Governance matters: an ecological association between governance and child mortality

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Background: Governance of a country may have widespread effects on the health of its population, yet little is known about the effect of governance on child mortality in a country that is undergoing urbanization, economic development, and disease control.

Methods: We obtained indicators of six dimensions of governance (perceptions of voice and accountability, political stability and absence of violence, government effectiveness, regulatory quality, rule of law, and control of corruption) and national under-5 mortality rates for 149 countries between 1996 and 2010. We applied a semiparametric generalized additive mixed model to examine associations after controlling for the effects of development factors (urbanization level and economy), disease control factors (hygienic conditions and vaccination rates), health expenditures, air quality, and time.

Results: Governance, development, and disease control showed clear inverse relations with the under-5 mortality rate (p<0.001). Per unit increases in governance, development, and disease control factors, the child mortality rate had a 0.901-, 0.823-, and 0.922-fold decrease, respectively, at fixed levels of the other two factors.

Conclusions: In the effort to reduce the global under-5 mortality rate, addressing a country's need for better governance is as important as improvements in development and disease control.

Keywords: Child mortality, Governance, Social determinants, Urbanization, World health

Introduction

Governance, broadly defined as the process by which the authority of a country exercises government formation, sound policy making and effective policy implementation, is regarded as a crucial determinant of population health.[1,2] The effect of governance on the health of a country's population is determined by the government's response to its citizens' needs, its distribution of health-related program resources, and its management of social and environmental conditions such as economic development, food security and public education.[3,4] Therefore, a country's governance is viewed as a key factor in achieving the United Nations (UN) Millennium Development Goals (MDG).[5,6]

Historical and contemporary political analyses have shown that governments are key players in devising public policies on labor markets, welfare systems, and economic growth strategies.[7,8]

Core capabilities of an effective government are protecting the population from violence, preventing bureaucratic corruption, and supplying and meeting needs for public goods and services.[9] Effective governance entails high-quality public services and the ability to contribute effectively to population health without undue political influence.[10] Hence, effective governance, together with greater investments in infrastructure related to health, can improve people's daily living environment, quality of life, and health.[11] In contrast, less effective governance will be unable to improve the key socioeconomic determinants needed to benefit population health.[12] Poor governance i.e., abusing citizens, failing to provide equal protection under the law, or corrupting and mismanaging resources, infrastructure or the economy, is detrimental to population health.[6]

There has been a growing quest for better governance in the pursuit of health equity at the global level.[12] This issue is

particularly important as progress toward the MDG for child mortality has been slower than expected.[6,13] Lozano et al. estimated that only 7% (9 out of 137) of developing countries were likely to meet the target child mortality rate by 2015.[14] In 2010, global donors committed US$40 billion to accelerate progress toward this MDG.[15] However, lack of effective governance was found to be a substantial risk factor, resulting in an inability to utilize aid resources and eventually in failure to institute a good healthcare system.[16]

Another concern has been the interplay between governance and population health in the context of the trend toward country-level urbanization and the pursuit of economic growth for better living and health conditions.[3,10,17,18] People who live in urban settings or in countries with relatively better economic status are likely to have better access to food, sanitation, education, employment and healthcare - all factors that may contribute to better health.[19] A failure of governance in the course of a country's path toward urbanization and economic development can result in ineffective health policies and services, resulting in unhealthy living conditions such as informal urban settlements and slums.[18,20] Such poor living conditions are usually associated with unsafe drinking water and lack of improved sanitation facilities, and may place people at risk of contracting easily preventable diseases.

Attention is also being paid to the role of governance in the practice of disease control, especially during the course of urbanization.[21] Urbanization in the demographic sense is defined as the process of increasing the concentration of people living in urban areas. Moore notes that greater population density in urban settings is associated with greater potential for disease transmission and greater susceptibility to disease epidemics.[22] Communicable and non-communicable chronic diseases alike, including malaria, HIV/AIDS, and illness related to air pollution, have been increasing dramatically in rapidly urbanizing areas of Africa and Asia, and in various countries in other parts of the world with relatively low per capita incomes.[20,21,23] The crowding in high-density urban environments requires good urban governance for effective disease control.[20]

Children, as a result of physiological and behavioral differences from adults, are more susceptible to environmental, political, and socioeconomic factors.[7,24] As global efforts toward reducing child mortality get under way, an understanding of how governance affects child health in the context of urbanization, economic development and disease control, especially in countries with poor governance, is essential. However, attempts to estimate the effect of governance on child mortality in the context of a country's urbanization, economic development and disease control are generally hampered by a lack of comparable indicators across countries. In addition, yearly variability in all these factors, together with the continuous effect of governance indicators, is likely to lead to complications; longitudinal analysis should therefore be used.

We aimed to investigate how country-level child mortality is associated with urbanization, economic development, disease control, and governance. To address this issue, we collected publicly available country-specific data and conducted cross-national comparisons and longitudinal data modeling. The objective of our study was to investigate the ecological association between governance and child mortality and to provide global health efforts with further evidence of the need for better governance.

Materials and methods

Data sources

We obtained data on child health and its predictors, from publicly available databases, for the period 1996 to 2010 for 149 countries (representing 96.5% of the world's population in 2010[25]) that offered available data for analyses. The measure used to indicate child health status in each country was the under-5 mortality rate reported by the UN, which measures the probability of a child dying between birth and his or her 5th birthday (an exact age of 5 years), expressed per 1000 live births. Yearly under-5 mortality rates were extracted from the interpolated demographic indicators in the UN document World Population Prospects (WPP).[25]

The definitions and sources of the key determinants of under-5 mortality rates investigated in this study are shown in Box 1. Governance indicators were extracted from the Worldwide Governance Indicators (WGI) reported by the World Bank.[1,26] The WGI, a database published by the World Bank in 1996, consists of six dimensions of governance: voice and accountability, political stability and absence of violence, government effectiveness, regulatory quality, rule of law, and control of corruption.[1] It was updated every 2 years between 1996 and 2002 and has been updated annually since 2002.[1] The six governance indicators were aggregated from 441 indicators of 35 data sources for 212 countries and territories. These data were based on surveys of individuals or domestic firms with first-hand knowledge of the governance situation in the country to reflect the common perceptions of diverse data providers, including commercial businesses (averaged share of sources=31%), surveys of firms or households (27%), non-governmental organizations (16%), and the public sector (26%).[1] The unobserved components model was applied to construct an aggregate of the six governance dimensions from these individual measures.[1] Data were first rescaled and then averaged with weights based on the precision of the individual data sources for each of the governance indicators: commercial businesses (averaged share of weights=0.37), surveys of firms or households (0.14), non-governmental organizations (0.22), and the public sector (0.28).[1] To facilitate cross-country and over-time comparison, the scores were normally distributed, with a mean of zero and a standard deviation of one.[1,27] With such transformation, the indicator acted as proxy of a country's relative state of governance.[27] These WGI scores were used to reflect relative levels of governance among studied countries, and do not directly quantify absolute qualities of governance.

Urbanization was measured as the proportion of a country's population living in areas classified as urban, according to the criteria used by that country.[25] We chose national economies for our analysis because poverty perpetuates inadequate living conditions and drives up child mortality.[28] Population immunization rate (e.g. against measles, and diphtheria, pertussis, and tetanus [DPT]), clean water supply, and sanitation were also considered in our analysis because they are vital elements in preventing disease outbreaks. These data were obtained from the World Bank's World Development Indicators and country reports. High population density with inadequate medical and hygienic services contributes to a rising incidence of communicable diseases in urban environments.[28] The evidence on the effect of health expenditures on reducing child mortality is inconclusive: some studies have found a country's health expenditures to have positive effects on population health outcomes,[29,30] while others have

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Box 1. Definition and source of the selected indicators of governance, development, and disease control

Voice and accountability
Perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media[1] (World Bank's World Governance Indicators [WGI][1, 26])

Political stability and absence of violence
Perceptions of the likelihood that the government will be destabilized or overthrown by unconstitutional or violent means, including politically motivated violence and terrorism[1] (World Bank's WGI[26])

Government effectiveness
Perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies[1] (World Bank's WGI[26])

Regulatory quality
Perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development[1] (World Bank's WGI[26])

Rule of law
Perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence[1] (World Bank's WGI[26])

Control of corruption
Perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as 'capture' of the state by elites and private interests[1] (World Bank's WGI[26])

Urbanization
Proportion of a country's population living in areas classified as urban, according to the criteria used by each country (United Nations' World Population Prospects[25], Ministry of the Interior of Taiwan[52])

Economy
The state of each country's economy was calculated from income based on the yearly expenditure-side gross domestic product (GDP) at purchasing power parity (Penn World Table version 8.0[53])

Immunization
Proportion of children aged 12–23 months in each country who had received immunization against measles and against diphtheria, pertussis, and tetanus (DPT) (World Bank's World Development Indicators [WDI][54], Department of Health of Taiwan[55])

Clean water supply
Proportion of the population in each country with access to an improved water source (World Bank's WDI[54], Ministry of Economic Affairs of Taiwan[56])

Sanitation
Proportion of a country's population with access to improved sanitation facilities (World Bank's WDI[54], Ministry of the Interior of Taiwan[57])

Health expenditures
Sum of public and private health expenditures as a percentage of total GDP, which covers the provision of health services (preventive and curative), family planning activities, nutrition activities, and emergency aid designated for health but does not include provision of water and sanitation (World Bank's WDI[54], Social Indicators of Taiwan[58])

Air quality
Annual average concentrations of particulate matter with diameter $<10\ \mu$ (PM_{10})[a] (World Bank's WDI[54], Environmental Protection Administration of Taiwan[59])

[a] The World Bank collected the PM_{10} data from the WHO and then estimated the country-level PM_{10} data using urban-population-weighted PM_{10} levels in residential areas of cities larger than 100 000.[54] For Taiwan, we used the average PM_{10} data collected from ambient air quality monitoring stations located in areas of high population density.[59]

shown minor or non-significant effects on child mortality.[31–33] For this study, we included health expenditures as a variable in our factor selection process. We also included air pollution, because it can reflect a country's environmental quality during urbanization and industrialization[34] and is associated with various adverse health effects for children, including increased hospital admissions for acute respiratory conditions, increased medication use in children with asthma, and mortality.[35–37] The major sources of urban air pollution are burning of fossil fuels or biomass, power generation, industrial processes, and motor vehicle activities.[38]

Particulate matter, one of the typical urban pollutants, is associated with level of economic activity, population size, energy consumption, and pollution-related regulations and controls in urban areas.[38]

Data analysis

We first applied a factor analysis with a varimax rotation to reduce the number of correlated variables and identify and categorize interrelated variables.[39] Factors with eigenvalues >1 were

selected for further modeling. Next, the effects of selected factors on the under-5 mortality rate were analyzed using the semiparametric generalized additive mixed model, with the logarithm of the under-5 mortality rate (Y) to base 10 of a country as the dependent variable, selected factors (F_i) as fixed-effect variables, and the intercept as the random-effect variable:

$$\log_{10} Y_{j,t} = \beta_0 + b_{0j} + \sum_i \beta_{i,j} \times F_{i,j,t} + f(T) + \varepsilon_{j,t}$$

where $i \in (1, 2, 3, \ldots)$ denotes the number of selected factors, $j \in (1, 2, \ldots, 149)$ denotes the country code, and $t \in (1, 2, \ldots, 15)$ denotes the calendar year from 1996 to 2010. The decision on whether to keep or drop factors (F_i) was based on the Akaike information criterion. The time smoother $f(T)$ was estimated by a cubic B-spline to control temporally autoregressive correlations. $\varepsilon_{j,t}$ was the error term following a normal distribution with mean zero and variance $\sigma_{j,t}$. The random intercept b_{0j} was an unstructured spatial term following a normal distribution with mean zero and estimated variance 0.1980 to control for spatial heterogeneity among countries. All parameters were derived by the maximum subject-specific pseudolikelihood.

All statistical analyses were performed by the PROC CORR, FACTOR, and GLIMMIX procedures in SAS V9.2 (SAS Institute, Cary, NC, USA). Graphs were drawn using SigmaPlot V10.0 (Systat Software, Richmond, CA, USA).

Results

Table 1 shows the averaged means, standard deviations, minimums, and maximums for the under-5 mortality rate, the six governance indicators, and the other eight selected determinants of child mortality across 149 countries in 2010. On average, the difference in mortality rate between countries with the lowest and the highest rates was 89-fold, with the lowest rate being observed in Singapore (2.28 per 1000 live births) and the highest rate in Chad (202.89 per 1000 live births). The lowest governance scores were: voice and accountability (–2.02) and regulatory quality (–2.08) in Turkmenistan, political stability and absence of violence score (–2.73) in Pakistan, government effectiveness

Table 1. Averaged means, standard deviations, minimums, and maximums for 149 countries' under-5 mortality rate (deaths at age <5 years per 1000 live births) and indicators of governance, development, and disease control

Indicators	Mean[a]	SD	Minimum	Median	Maximum	Mode
Under-5 mortality rate	49.88	51.65	2.28	27.07	202.89	–
Governance indicators						
Voice and accountability score (points)	−0.10	0.97	−2.02	−0.14	1.61	–
Political stability and absence of violence score (points)	−0.19	0.92	−2.73	−0.06	1.44	–
Government effectiveness score (points)	−0.02	0.99	−1.73	−0.21	2.24	–
Regulatory quality score (points)	0.01	0.94	−2.08	−0.15	1.90	–
Rule of law score (points)	−0.11	0.99	−1.79	−0.36	1.97	–
Control of corruption score (points)	−0.09	1.01	−1.50	−0.39	2.38	–
Development-related indicators						
Urbanization level (% of a country's population living in urban areas)	55.99	22.15	11.00	58.15	100.00	40.10
Log transformed expenditure-based GDP at purchasing power parity (millions of international dollars)	10.99	2.05	5.66	10.90	16.39	
Disease control-related indicators						
Clean water supply (% of population with access to an improved water source)	86.82	15.68	44.00	93.00	100.00	100.00
Sanitation (% of population with access to improved sanitation facilities)	70.94	30.44	9.00	83.00	100.00	100.00
Immunization: measles (% of children ages 12–23 months immunized against measles)	87.68	13.15	33.00	93.00	99.00	99.00
Immunization: DPT (% of children aged 12–23 months immunized against DPT)	88.38	13.37	33.00	94.00	99.00	99.00
Health expense-related indicators						
Health expenditures, total (% of GDP)	6.91	2.89	0.68	6.48	20.80	4.39
Pollution-related indicator						
PM_{10} concentration at country level ($\mu g/m^3$)	36.50	25.17	6.00	29.00	137.00	27.00

SD: standard deviation; GDP: gross domestic product; DPT: diphtheria, pertussis, and tetanus; PM_{10}: particulate matter with diameter <10 μ.
[a] Values were estimated using the latest available data for each country. All data were from 2010 with the following exceptions: clean water supply data for Argentina (2007), Equatorial Guinea (2006), Grenada (2004), Lithuania (2009), Panama (2009), Romania (2008), Tunisia (2009), Turkmenistan (2006), and Venezuela (Bolivarian Republic of) (2007); sanitation data for Argentina (2007), Equatorial Guinea (2006), Lebanon (2005), Latvia (2009), Lithuania (2009), Panama (2009), Romania (2008), Tunisia (2009), and Venezuela (Bolivarian Republic of) (2007); and health expenditure data for Zimbabwe (2001).
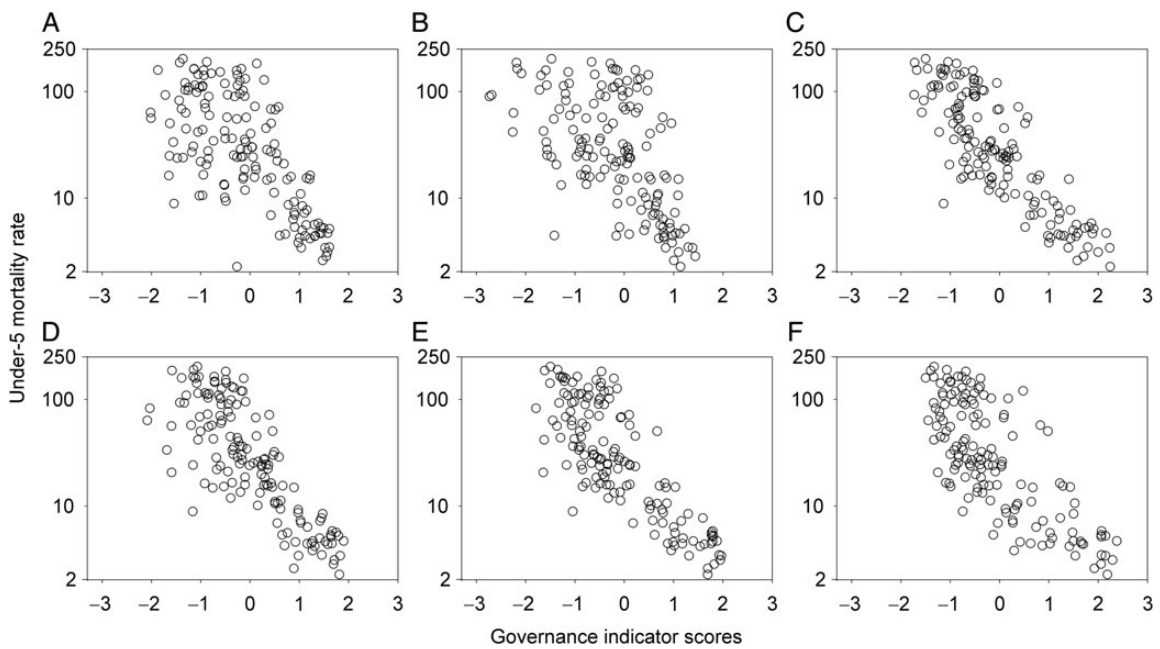
Figure 1. Ecological relations between national under-5 mortality rate (deaths at age <5 years per 1000 live births) and the World Bank's six Worldwide Governance Indicators across 149 countries in 2010. (A) Voice and accountability; (B) political stability and absence of violence; (C) government effectiveness; (D) regulatory quality; (E) rule of law; (F) control of corruption.

Table 2. Pearson correlation matrix for the selected indicators of governance, development, and disease control across 149 countries

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
(1) Voice and accountability	1	0.68	0.83	0.86	0.84	0.81	0.48	0.31	0.56	0.47	0.39	0.43	0.50	−0.36
(2) Political stability and absence of violence	0.68	1	0.72	0.69	0.78	0.74	0.43	0.09	0.49	0.46	0.43	0.46	0.29	−0.35
(3) Government effectiveness	0.83	0.72	1	0.93	0.95	0.94	0.58	0.49	0.64	0.60	0.46	0.50	0.41	−0.36
(4) Regulatory quality	0.86	0.69	0.93	1	0.92	0.88	0.55	0.44	0.60	0.57	0.45	0.49	0.41	−0.37
(5) Rule of law	0.84	0.78	0.95	0.92	1	0.95	0.54	0.40	0.61	0.57	0.45	0.49	0.42	−0.34
(6) Control of corruption	0.81	0.74	0.94	0.88	0.95	1	0.55	0.37	0.57	0.54	0.40	0.45	0.45	−0.34
(7) Urbanization	0.48	0.43	0.58	0.55	0.54	0.55	1	0.46	0.65	0.63	0.42	0.39	0.29	−0.28
(8) Economy[a]	0.31	0.09	0.49	0.44	0.40	0.37	0.46	1	0.42	0.42	0.32	0.29	0.17	−0.10
(9) Clean water supply	0.56	0.49	0.64	0.60	0.61	0.57	0.65	0.42	1	0.80	0.69	0.70	0.28	−0.38
(10) Sanitation	0.47	0.46	0.60	0.57	0.57	0.54	0.63	0.42	0.80	1	0.69	0.67	0.27	−0.35
(11) Immunization: measles	0.39	0.43	0.46	0.45	0.45	0.40	0.42	0.32	0.69	0.69	1	0.92	0.22	−0.32
(12) Immunization: DPT	0.43	0.46	0.50	0.49	0.49	0.45	0.39	0.29	0.70	0.67	0.92	1	0.25	−0.33
(13) Health expenditures	0.50	0.29	0.41	0.41	0.42	0.45	0.29	0.17	0.28	0.27	0.22	0.25	1	−0.31
(14) PM$_{10}$	−0.36	−0.35	−0.36	−0.37	−0.34	−0.34	−0.28	−0.10	−0.38	−0.35	−0.32	−0.33	−0.31	1

DPT: diphtheria, pertussis, and tetanus; PM$_{10}$: particulate matter with diameter <10 μ. p-values for all correlations <0.001.
[a] Economy indicator was log transformed.

(−1.73) in Comoros, rule of law (−1.79) in Zimbabwe, and control of corruption (−1.50) in Equatorial Guinea. Most of the highest governance indicator scores were observed in European countries, including voice and accountability (1.61) in Switzerland, political stability and absence of violence (1.44) in Luxembourg, rule of law (1.97) in Finland, and regulatory quality (1.90) and control of corruption (2.38) in Denmark; the highest government effectiveness score was observed in Singapore (2.24).

Scatter plots of 2010 national data for the under-5 mortality rate, associated with the six governance indicators, are shown in Figure 1. All six dimensions of governance show inversely linear relations with the under-5 mortality rate.

Table 3. Factor loading matrix for the major factors affecting population health across 149 countries

	Factor 1 (Governance)	Factor 2 (Disease control)	Factor 3 (Development)
(1) Voice and accountability	0.8224[a]	0.1823	0.1557
(2) Political stability and absence of violence	0.8258[a]	0.3040	−0.1253
(3) Government effectiveness	0.8630[a]	0.2429	0.3400
(4) Regulatory quality	0.8491[a]	0.2344	0.2976
(5) Rule of law	0.9035[a]	0.2435	0.2378
(6) Control of corruption	0.8942[a]	0.1855	0.2363
(7) Urbanization	0.3999	0.2700	0.6174[a]
(8) Economy[b]	0.1558	0.1469	0.8708[a]
(9) Clean water supply	0.3836	0.6576[a]	0.4081
(10) Sanitation	0.3451	0.6434[a]	0.4630
(11) Immunization: measles	0.1904	0.9305[a]	0.1225
(12) Immunization: DPT	0.2544	0.9188[a]	0.0670
(13) Health expenditures	0.2925	0.1007	0.0810
(14) PM_{10}	−0.2116	−0.1713	−0.0263

DPT: diphtheria, pertussis, and tetanus; PM_{10}: particulate matter with diameter <10 μ.
[a] Factor loading >0.5.
[b] Economy indicator was log transformed.

Table 4. Estimated[a] fixed effects of determinants[b] on under-5 mortality rates at the country level

Determinants	Coefficients (95% CI)
Intercept	1.4067 (1.2985 to 1.5150)
Governance (Factor 1)	−0.0453 (−0.0569 to −0.0336)
Disease control (Factor 2)	−0.0351 (−0.0443 to −0.0258)
Development (Factor 3)	−0.0846 (−0.1020 to −0.0672)

[a] Estimated using a semi-parametric generalized additive mixed model for data from 149 countries from 1996 to 2010.
[b] Factors were derived from factor analysis. Factor 1, named 'governance', was related to the six Worldwide Governance Indicators (i.e. voice and accountability, political stability and absence of violence, government effectiveness, regulatory quality, rule of law, and control of corruption). Factor 2, named 'disease control', was related to hygienic condition (i.e. clean water supply and sanitation) and immunization rate against measles and DPT. Factor 3, named 'development', was related to urbanization and economy (in log transformation).

Table 2 shows the correlation among the predictors. All of these predictors are significantly correlated, with p-values of <0.001. High correlations are observed between the governance indicators (Pearson's correlation coefficient, r=0.68–0.95, $p<0.001$); between clean water supply and sanitation (r=0.80, $p<0.001$); and between immunization against measles and DPT (r=0. 92, $p<0.001$).

Table 3 shows three factors with eigenvalues >1 and thus qualified for further modeling. The cumulative variance explained by these three factors reached 76.38%. The six WGI showed the largest loadings for factor 1, named 'governance'. The relative contributions of the six indicators towards governance, ranked from high to low, were rule of law, control of corruption, government effectiveness, regulatory quality, political stability and absence of violence, and voice and accountability. Hygienic condition, including clean water supply and sanitation, and immunization rate against measles and DPT had the largest loadings for factor 2, named 'disease control'. The relative contributions of the four disease-control factors, ranked from high to low, were immunization against measles, immunization against DPT, clean water supply, and sanitation. Urbanization and economy showed the largest loadings for factor 3, named 'development'. Economy showed a higher contribution to development than urbanization.

Table 4 lists the influence of the three qualifying factors on under-5 mortality rates. All three factors were inversely associated with the log-transformed mortality rates ($p<0.001$). The coefficients β_1, β_2, and β_3 suggest that, per unit increases in governance, disease control, and development, the child mortality rate had a 0.901-fold ($=10^{-0.0453\times1}$) (95% CI 0.877–0.926), 0.922-fold ($=10^{-0.0351\times1}$) (95% CI 0.903–0.942), and 0.823-fold ($=10^{-0.0846\times1}$) (95% CI 0.791–0.857) decrease, respectively, at fixed levels of other two factors.

Discussion

This study contributes to our understanding of global child health issues by showing the significant association between governance and under-5 mortality rates at country level, taking into account factors of development (mainly urbanization and economy) and disease control (mainly hygienic conditions and immunization rates). As the difference in child mortality rates between countries

remained as high as 89-fold in 2010, our results indicate that the effect of governance on child mortality is just as important as the effect of development and disease control. Per unit increases in governance, disease control and development could contribute to a 0.901-, 0.922-, and 0.823-fold decrease, respectively, in under-5 mortality rates at fixed levels of the other two factors. Our model predicted best for Taiwan, Uganda, Philippines, Slovakia, and Norway, and worst for Equatorial Guinea, Nepal, Luxembourg, Oman, and the Maldives.

Improvements in a country's level of development (mainly urbanization and economy) have always been the primary factors for reductions in the under-5 mortality rate.[40] The contribution of urbanization to better health could be associated with economic development. However, the recent economic downturn has threatened positive health outcomes in many countries by affecting food prices and increasing nutrition deficiencies.[41] Our results suggest that even if a country has not benefited from urbanization or economic growth, the plausible positive role of better access to improved social and environmental conditions, enabled under effective governance, might be an alternative for a country pursuing reductions in its child mortality rate. These results are especially useful in the context of the current global economic crisis.

Immunization rate against measles increased from 79.5% to 87.7% and that against DPT increased from 79.7% to 88.4%, for the studied 149 countries from 1996 to 2010. The increased delivery of immunization services by domestic and international efforts, such as the Global Alliance for Vaccines and Immunization and the Global Fund to Fight AIDS, TB and Malaria, lowered child mortality rates in most countries.

There is a growing quest for better governance at both the country and global level in the pursuit of health equity.[12] Our findings indicate that the association of governance with child mortality should not be underestimated. Governance represents the characteristics of the management of a social organization. From the viewpoint of a country, its governance consists of the traditions and institutions by which authority is exercised and the country is governed.[1] According to the concepts developed by the World Bank, governance of a country represents: 1. the process by which the government is selected, monitored, and replaced; 2. the capacity of the government to effectively formulate and implement sound policies; 3. the respect of citizens and the state for the institutions that govern economic and social interactions among them.[1] Experts have suggested that countries with better governance are likely to have health policies that benefit the social determinants of health.[5,18] In contrast, poor governance might negatively impact health expenditures and health services for the general population.[5,10] Corruption, or the misuse of public power for private gain, has been the most studied factor of governance in relation to its detrimental impact on the healthcare system, resource distribution, and health outcomes.[1,32,42,43] A study on the progress of MDG 1, a program with the goal of eradicating extreme hunger and poverty, indicated that political decisions on government expenditures played a key part in meeting the MDG 1 goal in 88 countries.[44] For example, poor-quality public administration and inefficient healthcare spending have been shown to have a negative impact on child health (including child mortality rates) in some Middle Eastern and African countries.[45] Previous evidence has also indicated that around 5–10% of health-related budgets disappeared before they were spent on real practices.[42]

Anti-corruption efforts can be demonstrated to be a key component of good governance and even a reason to wean countries off foreign aid.[46,47]

Although corruption is recognized conceptually as an important driver of population health via its interaction with various socioeconomic determinants, there has been limited research on the effects of corruption on health that also considers the demographic factors of population growth and aggregation. These factors put direct pressure on health resource use, in addition to the interplay of governance (as defined by WGI) in this changing world.[8,48] Our findings presented here consider the effect of a demographic factor (i.e. urbanization), and also incorporate governance, encompassing the concept of voice and accountability, political stability and absence of violence, government effectiveness, regulatory quality, rule of law, and control of corruption.

The use of a global and longitudinal dataset of under-5 mortality rates was necessary to understand the health impacts and potential applications of health policies and resolutions. To our knowledge, this is the first study to address the effects of governance on child mortality that uses longitudinal data and adjusts for the effect of time (i.e. calendar year), development factors (i.e. urbanization and economy), and disease control factors (i.e. clean water supply, sanitation, and measles and DPT vaccination rate) on a global scale. The inclusion of a large number of countries enhances data completeness. Our further analyses of removing the top five countries with lowest and highest governance scores indicated that association between governance and child mortality remained robust. However, our ecological dataset was limited to inter-country and not intra-country comparisons.

Limitations

Our findings should also be cautiously interpreted within the constraints of an ecological study.[49] Important contributors to the total burden of child mortality, such as nutrition and intra-country inequality, warrant a framework that explores the causal pathways between child mortality and its determinants. For example, the distribution of the economy (e.g. Gini coefficient) and other determinants of health among different social groups within a country (e.g. urban–rural and intra-urban differences) also influence inequalities in health outcomes at the intra-country level.[50,51] Because intra-country data on urban–rural health conditions and health risks were limited and incomplete, for this study we could not differentiate health impacts by urban–rural areas or by demographic characteristics, such as age and sex, within a country. Our model may therefore have overestimated the health of subpopulations with lower socioeconomic status, and this limitation should be taken into account in future studies.

Several other limitations should be noted. One limitation is potential confounding factors. A major challenge for ecological studies is the scarcity of comparable data. Estimates vary depending on how many potential confounding factors are controlled, how many countries are included, and over what span of time data are collected. For these reasons, we used the largest possible number of confounding factors to examine whether adding predictors as fixed effects would provide better model fitness. We may have overestimated the effects of significant determinants in our models by not fully considering these unmeasured factors, because of the scarcity of available data. However,

when we added confounding factors as fixed effects, our models showed the number of countries to drastically decrease. For example, the number of countries with data available decreased from 149 to 55 when we added literacy rate, nutritional status and Gini coefficient into our model. Therefore, we preferred to report the findings based on our current model, which had the largest number of studied countries and increased representativeness. In addition, we treated the country itself as the random effect to control for the effects of country heterogeneity, which would act as a proxy variable for these unmeasured factors. If more comparable and comprehensible data were available, we would expect a better estimation.

Conclusions

Governance should be taken into account in global health efforts to reduce the under-5 mortality rate in the context of global urbanization, economic growth, and disease control. Countries should target their efforts toward providing healthier physical and social living environments through better governance. Global health communities should start collecting useful information related to indicators of governance and initiate studies into the causal pathways between governance and important socioeconomic determinants of population health.

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