Government Health Care Spending and Child Mortality

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abstract

BACKGROUND: Government health care spending (GHS) is of increasing importance to child health. Our study determined the relationship between reductions in GHS and child mortality rates in high- and low-income countries.

METHODS: The authors used comparative country-level data for 176 countries covering the years 1981 to 2010, obtained from the World Bank and the Institute for Health Metrics and Evaluation. Multivariate regression analysis was used to determine the association between changes in GHS and child mortality, controlling for differences in infrastructure and demographics.

RESULTS: Data were available for 176 countries, equating to a population of ~5.8 billion as of 2010. A 1% decrease in GHS was associated with a significant increase in 4 child mortality measures: neonatal (regression coefficient [R] 0.0899, P = .0001, 95% confidence interval [CI] 0.0440–0.1358), postneonatal (R = 0.1354, P = .0001, 95% CI 0.0678–0.2030), 1- to 5-year (R = 0.3501, $P < .0001$, 95% CI 0.2318–0.4685), and under 5-year (R = 0.5207, $P < .0001$, 95% CI 0.3168–0.7247) mortality rates. The effect was evident up to 5 years after the reduction in GHS ($P < .0001$). Compared with high-income countries, low-income countries experienced greater deteriorations of ~1.31 times neonatal mortality, 2.81 times postneonatal mortality, 8.08 times 1- to 5-year child mortality, and 2.85 times under 5-year mortality.

CONCLUSIONS: Reductions in GHS are associated with significant increases in child mortality, with the largest increases occurring in low-income countries.

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WHAT'S KNOWN ON THIS SUBJECT: After the recent economic recession, policy interventions including austerity measures led to reductions in government spending on health care in many countries. However, there is limited research into the effects of changes in government health care spending on child health.

WHAT THIS STUDY ADDS: Reductions in government health care spending are associated with long-lasting adverse effects on child health globally, especially in low-income countries. Given pressures to diminish health expenditures, we caution that reduced spending should be achieved through increased efficiency of care delivery.

The World Health Organization's fourth Millennium Development Goal (MDG 4) aimed to reduce under-5 mortality by two-thirds between 1990 and 2015.[1] However, although progress has been made, recent analyses estimated that only 10 countries of 67 with high child mortality (≥40 deaths per 1000 live births) were on track for meeting the MDG 4 target.[2] Studies have tried to address key components pertinent to aiding progress on maternal and child health. These include health care interventions (for example, skilled birth attendants and measles vaccination) and socioeconomic inequity measures in middle- to low-income countries,[3] as well as increased coverage of high-impact child survival interventions including insecticide-treated bed nets, nutritional interventions, care seeking, and treatment of childhood diarrhea and pneumonia.[4]

Economic fluctuations contribute to periods of prosperity and austerity together with changes in key areas of government funding, namely: health, education, and infrastructure.[5,6] The effects of economic crises on population health have been explored in single groups or small groups of high-income countries,[7–13] with a broad range of health outcomes including child health being adversely affected.[14–16] After the recent global recession and policy interventions including austerity measures, government health care spending (GHS) has decreased in several countries.[17] The role of GHS has also been the focus of cost-control debates in developed countries.[18]

To date, however, little research has explored the effect of changes in GHS on population health globally. In light of the recent movements to extend the MDG initiative, and calls for a renewed child survival strategy and longer-term targets for 2035,[19] it is pertinent to determine how economic fluctuations, and more specifically, changes in GHS may affect child mortality.

We sought to determine the effect of reductions in GHS on child mortality rates worldwide between 1981 and 2010, comparing these relationships in high- and low-income countries.

METHODS

Data Collection

Economic data were extracted from the World Bank's World Development Indicators, 2013 edition.[17] Child mortality data were obtained from the Institute for Health Metrics and Evaluation.[19] Data were collectively available for 176 countries. The definitions of child health outcomes, GHS (measured as a percentage of total government spending), and high- and low-income countries are described in Supplemental Table 4.

Statistical Analysis

We used multivariate regression analysis to measure the associations between child mortality (dependent variable) and changes in GHS (independent variable). All decreases in government spending on health care were incorporated into the analysis, and the change in mortality associated with a 1% decrease in GHS was calculated. To ensure that the results were not confounded by extreme variations in certain countries, we used a fixed-effects approach in the regression models, including 176 dummy variables for the 176 countries included in the analysis. This approach meant that models evaluated mortality changes within individual countries while holding constant time-invariant differences between countries, including higher predispositions to child mortality and political, cultural, and structural differences. We also controlled for country population demographics by introducing controls for the total population size, percentage of the population older than 65 years, and percentage of the population younger than 15 years. Using the Cook–Weisberg test,[20] the data were found to be characterized by heteroskedasticity (where subsamples have different distributions). Robust standard errors were therefore included in the regression models, accounting for the heterogeneity in the dataset, for example, due to differences in the way that countries measured government spending. This methodology has been widely used in health-economic studies and is regarded as a statistically robust approach.[7,21]

Our basic linear fixed-effects statistical model uses the following equation:

$$\Delta H = U \times \alpha \times D \times \varepsilon,$$

where H is the health metric (child mortality); U is the measure of government health spending; α represents the population structure of the country being analyzed; D is a dummy variable for each country included in the regression model; and ε is the error term.

We conducted 1- to 5-year time-lag multivariate analyses to evaluate the longer-term effects of a 1% decrease in GHS in a single year on child mortality. We also categorized countries as high and low income using the definitions in Supplemental Table 4, and we repeated the multivariate regression analyses using the same model for each of these categories. Robustness checks were performed to ensure validity of results (see Results).

We used Stata SE version 12 for the analysis (Stata Corp, College Station, Texas).

RESULTS

Child Mortality Data

Data were collectively available for 176 countries (Supplemental Table 5), equating to a population of ~5.8 billion as of 2010. Table 1 shows the results of multivariate regression analyses for the 176 countries worldwide between 1981 and 2010. A 1% decrease in GHS was associated with a significant increase in child mortality rates; neonatal (regression coefficient [R] 0.0899, P = .0001, 95% confidence interval [CI] 0.0440–0.1358), postneonatal (R = 0.1354, P = .0001, 95% CI 0.0678–0.2030), 1- to 5-year (R = 0.3501, P < .0001, 95% CI 0.2318–0.4685), and under 5-year (R = 0.5207, P < .0001, 95% CI 0.3168–0.7247) mortality.

We conducted time-lag analyses to assess the effect on child mortality 1 to 5 years after a 1% decrease in GHS in a single year (Table 1, Fig 1). All 4 child mortality measures consistently displayed significant deteriorations up to 5 years after the decrease in GHS. The magnitude of the regression coefficient decreased as the time from the change in GHS elapsed.

Countries were categorized as high and low income in accordance with World Bank definitions (Supplemental Table 4). Compared with high-income countries, low-income countries displayed larger, significant deteriorations in all 4 child mortality measures (Table 2, Fig 2). Specifically, after a 1% decrease in GHS, low-income countries experienced greater deteriorations of ~1.31 times neonatal mortality; 2.81 times postneonatal mortality; 8.08 times 1- to 5-year mortality, and 2.85 times under-5 mortality, compared with high-income countries (Table 2).

Robustness Checks

A series of further analyses were performed to evaluate the robustness of our results (Table 3). To isolate the impact of the changes in GHS, we introduced additional economic controls, adjusting for inflation, gross domestic product (GDP) per capita, government debt as percentage of GDP, and real interest rates; decreases in GHS continued to be associated with an increase in all mortality measures. Second, we introduced infrastructure controls, adjusting for urbanization, access to water, and calorie intake; decreases in GHS continued to be associated with significant increases in all mortality measures except postneonatal mortality. Third, we introduced infectious disease controls to account for child HIV prevalence, tuberculosis treatment success rates, and diphtheria/pertussis/tetanus immunization rates; decreases in GHS continued to be associated with significant increases in all mortality measures. After introducing all economic, infrastructure, and infectious disease controls simultaneously into our model, decreases in GHS continued to be associated with significant increases in all mortality measures. Fourth, we controlled for out-of-pocket health expenditures; decreases in GHS continued to be associated with significant deteriorations in all metrics except neonatal mortality. Fifth, we controlled for private health care spending; decreases in GHS continued to be associated with a significant increase in all mortality measures. Finally, we repeated the analysis using an alternative data source for child health outcomes: mortality measures from the World Bank (Table 3), which uses 3 mortality categories: neonatal, infant, and under-5.[17] Decreases in GHS were also associated with significant increases in all 3 mortality measures.

TABLE 1 Child Health Outcomes 0 to 5 Years After a 1% Decrease in GHS

Time Lag	Number of Excess Deaths per 1000 Live Births							
	Neonatal		Postneonatal		1 to 5 Years		Under 5 Years	
	R	P	R	P	R	P	R	P
0 years	0.0899	.0002*	0.1354	.0001*	0.3501	<.0001*	0.5207	<.0001*
1 year	0.0895	.0002*	0.1367	.0001*	0.3443	<.0001*	0.5168	<.0001*
2 years	0.0852	.0003*	0.1295	.0001*	0.3217	<.0001*	0.4866	<.0001*
3 years	0.0786	.0002*	0.1217	.0002*	0.2902	<.0001*	0.4461	<.0001*
4 years	0.0773	.0001*	0.1172	.0001*	0.2597	<.0001*	0.4147	<.0001*
5 years	0.0668	.0001*	0.1006	.0001*	0.2084	<.0001*	0.3442	<.0001*

Multivariate regression analyses were used to assess the association between 1% decreases in GHS and 4 child mortality metrics. We controlled for population size, population structure (proportion of population younger than 15 years and older than 65 years), and intercountry differences in health care infrastructure in addition to political, cultural, and structural differences (by introducing dummy variables for all of the countries in the dataset). Data were obtained from the World Bank[17] and the Institute for Health Metrics and Evaluation.[38] The regression coefficient (R) represents the number of excess deaths per 1000 live births after a 1% decrease in government health care spending.
*P < .001.

DISCUSSION

Our analysis has demonstrated an association between GHS and child mortality at the global level. Specifically, we have shown that a 1% decrease GHS is associated with significant increases in child mortality across 176 countries worldwide. The association is significant for up to 5 years after decreases in GHS and remains after controlling for economic, infrastructure, infectious disease, out-of-pocket expenditure, and private health spending indicators. Low-income countries experienced the largest changes in child mortality, in some cases up to 8 times those of the high-income countries.

The mechanisms by which reductions in GHS increase child mortality are not widely explored in the current literature. In most countries, the public sector plays a significant role in providing health and education services.[5,6] Countries use different measures to limit GHS at times of austerity and in the context of cost control. Some attempt to enforce pay cuts to health care workers; others constrain the amounts spent on pharmacological interventions and medical equipment.[6,18] Other strategies used to reduce the health care payment burden are to increase out-of-pocket expenses, by increasing patient or employer premiums and introducing user charges.[18]

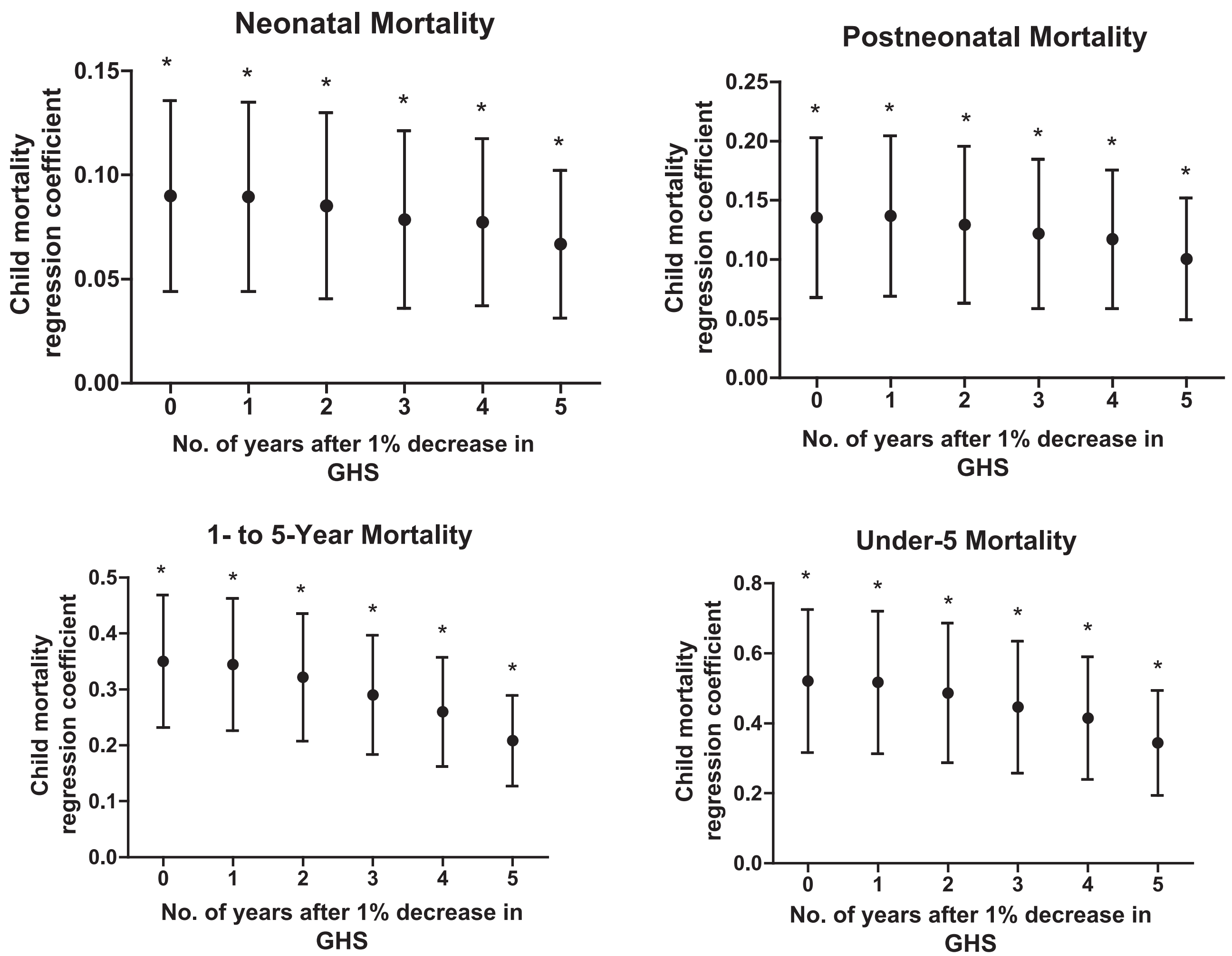

FIGURE 1
Time-lag analysis of changes in GHS and 4 child mortality measures. Multivariate regression analysis was used to assess the relationship between changes in GHS and child mortality. The child mortality regression coefficients and their corresponding CIs are displayed for a time frame of up to 5 years after a 1% decrease in GHS. *$P < .001$.

TABLE 2 Child Health Outcomes 0 to 5 Years After the Change in GHS in High- and Low-Income Countries

Mortality Category	Number of Excess Deaths per 1000 Live Births			
	R	RSE	*P*	95% CI
High-income countries (n = 19)				
Neonatal	0.1397	0.0254	<.0001*	0.0897–0.1897
Postneonatal	0.0606	0.0123	<.0001*	0.0365–0.0847
1 to 5 years	0.0187	0.0037	<.0001*	0.0115–0.0259
Under 5 years	0.2183	0.0410	<.0001*	0.1377–0.2990
Low-income countries (n = 71)				
Neonatal	0.1845	0.0414	<.0001*	0.1033–0.2657
Postneonatal	0.2701	0.0606	<.0001*	0.1511–0.3890
1 to 5 years	0.6228	0.1089	<.0001*	0.4092–0.8364
Under 5 years	0.9789	0.1862	<.0001*	0.6137–1.3442

Countries were divided by high and low income according to gross national income per capita in US dollars, calculated by using the World Bank atlas method.[39] We controlled for population size, population structure (proportion of population younger than 15 years and older than 65 years), and intercountry differences in health care infrastructure in addition to political, cultural, and structural differences (by introducing dummy variables for all of the countries in the dataset). The regression coefficient (*R*) represents the number of excess deaths per 1000 live births after a 1% decrease in GHS. RSE is robust standard of errors in R.
*$P < .001$.

Non–price rationing of health care (for example, increases in waiting times) is also used to reduce health care costs.[18] All of these measures potentially diminish access to health care and the quality of care delivered.

Reduced GHS also results in lower hospital budgets, which in turn reduces the availability of hospital resources,[22] including reductions in the quantity of health workers.[18] For example, from 1975, the long-lasting economic crisis led to a decline in health expenditures, imports of medical supplies and drugs, and salaries for physicians (resulting in them leaving the country); under-5 mortality increased for almost 20 years.[24] Prematurity is a leading

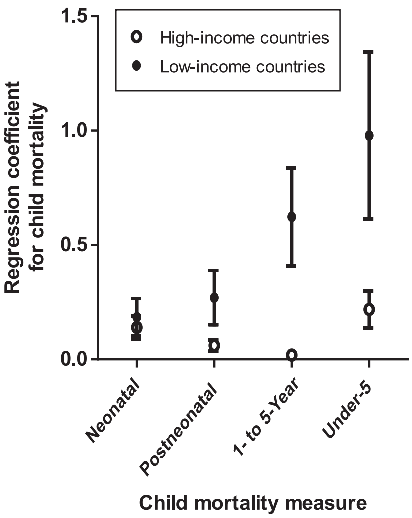

FIGURE 2

Child health outcomes after a 1% decrease in GHS in high- and low-income countries. Multivariate regression analysis was used to assess the relationship between changes in GHS and child mortality in high- and low-income countries. The child mortality regression coefficients and their corresponding CIs are displayed after a 1% decrease in GHS.

cause of newborn deaths and under-5 mortality; up to two-thirds of these deaths can be prevented if skilled health professionals perform effective health measures at birth and in the first week of life.[25] Public health campaigns to improve the recognition of illness and the promotion of effective management of infections, birth asphyxia, and preterm or low-birth-weight babies require health care funding.[26] Higher-technology interventions such as assisted ventilation for neonates are also extremely costly.[26] For the postneonatal period, the leading causes of death include pneumonia and diarrhea.[1] Reduced GHS may reduce the availability of relevant medications, such as antibiotics, and supportive oxygen therapy.[4,25]

We found the increased child mortality to be significant up to 5 years after a reduction in GHS. Although in our study we have not explored the effects beyond 5 years, it is not inconceivable that reductions in health care spending may have long-term effects on the economy of a nation. Specifically, reduced health care spending may reduce GDP per capita, as (1) less healthy populations are less productive economically, and (2) reduced investments in health care and weaker efforts toward preventive measures can result in worsened outcomes, development of more severe disease, and requirements for more expensive care.[27] Therefore, reductions in GHS may culminate in greater costs to a nation's economy.[28]

Our analysis has also shown that cuts in GHS adversely affect child health to a greater scale in low-income countries. More than 70% of all under-5 deaths occur in Africa and southeast Asia, with a background of poverty, suboptimal care seeking, and weak health care systems.[29,30] This difference is likely because the lowest-income countries may have preexisting weak health systems, which suffer most when GHS is reduced, as key components of basic health care may be lost, costing substantially more lives than in high-income countries, where effective health systems may be more resilient to budgetary cuts.[31–33] Low-income countries are also more vulnerable to economic shocks, as they are more likely to have national debt and strong dependence on a single production good.[24] Resource scarcity has led to the need for innovations in health systems to sustain effective responses and improvements in health; however, weak systems in low-income countries may hinder the receptiveness to innovation.[34] The literature focusing on the health effects of economic fluctuations and government expenditures in low-income countries is limited. One study in Uganda demonstrated that increased health care expenditures, especially on vaccination, have a positive impact on infant mortality. Increasing the rate of vaccination to 100% was considered the most influential and probably most cost-effective intervention, reducing infant deaths by 16 per 1000 births.[35] Other high-impact child survival interventions shown to quickly reduce mortality include appropriate treatment of childhood diarrhea and pneumonia.[4] Our study demonstrates the need for additional research into the mechanisms by which economic factors affect child mortality in low-income countries, to encourage policies and interventions that will effectively reduce preventable child deaths.

Finally, caution must be taken in debates concerning cost control and budget restrictions of health care. Increases in health care spending do not always translate to clinically better outcomes; the United States has one of the highest health care expenditures per capita but does not appear to be efficient and effective in meeting the health needs of children.[36] In comparison, the United Kingdom has achieved significantly better clinical outcomes with lower health care expenditures.[36] It is important to note that if budgetary cuts are implemented without simultaneous efficiency gains, or sufficient support in child health care, rises in child mortality may occur. A recent article in *The Lancet* emphasized that reductions in inequality are important in reducing child mortality in high-income countries.[37] Although we propose that substantial additional investments will be required to improve child health beyond the MDG target of year 2015, policymakers should note that a health care system must translate increases in spending to significant improvements in population health.

Our study has several limitations. First, our analysis was performed on 176 countries at a global level; thus our results reflect a collective effect rather than country- or regional-specific trends. Nevertheless, we have conducted subanalyses comparing the strength of associations between decreases in GHS and increases in child mortality in high- and low-income countries. Second, the

TABLE 3 Robustness Checks

Robustness Check	Controls Used in Multiple Regression	Total Number of Controls in Regression	Neonatal Mortality		Postneonatal Mortality		1- to 5-Year Mortality		Under 5-year Mortality	
			R	*P*	*R*	*P*	*R*	*P*	*R*	*P*
Economic controls	Original analysis controls plus inflation, GDP per capita, government debt as a percentage of GDP, real interest rates	183	0.0810	.0181*	0.1611	.0011**	0.4509	<.0001***	0.6233	.0001***
Infrastructure controls	Original analysis controls plus urbanization, access to water, calorie intake	182	0.0594	.0064*	0.0965	.1634	0.2877	<.0001***	0.6233	.0001***
Infectious disease controls	Original analysis controls plus child HIV prevalence, TB treatment success rate, DPT immunization rate	182	0.0777	.0031*	0.1295	.0008***	0.4338	<.0001***	0.5758	<.0001***
Economic, infrastructure, and infectious disease controls combined	Original analysis controls plus above economic, infrastructure, and infectious disease controls	189	0.0837	.0373*	0.1748	.0018**	0.5858	<.0001***	0.752	.0001***
Out-of-pocket expenditure controls	Original analysis controls plus out-of-pocket health expenditures	180	0.0358	.0997	0.0695	.0239*	0.2304	.0001***	0.3026	.0020***
Private health spending controls	Original analysis controls plus private health spending as a percentage of GDP	180	0.0747	.0006***	0.1140	.0003***	0.3333	<.0001***	0.4728	<.0001***
Child health outcome dataset from World Bank	Original analysis controls	179	0.0821	.0009***	0.3556[a]	.0001[a]***	—	—	0.7513	<.0001***

Multiple regression analyses were rerun using the controls in the original analysis (population size, proportion of population younger than 15 years and older than 65 years, and 176 country controls), in addition to those mentioned in the table. We also performed multivariate regression analyses using an alternative child outcome dataset: neonatal, infant and under-5 mortality from the World Bank.[17] The data show the association between a 1% reduction in GHS and 4 child mortality metrics (3 metrics for the World Bank dataset), using the mentioned controls. DPT, diphtheria/pertussis/tetanus; *R*, regression coefficient; TB, tuberculosis.

[a] Termed "infant mortality."

* $P<.05$.

** $P<.01$.

*** $P<.001$.

retrospective observational nature of our study does not allow us to draw inferences about causality. Third, effects of changes in economic factors including changes in government expenditure may be delayed and long lasting;[33] we analyzed only the short-term effects up to 5 years after the reduction in GHS, and further longitudinal analysis may be useful. Fourth, we have not modeled intrayear variations in mortality; however, by looking at whole years, we eliminate spurious trends that might be seen as seasonal in nature. Fifth, although we focus on the quantity of government spending on health care, we do not factor how efficiently or effectively these funds were spent. Indeed, it is entirely feasible that a country may spend less on health care and achieve greater outcomes due to efficient application of funds or avoidance of ineffective or inappropriate interventions. Finally, we have not been able to classify the type of GHS, as these data are not publicly available from the World Bank.

Nevertheless, our study used worldwide data, taken from high-quality, objective, and centralized databases, avoiding selection and recall bias. The volume of data used allowed for high statistical power and multiple robustness checks. By focusing on countries at a global level over a 30-year period, this study permitted consideration of macroscopic trends. Notably, our study used a fixed-effects multivariate regression analysis model. This model, along with the multiple robustness checks, accounts for many criticisms leveled at other studies looking at the relationship between health outcomes and economic changes: namely, the omission of potential confounders that are likely to be correlated with both GHS and child mortality. By using this panel-data approach, we also controlled for time-invariant heterogeneity between countries, something that aggregate, time-series analyses fail to do. In addition, all data used are publicly accessible, supporting the reproducibility of our study.

CONCLUSIONS

Our results have shown that reductions in GHS are associated with long-lasting increases in child mortality at a global scale, especially in low-income countries. Given plans to extend the MDG initiative, it is important to appreciate that economic changes, in particular changes in government spending, may affect child health outcomes. Given the risk of reductions in health expenditures, we caution that reduced spending should be achieved through increased efficiency of care delivery; otherwise, child outcomes may worsen.

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