http:// ijp.mums.ac.ir
Original Article (Pages: 4071-4080)

The Correlation of Human Development Index on Fertility and Mortality Rate: a Global Ecological Study

Amir Almasi-Hashiani[1], Mahdi Sepidarkish[1], Samira Vesali[1], *Reza Omani-Samani[1]

[1]Department of Epidemiology and Reproductive Health, Reproductive Epidemiology Research Center, Royan Institute for Reproductive Biomedicine, ACECR, Tehran, Iran.

Abstract

Background

Several studies have examined the relationship between Human Development Index (HDI) and various health outcomes. The aim of this study was to investigate the relationship between HDI, and infant mortality rate, mortality rate of children under one year and under 5 years, maternal mortality rate, and total fertility rate.

Materials and Methods

In this ecologic study, data on HDI, total fertility rate (TFR), maternal mortality rate (MMR), neonatal mortality rate (NMR), infant mortality rate (IMR) and mortality rate in children under 5 years of age (< 5MR), were extracted from 188 countries in 2014 in the world. The data required in this study was obtained from the World Bank. Data analysis was performed using Pearson correlation in Stata version 12.0 software.

Results

In this study, a negative significant correlation was observed between HDI and IMR (r = -0.878, P = 0.001), NMR (r = -0.870, 95% CI: -0.902, -0.828, P = 0.001), <5MR (r = -0.858, 95% CI: -0.893, -0.813, P = 0.001), MMR (r = -0.807, 95% CI: -0.853, -0.747, P = 0.001) and TFR (r = -0.831, 95% CI: -0.872, -0.778, P = 0.001).

Conclusion

IMR, children under one year old and under 5 years, and MMR mostly occur in developing countries. There was a correlation between HDI and its components, and the neonatal, infants, children under 5 years, maternal mortality rate and total fertility. The average annual percentage change of HDI also had a correlation with neonatal, infants, children under 5- year mortality rate, total fertility and maternal deaths.

Key Words: Ecologic study, Fertility rate, Human Development Index, Mortality rate.

*Please cite this article as: Almasi-Hashiani A, Sepidarkish M, Vesali S, Omani-Samani R. The Correlation of Human Development Index on Fertility and Mortality Rate: a Global Ecological Study. Int J Pediatr 2016; 4(12): 1795-1802. DOI: **10.22038/ijp.2016.7680**

Corresponding Author:

Reza Omani-Samani, Department of Epidemiology and Reproductive Health at Reproductive Epidemiology Research Center, Royan Institute for Reproductive Biomedicine, ACECR, Tehran, Iran.
P.O. Box: 16635148

Email: r.samani@gmail.com

Received date Sep.23, 2016; Accepted date: Oct. 22, 2016

1- INTRODUCTION

Human Development Index (HDI) is a composite index of life expectancy, education and Gross Domestic Product (GDP) per capita of each country, and it can be indicative of human development (1-4). According to the index, countries are ranked in terms of human development. World Bank ranking in 2015 revealed that countries such as Norway, Australia, Switzerland, Denmark and the Netherlands are ranked at first to fifth, while the countries of Burkina Faso, Burundi, Chad, Eritrea and Niger are in the lowest rank (5). Several studies have examined the relationship between HDI and various health outcomes, and it was found that there is a relationship between the index and diseases and different consequences, such as physical activity, kidney cancer, Helicobacter pylori, mortality and the incidence of bladder cancer, colorectal and ovarian cancers (6-13).

Death at an early age (especially in infants, children under one year and children under 5 years) and maternal mortality is one of the biggest health problems worldwide. It can be influenced by the economic and social situation (14). Despite the downward trend of the deaths in most countries, in some others, like African countries, its decreased speed is inconsiderable (15). The infant mortality rate was 63 deaths per 1,000 live births in 1990 and it reduced to 32 deaths per 1,000 live births in 2015 (16). Despite this decreasing trend, World Health Organization (WHO) in 2015 declared that about 4.5 million deaths occurred in children under one year around the world. The highest was seen in the WHO African Region with 55 cases per 1,000 live births, which was about 5 times than the WHO European regions with a rate of 10 cases per 1000 live births (16). Therefore, intervention to reduce maternal mortality and mortality in the first year of life is important for all countries and WHO. In a study by Alijanzadeh et al. (17), a statistically significant correlation was reported between HDI and infant mortality rate. In their study, data obtained only from 135 countries in 2015 in the world were evaluated. However, in the present study, we also gathered and analyzed data on mortality rates in other ages; but in other similar studies, the relationship between HDI and other health-related outcomes was investigated and a relationship between HDI, and mortality and fertility was not examined. Therefore, the aim of this study was to investigate the relationship between HDI, and infant mortality rate, mortality rate of children under one year and under 5 years, maternal mortality rate and total fertility rate.

2- MATERIALS AND METHODS

2-1. Study Design and Population

In this ecologic study, data on HDI, total fertility rate, maternal mortality rate, infant mortality rate, and mortality rate under one year old and under 5 years were extracted from 188 countries in 2014 in the world [Africa (51 countries), America (34 countries), Asia (50 countries), the Pacific (4 countries) and Europe (49 countries)]. The all required data in this study including HDI, mortality rates and fertility rate was obtained from the World Bank (5). Data required for each indicator were separately in Excel files and then merged and cleaned using Stata software. HDI was considered as a new scale of measuring development in communities in 1990. This index is based on the fundamental idea that necessary for a better life, in addition to having higher incomes, is development of human abilities and capacities. HDI measures a country's average achievement in three dimensions of human development, including long life with health, knowledge and standard of living. Long life with good health is measured through life expectancy at birth, knowledge (a combination of adult literacy

rate and combined net enrollment ratio for primary, secondary and higher education) standard of living (by gross domestic product [GDP] per capita). HDI is ranged from zero to one. HDI value shows that each country has possessed how much of your path to achieve the highest possible value, and also provides the ability to compare it between countries (5).

Maternal mortality rate is defined as maternal deaths due to pregnancy related causes during pregnancy or 42 days after delivery for every 100,000 live births. The mortality of children under one year is defined as the number of deaths before completing one year of age per 1,000 live births in a specified year. Infant mortality rate is defined as the number of infant deaths in the first 28 days of life per 1,000 live births in a specified year (5).

In this study, Total Fertility Rate (TFR) represents the number of children that would be born to a woman if she was to live to the end of her childbearing years and bear children in accordance with age-specific fertility rates of the specified year (5).

2-2. Ethical considerations

In the ecological study, data were extracted from different countries. Therefore, there is no ethical problem in the use and reporting of the data. Preliminary data also, were obtained from the World Bank does without limit access to it.

2-3. Statistical Analysis

The extracted data were analyzed using Stata software version 12.0 with commands of pwcorr, corrci and scatter. Tables and figures were used for reporting results. Relationship between mortality rates and fertility rate, and HDI, HDI dimensions and average annual HDI growth (A smoothed annualized growth of the HDI in a given period, calculated as the annual compound growth rate) was assessed using Pearson correlation. The level of significance was considered less than 0.05.

3-RESULTS

In this study, data from 188 countries on the HDI, mortality rates and total fertility rate were analyzed. Findings showed a significant negative correlation between HDI, and the infant mortality rate (r = -0.878, 95% confidence interval [CI]: -0.908, -0.838, P = 0.001), neonatal mortality rate (r = -0.870, 95% CI: -0.902, -0.828, P = 0.001), mortality rates in children under 5 years of age (r = -0.858, 95% CI: -0.893, -0.813, P = 0.001), maternal mortality (r = -0.807, 95% CI: -0.853, -0.747, P = 0.001) and total fertility rate (r = -0.831, 95% CI: -0.872, -0.778, P = 0.001) (**Figure.1**).

As shown in **Table.1**, there was a significant negative correlation between the components of HDI with neonatal mortality rate, infant mortality rate, maternal mortality rate and total fertility rate. The relationship between the average annual HDI growth (as a percentage) and HDI components, and mortality and fertility rates was evaluated during 1990 to 2014. As can see in **Table.1**, a significant positive correlation was observed between average annual HDI growth and infant mortality rate (r = 0.508, 95% CI: 0.373, 0.623, P = 0.001), neonatal mortality rate (r = 0.539, 95% CI: 0.409 , 0.648, P = 0.001), mortality rates in children under 5 years of age (r = 0.520, 95% CI: 0.386, 0.632, P = 0.001), maternal mortality rate (r = 0.476, 95% CI: 0.336 , 0.596, P = 0.001) and total fertility rate (r = 0.491, 95% CI: 0.352, 0.608, P = 0.001) (**Figure.2**).

According to word bank ranking, all existing countries were categorized in to four groups (very high, high, medium and low) by HDI. Correlation between HDI, and fertility and mortality rates was assessed considering these four groups

(**Table.2**). Findings showed that 49 countries took very high, 56 countries high, 30 countries medium and 44 countries low by HDI.

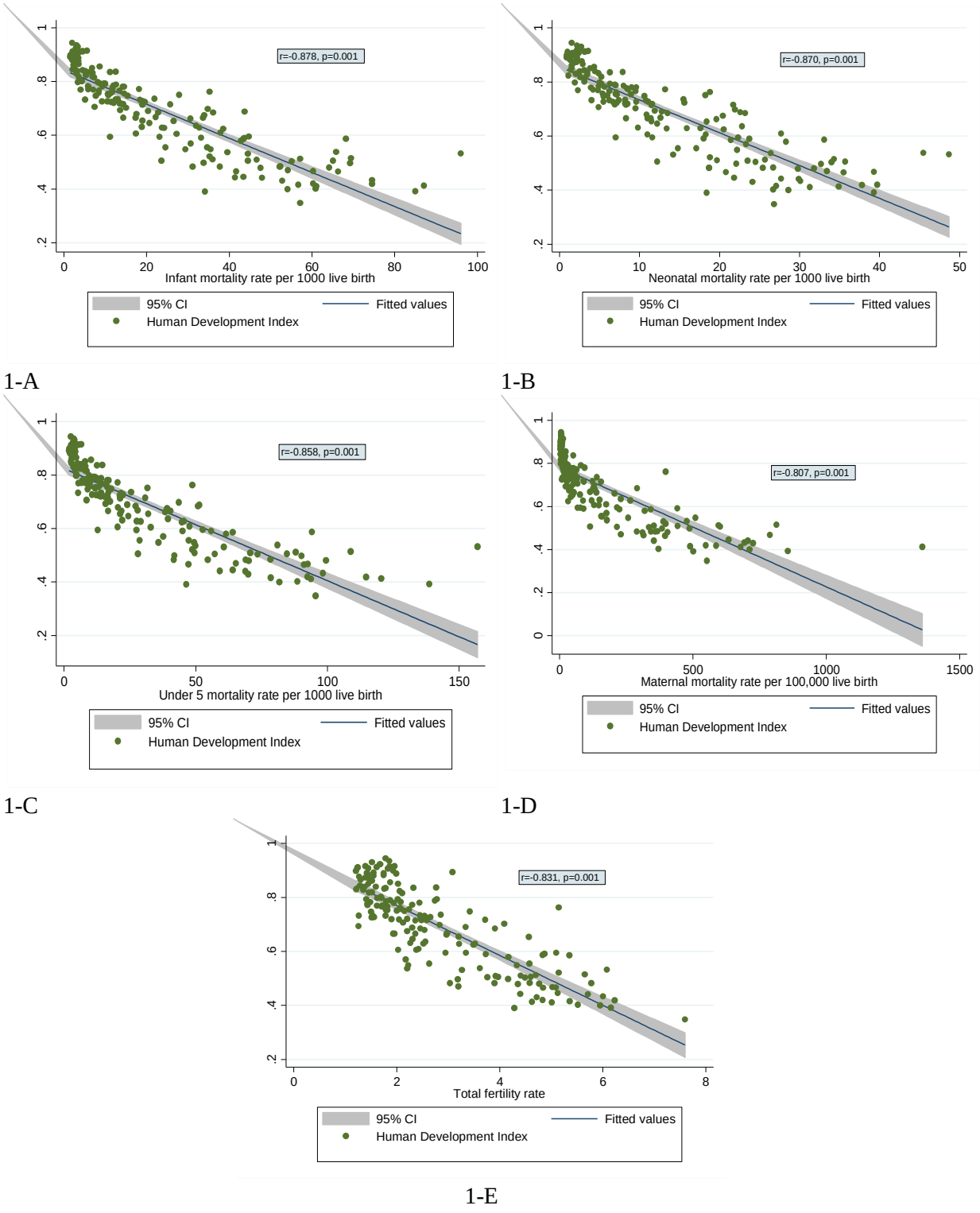

Fig.1: The correlation of human development index with infant (1-A), neonatal (1-B), under 5 (1-C), maternal mortality rate (1-D) and fertility rate (1-E).

Table-1: The relationship of human development index and their components on mortality and fertility rate

Variables		Correlation coefficients	95% CI		P-value
HDI	IMR 2015	-0.878	-0.908	-0.838	0.001
HDI	NMR 2015	-0.870	-0.902	-0.828	0.001
HDI	MMR 2015	-0.807	-0.853	-0.747	0.001
HDI	U5MR 2015	-0.858	-0.893	-0.813	0.001
HDI	TFR 2014	-0.831	-0.872	-0.778	0.001
Life expectancy	IMR 2015	-0.915	-0.936	-0.886	0.001
Life expectancy	NMR 2015	-0.872	-0.904	-0.831	0.001
Life expectancy	MMR 2015	-0.826	-0.868	-0.772	0.001
Life expectancy	U5MR 2015	-0.906	-0.930	-0.875	0.001
Life expectancy	TFR 2014	-0.808	-0.855	-0.749	0.001
Mean years of schooling	IMR 2015	-0.775	-0.829	-0.707	0.001
Mean years of schooling	NMR 2015	-0.785	-0.837	-0.720	0.001
Mean years of schooling	MMR 2015	-0.710	-0.777	-0.627	0.001
Mean years of schooling	U5MR 2015	-0.759	-0.816	-0.688	0.001
Mean years of schooling	TFR 2014	-0.744	-0.805	-0.669	0.001
GNI	IMR 2015	-0.567	-0.661	-0.456	0.001
GNI	NMR 2015	-0.591	-0.681	-0.484	0.001
GNI	MMR 2015	-0.476	-0.584	-0.350	0.001
GNI	U5MR 2015	-0.535	-0.634	-0.418	0.001
GNI	TFR2014	-0.510	-0.613	-0.390	0.001
Average annual HDI growth	IMR 2015	0.508	0.373	0.623	0.001
Average annual HDI growth	NMR 2015	0.539	0.409	0.648	0.001
Average annual HDI growth	MMR 2015	0.476	0.336	0.596	0.001
Average annual HDI growth	U5MR 2015	0.520	0.386	0.632	0.001
Average annual HDI growth	TFR 2014	0.491	0.352	0.608	0.001

HDI: Human Development Index; **IMR**: Infant Mortality Rate; **NMR**: Neonatal Mortality Rate; **U5MR**: Under 5 Mortality Rate; **MMR**: Maternal Mortality Rate; **TFR**: Total Fertility Rate.

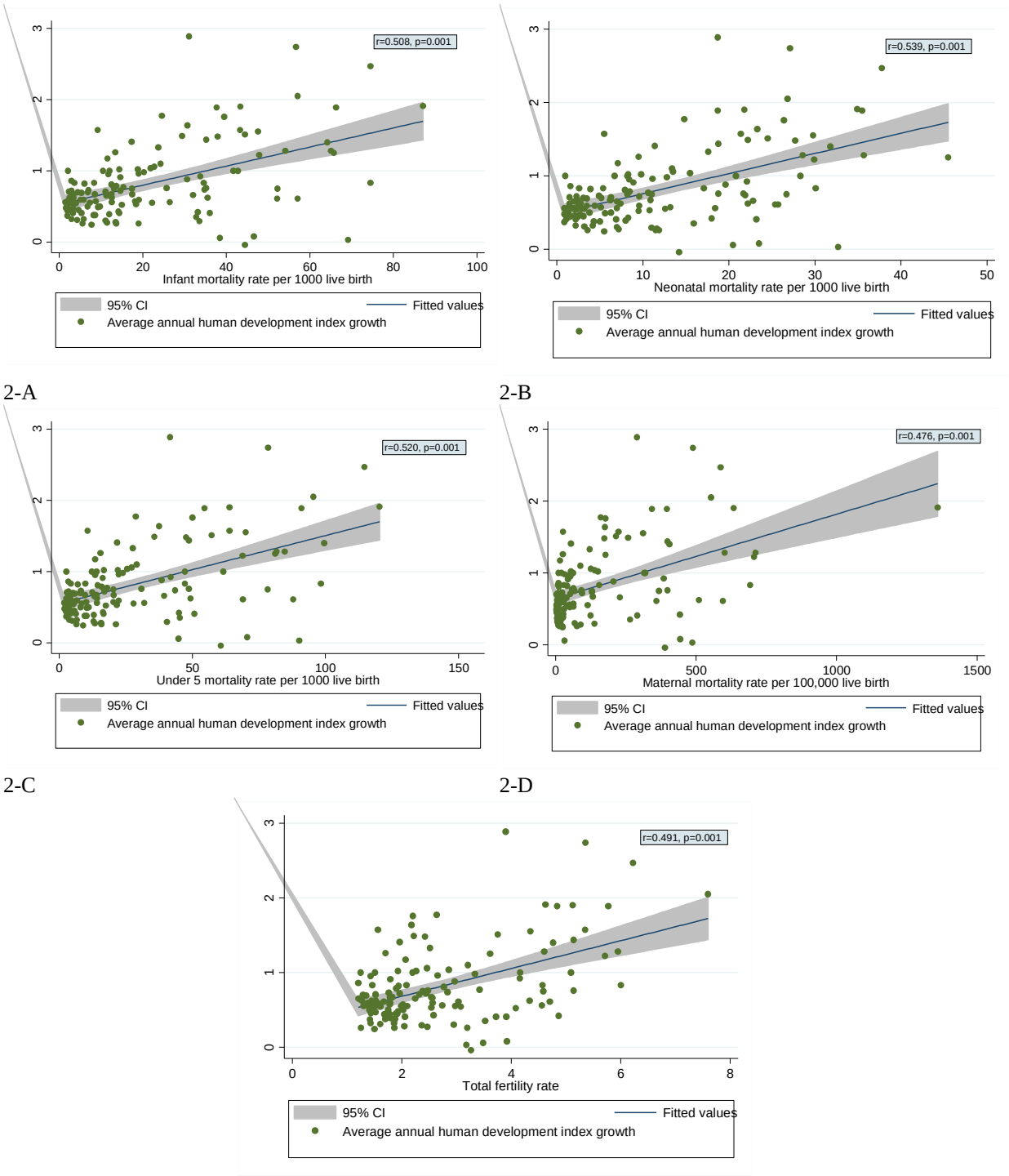

Fig.2: The correlation of average annual human development index growth with infant (1-A), neonatal (1-B), under 5 (1-C), maternal mortality rate (1-D) and fertility rate (1-E),

Table-2: The relationship of human development index on mortality and fertility rate based on human development index categories

HDI categories	Variables	Correlation coefficients	P-value
Very high	IMR 2015	-0.489	0.001
	NMR 2015	-0.415	0.004
	MMR 2015	-0.325	0.029
	U5MR 2015	-0.488	0.001
	TFR 2014	-0.032	0.828
High	IMR 2015	-0.343	0.012
	NMR 2015	-0.348	0.011
	MMR 2015	-0.176	0.229
	U5MR 2015	-0.308	0.026
	TFR 2014	-0.283	0.046
Medium	IMR 2015	-0.326	0.055
	NMR 2015	-0.297	0.082
	MMR 2015	-0.442	0.007
	U5MR 2015	-0.357	0.034
	TFR2014	-0.450	0.006
Low	IMR 2015	-0.291	0.061
	NMR 2015	-0.126	0.424
	MMR 2015	-0.490	0.001
	U5MR 2015	-0.336	0.029
	TFR 2014	-0.614	0.001

HDI: Human Development Index; **IMR**: Infant Mortality Rate; **NMR**: Neonatal Mortality Rate; **U5MR**: Under-5 Mortality Rate; **MMR**: Maternal Mortality Rate; **TFR**: Total Fertility Rate.

4- DISCUSSION

In this study, data from 188 countries were analyzed and findings revealed that there is a significant negative correlation between HDI and its components, and mortality rates of children under one year old, infants, children under 5 years, total fertility and mothers. It was also found that most deaths in neonatal, infant, under 5 years old and mothers can be observed in countries with low HDI and there was a statistically significant correlation between these two factors. A significant relationship was observed between the components of HDI and mortality rates in different age groups. The results indicate that HDI is a good indicator of development state of various countries and is consistent with health outcomes in different countries. Average annual percentage change had a direct and significant correlation with mortality rates of children under one year old, infants, children under 5 years, mothers and total fertility during 1990 to 2015, unlike HDI. This could be because the percentage change in HDI is low in countries with a high rank HDI, while countries with low HDI rank can have more growth in this index. For example, in Norway HDI (with the value of one) in 1990 reached from 0.849 to 0.944 in 2014, with average development of 44 percent. However, in Iran HDI, with the value of one, increased from 0.567 to 0.766 in 2014, with average development of 126 percent. Therefore, in developing countries, HDI is higher, but

death rate higher; while the situation is the opposite in developed countries. Thus, direct relationship (positive correlation) between HDI and mortality rates of different age groups is justified.

The mortality rate of children, infants and mothers in countries with better HDI is lower, because of better prenatal care, better coverage of vaccination, proper nutrition, and better monitoring of mothers and infants. Whereas in developing countries deficiencies in maternal and child care, malnutrition, lack of complete vaccination, war and famine lead to more deaths in the age groups. For example, annual vaccination prevents 2 to 3 million deaths, so that improving vaccination coverage will prevent 5.1 million deaths. According to estimates of WHO 19.4 million children are deprived of basic vaccination coverage (18).

In a study by French, it has shown that between 1990 and 2011, a reduction of 41% occurred in the mortality rate of children under 5 years. The decline is not only due to better health care, but also economic development of the community (19), which is Gross national income (GNI) in HDI that its relationship with the mortality rate was also confirmed in this above study. In this study, the mean years of schooling showed a significant correlation with mortality rates. In the other words, with increasing education, health literacy of women is also rising. This leads to better health, better care of their children and more attention of women to health of their family, and thus reducing the mortality and morbidity.

Heide et al. also showed the relation among health, education, and health literacy. A significant inverse correlation was observed between GNI and mortality rates and poorer countries had a higher mortality (20). Economic inequalities in mortality rates have been also confirmed in other studies (21-24). More deaths in developing countries, in addition to the factors mentioned, could be due to pregnancy at an early age and low intervals among pregnancies (25, 26).
Our findings showed that HDI can be a good indicator of health status and level of development of various countries, and countries with high HDI also enjoy better health status.

4-1. Limitations of the study

According to the ecological study, the results of this study were not generalizable to small communities and it is recommended that similar studies be done individually in different societies. It is also recommended causes of infant mortality in different countries to be studied.

5- CONCLUSION

Mortality rates of infants, children under one year old and under 5 years, and maternal deaths mostly occur in developing countries. The results showed that there was a significant negative correlation between HDI and its components, and the deaths of children under one year old, infants, children under 5 years, total fertility and mothers. The average annual percentage change of HDI also had a significant positive correlation with mortality rates of children under one year old, infants, children under 5 years, total fertility and maternal deaths.

6- CONFLICT OF INTEREST

There is no conflict of interest among authors.

7- ACKNOWLEDGMENTS

The Royan Institute is grateful for the financial support of the project. The data used in this project was obtained from the World Bank.

8- REFERENCES

1. Anand S. Human Development Index: methodology and measurement. Human Development Report Office (HDRO), United Nations Development Programme (UNDP), 1994.

2. Noorbakhsh F. A modified human development index. World Development 1998;26(3):517-28.

3. Bray F, Jemal A, Grey N, Ferlay J, Forman D. Global cancer transitions according to the Human Development Index (2008–2030): a population-based study. The lancet oncology 2012;13(8):790-801.

4. Sagar AD, Najam A. The human development index: a critical review. Ecological economics 1998;25(3):249-64.

5. World Bank. UNITED NATIONS DEVELOPMENT PROGRAMME (UNDP). Human Development Index. [cited 2016 July]. Available at: http://hdr.undp.org/en/content/human-development-index-hdi.

6. Yan TL, Hu QD, Zhang Q, Li YM, Liang TB. National rates of Helicobacter pylori recurrence are significantly and inversely correlated with human development index. Alimentary pharmacology & therapeutics 2013;37(10):963-8.

7. Razi S, Ghoncheh M, Mohammadian-Hafshejani A, Aziznejhad H, Mohammadian M, Salehiniya H. The incidence and mortality of ovarian cancer and their relationship with the Human Development Index in Asia. ecancermedicalscience 2016;10.

8. Patel AR, Prasad SM, Shih Y-CT, Eggener SE. The association of the human development index with global kidney cancer incidence and mortality. The Journal of urology 2012;187(6):1978-83.

9. Pakzad R, Mohammadian-Hafshejani A, Mohammadian M, Pakzad I, Safiri S, Khazaei S, et al. Incidence and Mortality of Bladder Cancer and their Relationship with Development in Asia. Asian Pacific journal of cancer prevention : APJCP 2015;16(16):7365-74.

10. Marcucci C, Madjdpour C, Spahn DR. Allogeneic blood transfusions: benefit, risks and clinical indications in countries with a low or high human development index. British medical bulletin 2004;70(1):15-28.

11. Mahdavifar N, Ghoncheh M, Pakzad R, Momenimovahed Z, Salehiniya H. Epidemiology, Incidence and Mortality of Bladder Cancer and their Relationship with the Development Index in the World. Asian Pacific journal of cancer prevention : APJCP 2016;17(1):381-6.

12. Khazaei S, Rezaeian S, Mansori K, Sanjari MA, Ayubi E. Effects of Human Development Index and Its Components on Colorectal Cancer Incidence and Mortality: a Global Ecological Study. Asian Pacific journal of cancer prevention: APJCP 2015;17:253-6.

13. Dumith SC, Hallal PC, Reis RS, Kohl HW. Worldwide prevalence of physical inactivity and its association with human development index in 76 countries. Preventive medicine. 2011;53(1):24-8.

14. Kochanek KD, Xu J, Murphy SL, Miniño AM, Kung H-C. Deaths: final data for 2009. Natl Vital Stat Rep 2011;60(3):1-116.

15. Oestergaard MZ, Inoue M, Yoshida S, Mahanani WR, Gore FM, Cousens S, et al. Neonatal mortality levels for 193 countries in 2009 with trends since 1990: a systematic analysis of progress, projections, and priorities. PLoS Med 2011;8(8):e1001080.

16. World Health Organozation. Global Health Observatory (GHO) data. Infant mortality. Situation and trends. [cited 2016 July]. Available at: http://www.who.int/gho/child_health/mortality/neonatal_infant_text/en/.

17. Alijanzadeh M, Asefzadeh S, Zare SAM. Correlation Between Human Development Index and Infant Mortality Rate Worldwide. Biotechnology and Health Sciences 2016;3(1):141-6.

18. World Health Organization. Immunization coverage. Available at: http://www.who.int/mediacentre/factsheets/fs378/en/. Accessed in July 2016; cited 2016 August 2016.

19. French D. Did the Millennium Development Goals Change Trends in Child Mortality? Health economics. 2015.

20. van der Heide I, Wang J, Droomers M, Spreeuwenberg P, Rademakers J, Uiters E. The relationship between health, education, and health literacy: results from the Dutch Adult Literacy and Life Skills Survey. Journal of health communication 2013;18 Suppl.1:172-84.

21. Khazaei S, Ayubi E, Nematollahi S, Khazaei S. Variations of Infant and Under-five Child Mortality Rates around the World, the Role of Human Development Index (HDI). International Journal of Pediatrics 2016;4(5):1671-77.

22. Hosseinpoor AR, Van Doorslaer E, Speybroeck N, Naghavi M, Mohammad K, Majdzadeh R, et al. Decomposing socioeconomic inequality in infant mortality in Iran. International Journal of Epidemiology 2006;35(5):1211-19.

23. Hosseinpoor AR, Mohammad K, Majdzadeh R, Naghavi M, Abolhassani F, Sousa A, et al. Socioeconomic inequality in infant mortality in Iran and across its provinces. Bulletin of the World Health Organization 2005;83(11):837-44.

24. Hashiani AA, Ayubi E, Fahimfar N, Khosravi A, Karamzad N, Safiri S. Economic Inequality and Infant, Under-5-Year-Old, Maternal, and Crude Mortality Rates. Journal of Archives in Military Medicine 2015;3(3): e28205.

25. Hajizadeh M, Nandi A, Heymann J. Social inequality in infant mortality: What explains variation across low and middle income countries? Social science & medicine. 2014;101:36-46.

26. Ghaffari J, Abbaskhanian A, Nazari Z. Mortality Rate in Pediatric Intensive Care Unit (PICU): A Local Center Experience. International Journal of Pediatrics 2014;2(3.2):81-8.