [PubMed: 20634153].

9. Ghosh M. Regional disparities in education, health and human development in India. *IJHD.* 2011;**5**(1):5–28.

10. Fukuda-Parr S. The Human Development Paradigm: Operationalizing Sen's Ideas on Capabilities. *Feminist Economics.* 2003;**9**(2-3):301–17. doi: 10.1080/1354570022000077980.

11. healthinfo . . Available from: http://apps.who.int/healthinfo/statistics/mortality/whodpms/param.php.

12. Huan development reports . United nations development programme; . Available from: http://hdr.undp.org/en/content/human-development-index-hdi.

13. van Doorslaer E, Koolman X. Explaining the differences in income-related health inequalities across European countries. *Health Econ.* 2004;**13**(7):609–28. doi: 10.1002/hec.918. [PubMed: 15259042].

14. Reidpath DD, Allotey P. Infant mortality rate as an indicator of population health. *J Epidemiol Community Health.* 2003;**57**(5):344–6. [PubMed: 12700217].

15. United Nations . The millennium development goals report. New York 2007.

16. Auger N, Bilodeau-Bertrand M, Sauve R. Abortion and Infant Mortality on the First Day of Life. *Neonatology.* 2016;**109**(2):147–53. doi: 10.1159/000442279. [PubMed: 26726971].

17. Demombynes G, Trommlerova SK. What has driven the decline of infant mortality in Kenya in the 2000s?. *Econ Hum Biol.* 2015;**21**:17–32. doi: 10.1016/j.ehb.2015.11.004. [PubMed: 26707059].

18. Perin J, Walker N. Potential confounding in the association between short birth intervals and increased neonatal, infant, and child mortality. *Glob Health Action.* 2015;**8**:29724. doi: 10.3402/gha.v8.29724. [PubMed: 26562139].

19. Ghahiri A, Khosravi M. Maternal and neonatal morbidity and mortality rate in caesarean section and vaginal delivery. *Adv Biomed Res.* 2015;**4**:193. doi: 10.4103/2277-9175.166154. [PubMed: 26605232].

20. Chen L, Evans T, Anand S, Boufford J, Brown H, Chowdhury M, et al. Human resources for health: overcoming the crisis. *The Lancet.* 2004;**364**(9449):1984–90. doi: 10.1016/s0140-6736(04)17482-5.

21. Anand S, Barnighausen T. Human resources and health outcomes: cross-country econometric study. *The Lancet.* 2004;**364**(9445):1603–9. doi: 10.1016/s0140-6736(04)17313-3.

22. Aakvik A, Holmas TH. Access to primary health care and health outcomes: the relationships between GP characteristics and mortality rates. *J Health Econ.* 2006;**25**(6):1139–53. doi: 10.1016/j.jhealeco.2006.04.001. [PubMed: 16675052].

23. Strulik H. Economic growth and stagnation with endogenous health and fertility. *Population Economics.* 2004;**17**(3) doi: 10.1007/s00148-004-0188-z.

24. Razmi M. Investigating the Effect of Government Health Expenditure on HDI in Iran. *KMRP.* 2012;**2**.

25. Anand S, Bärnighausen T. Health workers and vaccination coverage in developing countries: an econometric analysis. *The Lancet.* 2007;**369**(9569):1277–85. doi: 10.1016/s0140-6736(07)60599-6.

26. Patrick SW, Warner KE, Pordes E, Davis MM. Cigarette Tax Increase and Infant Mortality. *Pediatrics.* 2016;**137**(1):1–8. doi: 10.1542/peds.2015-2901. [PubMed: 26628730].

27. Borrell C, Azlor E, Rodriguez-Sanz M, Puigpinos R, Cano-Serral G, Pasarin MI, et al. Trends in socioeconomic mortality inequalities in a southern European urban setting at the turn of the 21st century. *J Epidemiol Community Health.* 2008;**62**(3):258–66. doi: 10.1136/jech.2006.057166. [PubMed: 18272742].

28. Cutler D, Deaton A, Lleras-Muney A. The Determinants of Mortality. *J Econ Perspect.* 2006;**20**(3):97–120. doi: 10.1257/jep.20.3.97.

29. Susuman AS, Chialepeh WN, Bado A, Lailulo Y. High infant mortality rate, high total fertility rate and very low female literacy in selected African countries. *Scand J of Public Health.* 2015:1403494815604765.

30. Dubey M, Ram U, Ram F. Threshold levels of infant and under-five mortality for crossover between life expectancies at ages zero, one and five in india: A decomposition analysis. *PLoS One.* 2015;**10**(12):e0143764. doi: 10.1371/journal.pone.0143764. [PubMed: 26683617].

31. Asefzade S, Alijanzadeh M, Nassiri-Asl M. Correlation between Human Development Index and maternal mortality rate: [In Persian]. *Payesh.* 2013.

32. Davies A, Quinlivan G. A panel data analysis of the impact of trade on human development. *The Journal of Socio-Economics.* 2006;**35**(5):868–76. doi: 10.1016/j.socec.2005.11.048.

33. Morse S. Stirring the pot. Influence of changes in methodology of the Human Development Index on reporting by the press. *Ecological Indicators.* 2014;**45**:245–54. doi: 10.1016/j.ecolind.2014.04.023.

34. Ruiz JI, Nuhu K, McDaniel JT, Popoff F, Izcovich A, Criniti JM. Inequality as a Powerful Predictor of Infant and Maternal Mortality around the World. *PLoS One.* 2015;**10**(10):e0140796. doi: 10.1371/journal.pone.0140796. [PubMed: 26488170].