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FACTORS ASSOCIATED WITH CHILD MORTALITY IN DEVELOPING COUNTRIES: AN ECOLOGICAL STUDY IN 82 COUNTRIES

FAKTORI POVEZANI SA SMRTNOŠĆU DECE U ZEMLJAMA U RAZVOJU – EKOLOŠKA STUDIJA U 82 ZEMLJE

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*Key words*

Child mortality, developing countries, correlates

*Ključne reči*

Smrtnost dece, zemlje u razvoju, korelacije

*Abstract*

**Background:** In spite of good progress in child survival; child mortality is still an urgent concern for global community particularly for developing countries where the larger share of global child death occurs. Globally remarkable progress has been made, however in developing countries the progress is steady. Identifying correlates and designing intervention will have important role to reduce child mortality. There for this study aimed to identify correlates of child mortality in developing countries to show directions of interventions. **Methods:** By using aggregate health indicator data of 2008-2016 from WHO, World Bank, UNDP and UNICEF data bases among 82 developing countries analytical ecological study was conducted. The dependent variable was child mortality rate, while the independent variable was socio-economic, health care related and coverage of child survival interventions. Data was compiled in excel and analyzed using SPSS version 21. **Results:** child mortality rate is very high in developing countries and the difference between countries is also high. A significant correlation between child mortality and socio-economic, health care, child survival intervention and morbidity indicator variables was observed. Along with some of socio-economic variables Maternal Mortality Ratio, Total fertility rate and Crude birth rate had strong positive correlation, while access to improved sanitation and disease prevention indicator variables has strong negative correlation with CMR. **Conclusions:** child mortality is determined by multiples of socio-economic, health care system associated factors, disease burden, disease prevention activities and their complex interactions. Therefore Policy and programs targeted to improve child health should address these issues.

*INTRODUCTION*

World has made remarkable progress in child mortality reduction starting from 1990s at which its rate dropped from 91 per 1000 live births since 1990 to 43 per 1000 live births in 2015. At the country level around a third of countries has reduced child mortality rate by two third or more; among them only twelve are in low income countries. In spite of good progress in child survival; child mortality is still an urgent concern for global community. About 16,000 children died every single day which means 11 deaths every minute. The aforementioned figures are unacceptably high and hence a concerted effort is needed to fuel the pace of mortality reduction progress (1).

Sub Saharan Africa remains at the highest under-five mortality rate to all global regions with death of one child among 12 under-five children which is far higher than the average death in developed countries with one per 147.

Southern Asia also has high under-five mortality rate with 51 deaths per 1000 live births which is 30% of global under-five deaths (1, 2). Most deaths are clustered during neonatal period. Of 6.3 million under five deaths; around 44% occurred during neonatal period and majority of deaths (51.8%) are due to infectious causes (3).

At the end of the millennium development goal era; international communities agreed on a new framework entitled sustainable development goal which Planned to reduce child death significantly. By the end of 2030; end preventable deaths of newborn and under-five children; with all countries aiming to reduce neonatal mortality to at least as low as 12 deaths per 1000 live births and under five mortality as low as 25 deaths per 1000 live births (4).

To achieve the aforementioned ambitious child mortality reduction targets understanding the correlation between child survival status and the national macro variables is

essential to focus priority intervention in developing countries; therefore this study aims to undergo an ecological study for identifying correlating factors with child mortality among 82 developing countries.

## METHODS

### Study design and population

Analytical ecological study design was used with the intention to identify correlates of child mortality in developing countries. The study was conducted from November 1-December 30/2016 by using aggregates of health indicator data from WHO, World Bank, UNDP and UNICEF data bases. The source population was all children in developing countries; with the nature of the design each Developing countries are considered as unit of analysis. Developing countries are those countries or sovereign states which have gross national income (GNI) per capital in atlas method of < 4125 USD from 2014 estimation. There are a total of 82 developing countries according to World Bank 2016 report; among them 31 are low income counties (GNI of 1045 USD or less) and 51 are lower middle income counties with GNI of 1045-4125 USD<sup>(5)</sup>.

### Study variables and source of information

The source of information is WHO <sup>(6)</sup>, UNICEF <sup>(7)</sup>, UNDP <sup>(8)</sup> and World Bank <sup>(9)</sup> databases with the most recent available data of from 2008 to 2016 was used. Data reported from two or more of the above data bases are nearly similar to each other and the national demographic and health surveys. Separately available indicators were sorted and compiled based on selected developing countries list and identified indicators and secondary analysis was carried out. The outcome variable was child mortality rate (CMR) per 1000 live births; while the determinants were health and socio-economic indicators used by WHO and other organizations.

Determinant factors were described in to three categories. Socio-economic indicators: GNI, women unemployment rate, public expenditure for health, literacy rate; Health care system indicators: Skilled delivery service coverage, total fertility rate, crude birth rate, Maternal Mortality ratio (MMR), physician to public proportion, nurse and midwives proportion, vaccine coverage, health seeking for, child sleep under ITN, antimalarial use, exclusive breast feeding, house hold iodine consumption, vitamin A supplementation, safe water supply coverage and improved sanitation; and disease burden indicators: Tuberculosis incidence, HIV incidence, prevalence of Anemia among under five children, under nutrition and low birth weight were used. The variables were selected based on the existing evidence from previous studies.

### Operational definition

All variables were defined according to WHO, UNICEF, UNDP and World Bank standards <sup>(5-9)</sup>

✓ *Developing country*: countries with GNI per capital of 4125 USD or less in 2014

✓ *CMR*: The probability per 1000; of a child born in a specific year or period dying before reaching the age of five, if subject to age-specific mortality rates of that period.

✓ *GNI per capita*: Gross National Income divided by midyear population.

✓ *Health expenditure (% GDP)*: Level of total expenditure on health (THE) expressed as a percentage of gross domestic product (GDP).

### Statistical analysis

Each raw data obtained from data bases were compiled for specific indicators, and then to all developing countries using Microsoft excel. The organized data was exported to SPSS version 21 for analysis. Data was cleaned and exploratory data analysis carried out to check the levels of missing values, presence of influential outliers and normality. The normality of the quantitative variables was checked using the Kolmogorov-Smirnov test. Whenever violated, log transformation was used for the non-normal variables, non-parametric tests were used if still fails. Based on the final compiled data, descriptive analysis of both the independent and dependent variables of interest was performed. Finally, a Pearson or Spearman correlation analysis was performed to ascertain the degree of the relation between CMR and the remaining variables. All associations and tests were said to be significant at  $p < 0.05$ .

## RESULTS

### Description of variables

All of the 82 developing countries listed by the World Bank 2016 report with the definition of GNI per capital of 4125 USD or less were included in this study. Of them 31 are low incomes countries with GNI per capital of 1045 USD or less and 51 are lower middle income countries with GNI per capital of 4125 USD or less. The mean GNI is 1701(SD=1249) ranges between 260-4280 USD. Still there is wider economic gap even among developing countries. Also the percentage of public expenditure for health is different in amount.

In this developing countries the health coverage, availability and utilization of service is lower; while the burden of disease is higher. There is wider gape in skilled delivery service utilization which ranges 16% in Ethiopia to 100% coverage in 5 countries with a mean of 62.8% (SD= 30). Five countries had attained water coverage of 100% and another two have 100% access to improved sanitation. There are 0.5(SD= 0.8) physicians and 1.4(SD= 2.14) nurses per 1000 population, being the highest 3.5 physician in Ukraine and 11.9 nurses in Uzbekistan.

The incidence of TB is highest in Lesotho (788 per 100,000 populations) and lower in West Bank and Gaza which is 1, much lower than the average 195.4(SD=163) per 100,000. While HIV incidence is highest in Swaziland (2.36) with a mean of 0.134(SD= 0.36). These developing countries have the highest incidence of TB and HIV in the word. Among children the reported prevalence of anemia is between 14% and 86% with a mean prevalence of 49.4% (SD=18.8). Malnutrition is most prevalent in Burundi (57.5%), which is much higher than the average 26.2(SD=15.6); While LBW is prevalent in Mauritania. MMR ranged from 7 deaths per 100,000 live births in Cabo verd to 1360 deaths in Sierra Leon with a mean of 311(SD=268) (Table: 1).

Accordingly 78.3 % (SD=20) of children were vaccinated for measles, more over 8 countries had attained 99% coverage. Nearly half (50.3% SD=41.8) of children received Vitamin A supplementation with the range of 7-99% cover-

**Table: 1.** Description of CMR and related indicators among developing countries, 2008-15.

Indicators	Mean (SD)	Range
Child mortality rate (deaths per 1000 live births)	54(33)	5-139
<b>Socio-economic variables</b>		
GNI per capital (atlas method)	1701(1249)	260-4280
Health expenditure (% of GDP)	5.76(2.73)	1.5-13.7
Adult Literacy rate (%)	67(21)	32-100
<b>Health care system related variables</b>		
Skilled delivery coverage (%)	62.8(30)	16-100
Total fertility per a women	3.8(1.4)	1.3-7.6
Crude birth rate per 1000	29.5(9)	11-49
Ratio of Physician to 1000 population	0.5(0.8)	0.1-3.5
Ratio of Nurse and Midwife to 1000 population	1.4(2.14)	0.1-11.9
Improved water coverage (%)	75(22.7)	40-100
Improved sanitation coverage (%)	47.8(29)	7-100
<b>Disease burden related variables</b>		
TB incidence rate per 100,000 population	195.4(163)	1-788
HIV incidence rate (15-49 yrs)	0.134(0.36)	0.01-2.36
Prevalence of malnutrition	26.2(15.6)	6.4-57.5
Prevalence of Low birth weight	8.86(7.64)	5-35
Prevalence of Anemia in < 5 children	49.4(18.8)	14-86
MMR	311(268)	7-1360
<b>Disease prevention related variables</b>		
Measles vaccination coverage	78.3(20.2)	20-99
Health seeking for ARI	48.6(26)	23-94
Child with Diarrhea received ORS	39(22.7)	21-83
ITN utilization	22(25.6)	1.5-80.6
Child with fever received Antimalarial	12.5(17.8)	0.1-65
Exclusive Breast Feeding	38(23)	5-87
Vitamin A supplementation	50.3(41.8)	7-99

age. On the other hand proportion of Children with Diarrhea received ORS (39% SD=22.7), proportion of Children with fever received Antimalarial (12.5% SD=17.8) and proportion of <6 month infants Exclusively Breast Feed (38% SD=23) were extremely lower than the coverage of developed countries.

*Child mortality rate (CMR)*

The prevalence of CMR ranges from 5 deaths per 1000 live births in Cabo verd to 139 deaths per 1000 in Chad with a mean of 54(SD= 33). The rate of mortality is the highest of the world; however the rate of child mortality in Cabo verd and Ukraine is comparable to the CMR of most developed countries. It is noted that most countries sharing the highest global under five child death are in this list of developing countries (Table: 1).

*Correlation between CMR and other variables*

Among the socio-economic variables, GNI per capital was significantly negatively correlated with CMR. On the other hand except HIV incidence all Health care system related variables, Disease burden related variables and Disease prevention related variables were significantly correlated with CMR. Maternal Mortality Ratio, Total fertility

**Table: 2.** Correlation between CMR and related indicators among developing countries, 2008-15

Indicators	N	r	p.value
Child mortality rate (deaths per 1000 live births)	82	1	
<b>Socio-economic variables</b>			
GNI per capital (atlas method)	78	-0.6	<0.001
Health expenditure (% of GDP)	72	-0.13	0.9
Adult Literacy rate (%)	79	-0.17	0.14
<b>Health care system related variables</b>			
Skilled delivery coverage (%)	76	-0.40	<0.001
Total fertility per a women	75	0.76	<0.001
Crude birth rate per 1000	69	0.77	<0.001
Ratio of Physician to 1000 population	82	-0.50	<0.001
Ratio of Nurse and Midwife to 1000 population	80	-0.42	<0.001
Improved water coverage (%)	56	-0.36	0.001
Improved sanitation coverage (%)	66	-0.68	<0.001
<b>Disease burden related variables</b>			
TB incidence rate per 100,000 population	82	0.3	0.006
HIV incidence rate (15-49 yrs)	64	0.20	0.06
Prevalence of malnutrition	70	0.43	<0.001
Prevalence of Low birth weight	60	0.65	<0.001
Prevalence of Anemia in < 5 children	80	0.67	<0.001
MMR	82	0.86	<0.001
<b>Disease prevention related variables</b>			
Measles vaccination coverage	80	-0.48	<0.001
Health seeking for ARI	70	-0.48	<0.001
Child with Diarrhea received ORS	67	-0.52	<0.001
ITN utilization	43	-0.53	<0.001
Child with fever received	51	-0.56	<0.001
Exclusive Breast Feeding	71	-0.46	<0.001
Vitamin A supplementation	57	-0.40	<0.001

rate and Crude birth rate had strong positive correlation, while access to improved sanitation and disease prevention indicator variables has strong negative correlation with CMR (Table: 2).

**DISCUSSION**

The study assessed correlates of child mortality among 82 developing countries in which larger share of the global child mortality is recorded. It is shown that the highest burden of child death belongs to these groups of countries. More over the rate of decline in these countries was steady (1). In the study the rate of child mortality is found to be very high; which ranges from 5-139 death per 1000 live births with a mean of 54(SD= 33) and the major determinants are multifactorial; socio-economic, health care system and disease burden and preventive measures.

According to this study, disparities in socio-economic indicators have significant relationship with CMR. Wide variations in Child mortality levels exist among different income groups which urge countries to narrow disparities. The finding was supported by many other studies (10, 11); also the differences in developed and developing countries and the differences between income groups within countries

witness the effect of income (6-9). However Health expenditure (% of GDP) for health and Adult Literacy rate failed to have significant correlation with CMR.

The number of children a woman could have highly influence child mortality. The two variables which indicate women fertility; Total fertility rate and Crude birth rate had significantly and positively correlated with child mortality. This effect of fertility could be bidirectional; it affects the health of the mother as well as the child leading to child mortality. Similarly skilled delivery service utilization has significantly correlated with child mortality. This could be due to the fact that in addition to reducing maternal mortality the component of skilled delivery service is immediate new born care which could significantly reduce perinatal and child mortality (3, 11).

Also staffing patterns of health facilities was found to be significantly associated with child mortality. The number of physicians and nurses available for every 1000 population (staff density) has negatively associated with magnitude of CMR. This could be due to the fact that availability of health professional increase availability of child care service and improve the quality of existing service and further reduce child mortality. Similarly Access to improved sanitation and safe water supply are another factors observed to be related to child mortality. Both are inversely correlated with CMR, which is similar to the previous reports (12, 13). This is due to the fact that access to improved sanitation and safe water decrease the risk of communicable disease which has a larger share of child mortality.

Morbidity levels of relevant conditions in a population, perinatal conditions and burden of child hood problems had significantly influenced child deaths. Prevalence of anemia and malnutrition in < 5 children has positively and significantly correlated with CMR. As it was reported from previous studies malnutrition and anemia increase the risk of

infection which poses higher burden of death. Similarly Prevalence of Low birth weight and MMR had most significantly and positively associated to child mortality. This could be due to bio-regulatory mechanism failure in low birth and feeding problem associated with LBW or maternal death (12-15).

Disease prevention related variables were the other identified significant determinants of child mortality. In this study Measles vaccination coverage, Health seeking for ARI, proportion of Children with Diarrhea received ORS, ITN utilization, Child with fever received antimalarial, proportion of Exclusive Breast Feeding child and Vitamin A supplementation were negatively and significantly associated with child mortality. The preventive effect of these variables was reported from different studies. This could be due to the fact that major cause of child mortality in developing countries are measles, malaria, diarrhea, ARI underlined by malnutrition; intervention addressing this significantly reduce child mortality (14-16).

#### *Conclusion and recommendation*

Child mortality is a major public health issue in developing countries due to its prevalence and lower declining pattern. It is determined by multiples of socio-economic factors, health care system associated factors, disease burden and their complex interactions. Therefore Policy and programmes targeted to improve child health should address them.

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## Sažetak

Uprkos značajnom napretku u preživljavanju dece, njihova smrtnost i dalje ostaje urgentna briga svetske zajednice posebno u zemljama u razvoju gde se povećana smrtnost dece najviše i javlja. Na svetskom nivou napredak je značajan, ali u zemljama u razvoju vidi se stagnacija ovog procesa. Identifikovanje povezanosti i kreiranje intervencija imaju važnu ulogu u smanjenju smrtnosti dece. Ova studija ima cilj da identifikuje korelate smrtnosti dece u zemljama u razvoju i da pokaže smernice za intervencije.

**Metode.** Korišćeni su udruženi podaci o zdravlju u periodu 2006-2016. od SZO, Svetske Banke, Programa razvoja UN i UNICEF-a i urađena je ekološka studija za 82 zemlje u razvoju. Zavisna varijabla bila je stopa smrtnosti dece dok su nezavisne varijable bile socio-ekonomski status, kao i dostupnost intervencija zdravstvene zaštite u preživljavanju dece. Podaci su sastavljeni u Ekselu i obrađeni u programu SPSS, verzija 21.

**Rezultati.** Nađena je vrlo visoka smrtnost dece u zemljama u razvoju i velike razlike između pojedinih zemalja. Nađena je značajna korelacija između smrtnosti dece i varijabli socio-ekonomskog statusa, dostupnosti zdravstvene zaštite i intervencija u preživljavanju. Između pojedinih socio-ekonomskih varijabli nađena je jaka pozitivna korelacija između koeficijenta smrtnosti majki, stope ukupnog fertiliteta i ukupnog broja živorođenih, dok je jaka negativna korelacija smrtnosti dece nađena sa varijablama kao što su poboljšanje higijene i indikatori prevencije bolesti.

**Zaključak.** Smrtnost dece je određena brojnim faktorima kao što su socio-ekonomski status, faktori zdravstvene zaštite, opterećenja bolestima, preventivnim merama i njihovim kompleksnim interakcijama. Stoga ovim pitanjima treba da se bave politika i programi usmereni na poboljšanje zdravlja dece.

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