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The impact of health care spending and income inequality on stunting prevalence

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ABSTRACT

Design: Stunting prevalence data were collected for 86 countries over the period 1995-2010 and combined with panel data that included health care spending and income inequality variables as well as other underlying and socioeconomic variables. Country fixed-effects regression models were utilized to examine the impact of these variables on overall stunting prevalence, controlling for time trends.
Setting: While a number of cross-country analyses have examined the drivers of stunting prevalence reduction, few have examined the impact from health care spending or income inequality. The objective of this analysis was to determine the impact of health care spending and income inequality on overall stunting prevalence.
Subjects: The analysis was conducted at the country level using aggregate data, so no individual subjects were included in the analysis.
Results: The results show that investments in social health insurance, as a percent of government health care spending, are one of the main drivers of lowered stunting prevalence. In addition, we show that reducing income inequality, by increasing the share of income held by three lowest income groups, reduces stunting levels.
Conclusions: The results of the analysis highlight the important role of targeted health care spending and reductions in income inequality on stunting prevalence.

Key Words: Stunting, Health care spending, Income inequality

1. INTRODUCTION

Despite the plethora of studies that have examined the influence of different factors on stunting prevalence in children under five years of age,[1–5] few have examined if health care spending and income inequality also reduce stunting prevalence. Including measures of health care spending is important to assess how health systems are investing in nutrition programs, especially in the face of limited budgets. Adding measures of income inequality into a model is essential in understanding the complexity of childhood malnutrition and how childhood malnutrition relates to within-country income distributions. The complexity of understanding how trends in stunting prevalence may differ by low-income and low-middle income countries also needs to be examined.

Many conceptual models have been developed that examine the causes of stunting prevalence.[1–5] UNICEF developed one of the earliest conceptual frameworks to understand the causes of malnutrition,[4] which identified immediate, underlying and basic causes of child stunting. Immediate causes include inadequate dietary intake and diseases that operate at

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the individual level. Underlying causes include an unhealthy household environment, inadequate health services, household food insecurity, as well as inadequate care and feeding practices for women and children. Finally, basic causes of stunting include society level structures, resources and processes (such as access to land, education, employment, income, technology), and the quality of financial, human, physical and social capital as well as the sociocultural, economic, and political context.

Of the studies that have examined the contribution to stunting from these immediate, underlying and basic causes few have included a measure of health care spending in the model.[1,3] Frongillio et al. used total spending on health, as a percent of GDP, to measure health care spending, showing total spending on health as a percent of GDP is associated with higher levels of stunting for all countries, with Latin America as an exception.[1] Milman et al. used government spending as a percent of GNP per capita to capture the impact of health care spending. This measure included both spending on health care and education, making the interpretation less clear.[6]

The relationship between income inequality and stunting has also been examined within countries[7–10] and across countries.[6,11–13] Most of these analyses have used concentration indices to examine overall levels of income inequality across a number of different countries. A concentration index reflects the mean level of income inequality for the entire population. These analyses show that countries with more income inequality tended to have higher levels of stunting.[11,13] The drawback with using a concentration index is that it does not provide a mechanism to understand how income expansion of different income categories impacts stunting. Milman et al. used income distribution, finding that the higher the percentage of income distributed to the top 20% of population, the less stunting improved in that country over time.[6] This method, however, does not allow a full understanding of stunting changes in the lower income categories. Other analyses have used all income quintiles in the analysis, but only examined the relationship between income inequality and malnutrition at one time point, without capturing changes in income distribution over time.[7,8] A recent analysis that includes changes in income inequality over time examined changes in stunting levels within wealth quintiles. This study found reductions in stunting for the richest quintiles overall, but stunting inequality did not diminish.[14]

Our methodology expands on each of the models explained above in three ways. First, we provide a robust data set that includes stunting prevalence estimates for 86 countries over a 15 year period. Second, instead of using total health care spending as a percent of GDP as a general measure, we include two specific measures of health care spending: government spending on health care as a percent of total expenditures and government spending on social health insurance. The former captures how a government is planning and financing specific health and nutrition projects, while the latter is included as it has been used by a number of countries mainly to cover health care services for the employed or formal sector, but has been expanding to cover the informal and unemployed sectors of populations in a number of developing countries. Finally, we use an income inequality measure, the share of income held by five income quintiles, and measure how changes in these income shares impact overall stunting levels over time.

2. Data and methods

We used a panel model that included underlying proximate drivers of stunting and basic socioeconomic drivers of stunting in country *i* at time *t*, measuring their impact on stunting prevalence in country *i* at time *t*, according to the following model:

$$Y_{it} = \beta_0 + \beta_1 x_{it} + \beta_2 g_{it} + f_i + d_t + \varepsilon_{it}$$

Where Y_{it} was country level stunting prevalence, x_{it} represented a vector of underlying/proximate drivers (total government health expenditure as a percent of total government expenditure, social security expenditures as a percent of government health expenditures, female literacy rate as a percent of male literacy, fertility rate, access to safe water, immunization coverage, and income share of the population), g_{it} represented a vector of basic socioeconomic drivers (urban population, population density, and GDP/capita), f_i were country fixed effects, d_t represented time trends, and ε_{it} was an error term. Precise definitions of these variables are given in Table 1 below.

Female literacy rate as a percent of male literacy, fertility rate, and access to safe water were included in the model due to their inclusion in similar models reviewed.[1,6,12,13] We used the same measure of immunization coverage, DPT3, used by Frongillio et al.[1] often regarded as a fairly robust measure of health system performance and access to services for children under one year of age.[15] DPT3 coverage was lagged by five years to capture the delayed population impact of the DPT3 vaccination in the first year of life.

We also added to our model two health care spending measures and an income inequality measure. The two measures of country level health care spending were 1) overall commitment to health by the government measured as general government expenditure on health as a percent of total government expenditure and 2) contributions to social security, a government run health insurance scheme for the employed sector that has been recently expanded in a number of countries to cover additional populations. Our measure of income inequality was 'income share' held by the richest 20% of the population, the next richest 20%, the middle 20% and the next to poorest 20%. The income share held by the poorest 20% of the population was used as the reference group for the income inequality analysis (United Nations).

The basic socioeconomic development indicators in our model included percent of the population living in urban areas, population density, GDP/capita and country fixed effects. Country fixed effects controlled for any time-invariant, country level factors that impacted stunting prevalence (i.e. resources, institutions, infrastructure, cultural practices, as well as intergenerational stunting and residual stunting). Time trends were also included in all models to control for any natural fluctuation over time in stunting prevalence due to exogenous factors. The analysis was conducted examining stunting prevalence levels in three cohorts over the period 1995-2010: all countries, only lower-income countries, and only lower middle-income countries. Country income levels were determined using the World Bank's country income classification system. Random effects models were estimated and compared to the fixed effects estimations to test for consistency and efficiency using the Hausman test. Results of the Hausman test were reported for each estimation with a Hausman statistic and associated *p*-value.

At least one stunting prevalence data point for children less than five years of age was collected for 86 countries. Stunting prevalence was defined as the percent of the population under five years of age that was below two standard deviations of the median height for age according to the National Center for Health Statistics (NCHS/WHO) Population Reference. Data were collected from three main sources: Demographic Health Surveys,[16] UNICEF's Childinfo database,[17] and the WHO's nutritional database.[18] Stunting data were available for different years for each country over the period 1995-2010. For each of the 86 countries with at least two stunting prevalence data points, stunting prevalence was interpolated for missing years (between available data points) using the annual rate of change that has been used elsewhere.[19]

Due to changes in the reference population used to calculate stunting prevalence in countries before and after the year 2006, all stunting data collected prior to 2006 (but not including 2006) were adjusted upwards to correct for National Center for Health Statistics (NCHS/WHO) Population Reference that was previously used to calculate stunting prevalence. This correction was performed according to the algorithms provided by Yang and de Onis.[20] All stunting prevalence data extracted from the DHS were first verified as to whether the data were reported using the NCHS/WHO Population reference or the WHO Population Reference and then adjusted accordingly. Stunting data available through UNICEF Childinfo and WHO were provided in either the NCHS/WHO Population Reference or the WHO Population Reference.

Table 1 summarizes the variables and data sources included in the analysis.

Table 1. Variables and Data Sources, 1995-2010

Variable	Description	Source
Stunting Prevalence	Moderate and severe stunting prevalence; % <5 year old ,< -2SD height for age according to the NCHS/WHO Population Reference	DHS*, UNICEF, WHO
GGHE as % of General government expenditure	Total General Government Expenditure on Health as % of General Government Expenditure	WHO NCA†
Social Security Expenditure on Health (% of General Government Expenditure on Health)	Expenditure on Government Social Health Insurance as a % of Government Health Expenditure	WHO NCA
Female Literacy	Literacy Rate, female age 15 and above (as % of male); interpolated between years and extrapolated to year 2010	World Bank, WDI‡
Diphtheria Tetanus Toxoid and Pertussis (DTP3) Immunization	Coverage among 1-year-olds (%)	WHO
Urban Population	Urban population (% of total population)	World Bank, WDI
Female Labor Force Participation Rate	Percent of female population ages 15+	World Bank, WDI
Population Density	People per sq. km of land area	World Bank, WDI
Access to Water	Population using improved drinking water sources in rural areas (%); interpolated between years and extrapolated to year 2010	WHO
Income Share (quintiles of income)	Income Share quintiles of population (%); interpolated between years and extrapolated to year 2010	World Bank, WDI
Gross Domestic Product/capita	US Dollars	World Bank, WDI

Note. *DHS, Demographic and Health Survey; †WHO NCA, World Health Organization National Health Accounts; ‡WDI, World Bank World Development Indicators.

3. RESULTS

Table 2 provides summary statistics of the main outcome variable, percent of children under age five years old that are stunted and all the independent variables included in the empirical model for the three cohorts of countries used in our analysis (all countries, lower income countries and lower-middle income countries). The following variables have higher mean values in lower income countries versus the lower-middle income countries: stunting prevalence, fertility rate, population density, and first through fifth income share quintiles. The remaining variables have higher mean values in the lower-middle income countries and the all countries cohorts in comparison to the low income countries: government health care spending, social security spending, female literacy, DPT3, access to water, urban population, female labor force, the highest income quintiles and gross domestic product per capita. The level of stunting among under five year old children was 32.07% for all countries (N=86 countries; 641 country-time points), 43.01% for low-income countries (N=45; 301 country-time points), and 22.38% for lower-middle income countries (N=50; 340 country-time points). Trends for all the independent variables for the different country cohorts can be referenced in Table 2 as well.

Table 2. Descriptive data for model variables

	All countries (N=641)		Low-income countries (N=301)		Low-middle income countries (N=340)	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**
Stunting prevalence (%)	32.07	14.64	43.01	9.50	22.38	11.15
GGHE (% of GGE)	10.48	4.55	9.42	3.79	11.41	4.94
Social security expenditure (% of GGHE)	17.14	23.26	5.31	9.33	29.61	26.66
Female literacy (% of male literacy)	81.15	18.12	69.43	17.35	91.53	11.11
Fertility Rate (Births/woman)	3.98	1.68	5.23	1.46	2.87	0.91
Access to Water (%)	67.46	19.54	55.28	18.09	78.25	13.51
DTP3 (%)	80.52	16.86	71.63	18.64	88.39	9.84
Urban Population (%)	42.88	20.25	28.89	12.76	55.27	17.4
Population Density	115.42	178.72	125.86	193.32	106.17	164.46
Income Share, Lowest 20%	5.88	2.33	6.74	1.57	5.13	2.62
Income Share, Second 20%	9.76	2.40	10.62	1.50	9.00	2.77
Income Share, Third 20%	14.02	2.38	14.81	1.33	13.31	2.84
Income Share, Fourth 20%	20.46	2.12	20.90	1.01	20.06	2.69
Income Share, Highest 20%	50.05	8.34	47.00	4.79	52.75	9.76
Gross Domestic Product/capita	1,788.80	1,741.60	485.35	248.43	2,942.85	1,681.50

Table 3 shows the results of the analysis examining the contribution to stunting from different underlying and socioeconomic variables, as well as the two spending variables: government health expenditure as a percent of total government expenditures and social health insurance expenditure as a percent of government health expenditures. The first column shows the results for the entire cohort (N=86 countries). The last two columns show the results for low-income countries (N=45) and lower middle-income countries (N=50).

The following variables show consistent, significant results with respect to decreased levels of stunting prevalence across at least two of the country cohorts over time: social health insurance expenditures as a percent of total health expenditures, fertility rate, urban population, population density, DPT vaccination, and GDP/capita. More specifically, the results in Table 3 showed that a one percentage point increase in spending on social health care spending (as a percent of total health care spending) led to a 0.09 percentage point reduction in stunting prevalence in all countries; a 0.10 percentage point reduction in stunting prevalence in low-income countries; and a 0.06 percentage point reduction in stunting prevalence in low-middle income countries. A one percentage point increase in the percent of the population living in urban areas had the largest impact on stunting reduction in all countries and lower middle-income countries, reducing the percent of children stunted by 0.35 and 0.44 percentage points in all countries and lower middle-income countries, respectively. A one unit increase in the number of people per square kilometer of land area reduced stunting between 0.04 and 0.06 percentage points. The association between fertility rate and stunting was significant in the all countries cohort and the low-income cohort, where a higher fertility rate was associated with a higher level of stunting. Log GDP/capita demonstrated a consistent relationship with stunting across the different cohorts: higher GDP/capita was associated with lower stunting in country cohorts. As expected, DPT3 showed an association with decreased stunting. Namely, a 1 percentage point increase in DPT3 coverage was associated with a 0.04 percent point decrease in stunting for all countries and low-income countries. The Hausman test results showed that the fixed effects model was consistent and more efficient than the random effects model.

Table 3. Fixed effects regression examining the contribution to stunting prevalence from health care financing variables and other factors over the period 1995-2010

Variables	All countries (N=641)		Low-income countries (N=301)		Lower middle-income countries (N=340)	
	Beta	**SE**	**Beta**	**SE**	**Beta**	**SE**
GGHE/TGE	-0.03	0.04	-0.04	0.07	-0.10	0.06
SSH/ GHE	-0.09***	0.02	-0.10***	0.04	-0.06***	0.02
Female Literacy (%)	0.02	0.02	0.04*	0.02	-0.17	0.11
Fertility Rate (Births/woman)	1.81**	0.75	1.94**	0.8	-0.75	1.31
Access to Water (%)	-0.08*	0.04	-0.09	0.05	-0.04	0.06
DPT3 Vaccination Rate (%)	-0.04***	0.01	-0.04**	0.01	-0.02	0.02
Urban Population (%)	-0.35**	0.12	0.25	0.22	-0.44***	0.15
Population Density	-0.04***	0.01	-0.04***	0.01	-0.06***	0.01
Log GDP/capita	-3.14**	1.55	-14.58***	1.82	4.18**	1.75
Year	0.05	0.08	0.10	0.11	-0.20**	0.09
Constant	-22.44	153.11	-96.06	213.23	453.00	175.81
R-squared	0.98		0.96		0.98	
Hausman Test	24.60 (p = .0062)		32.40 (p = .0003)		42.66 (p < .0001)	

Note. *** p < .01, ** p < .05, * p > .10.

Table 4 presents the analysis of stunting prevalence from the same underlying and socioeconomic variables as in Table 3, with the addition of the variables measuring income share (in quintiles) of the population, as a proxy for inequality. The same variables that predicted lower levels of stunting Table 3 predicted lower levels of stunting in Table 4: social health insurance expenditures as a percent of total health expenditures, fertility rate, urban population, population density, DPT vaccination, and GDP/capita. Government health expenditure as a percent of total government spending was associated with lower stunting in low-income countries, when income inequality is included in the model. The Hausman test results show that the fixed effects model was consistent and more efficient than the random effects model.

The results for the added measure of inequality in Table 4 show that a reduction in income inequality, by increasing the share of income held by lower, poorer quintiles is associated with decreased stunting. More specifically, as the share of income increases in the second and third income quintiles, stunting decreases. The results are strongest for the low-income countries, where the movement out of extreme poverty to the second quintile reduced stunting prevalence by 5.5 percentage points. This demonstrates the importance of understanding income inequality on stunting in this cohort of countries. This pattern of income inequality showed a consistent relationship with stunting prevalence, although not significant, for lower middle-income countries.

4. DISCUSSION

While this is not the first study to examine trends in stunting prevalence across a number of countries,[1,2,6,19,21,22] this is the first to examine trends in stunting prevalence across a range of countries, using a robust measure of income inequality and including government level health care spending variables and income inequality. The results showed that a main driver of lowered stunting prevalence is investment in social health insurance programs. The results also showed that the largest reductions in stunting occur when income is increased for some of the poorest groups. The other consistent drivers of lower stunting prevalence were increased urbanization, population density, and DPT vaccination rates.

Our results related to income inequality were interesting and contribute to the literature on income inequality and health. Similar to the results reported by Milman et al.[6] who found that stunting increased as the percent of wealth held by richest 20% increased, we also found a correlation between income distribution and health. The more important finding in our results showed that as the income share of the second quintile increases compared to the first quintile, stunting prevalence decreased for the low income countries.

A similar trend was found for all countries, but the expansion of the third income quintile compared to that of the first had a larger reduction on stunting prevalence when low-income and low-middle income countries were analyzed together.

Table 4. Fixed effects regression examining the contribution to stunting prevalence from health care financing, income equality and other factors over the period 1995-2010

Variables	All countries (N=641)		Low-income countries (N=301)		Lower middle-income countries (N=340)	
	Beta	SE	Beta	SE	Beta	SE
GGHE/TGE	-0.03	0.04	-0.15**	0.07	-0.10	0.06
SSH/GHE	-0.06**	0.02	-0.06	0.04	-0.06**	0.03
Female Literacy	0.03	0.02	0.04	0.02	-0.18	0.12
Fertility Rate (Births/woman)	1.51**	0.72	1.66**	0.82	-1.03	1.35
Access to Water	-0.08**	0.04	0.04	0.07	-0.03	0.06
DPT Vaccination Rate	-0.04***	0.01	-0.04**	0.01	-0.02	0.02
Urban Population (%)	-0.3**	0.12	0.3	0.25	-0.43***	0.15
Population Density	-0.04***	0.01	-0.05***	0.01	-0.03	0.03
Income Share Lowest 20%	---	---	---	---	---	---
Income Share Second 20%	1.1**	0.56	-5.21*	2.14	0.51	0.6
Income Share Third 20%	-2.45***	0.83	-1.63	1.45	-1.39	0.87
Income Share Fourth20%	0.22	0.32	-1.61	1.01	0.37	0.32
Income Share of Top 20%	-0.46***	0.1	-2.43***	0.54	-0.16	0.16
Log GDP/capita	-2.21	1.52	-12.43***	2.14	4.72**	1.9
Year	-0.01	0.09	-0.04	0.13	-0.28**	0.11
Constant	138.98	170.44	383.47	261.8	603.08**	224.37
R-squared	0.98		0.97		0.98	
Hausman Test	35.61 (p = .0012)		33.94 (p = .0021)		48.58 (p < .0001)	

Note. ***p < .01, **p < .05, *p > .10.

It was more difficult to compare these results to other studies, as most studies did not measure country level changes in income inequality profiles and stunting.[12, 13] The majority of studies used data from within an individual country, with only one other study exploring trends across countries. Nonetheless, some general comparisons are possible. A 2006 study examining household wealth inequality and under-nutrition in Bangladesh showed a statistically significant difference in under-nutrition between the richest and poorest quintiles and a general trend towards a higher risk for under-nutrition as one moved from richer to poorer quintiles.[23] Another study utilizing the Gini coefficient as a measure of inequality in Ecuador found inequality to have a significant, adverse effect on stunting, but only at the provincial scale.[11] In contrast, Gary Reinbold[24] found the Gini coefficient as a measure of economic inequality to be a non-significant predictor of individual health, instead finding the difference between individual household wealth and mean community household wealth to be the most important predictor of stunting, with the odds of stunting.

The consistent results with regards to DPT3 coverage and fertility rate were to be expected. DPT3 was included in the model to capture the effectiveness of the health system and the impact of the contact between the child and the health provider in the facility. The results demonstrated that if a child is vaccinated early in life, the results can have important contributions in the long run. This was captured by lagging the DPT vaccination rate by five years. These results not only showed the importance of some vertical vaccination programs, but that improved vaccination coverage an increase in coverage in a country of a specific vaccination does correlate to the overall nutritional tracking of a child. Similarly, as expected, the higher the fertility rate, the higher the stunting prevalence.

Many different methodologies have been used to analyze and estimate current and future stunting prevalence both across and within countries.[1, 2, 6, 19, 21, 22] Each of these methodologies has strengths and weaknesses, as with the methodology used in this analysis. A strength of the current study is that it is one of the only studies to use actual reported stunting prevalence rates from a number of different sources[16–18] for 86 countries over the time period 1995 to 2010. Using data over time, we were able to control for time trends which capture global policy factors that may have had similar impacts on stunting in a number of different countries, such as the increased monitoring of under-nutrition in anticipation of reaching the MDGs in 2015. In addition, by using data for the same country over multiple time periods, a different stunting prevalence trend can be estimated for each country included in the analysis, based on country level variation in each of the included immediate, underlying/proximate and socioeconomic variables. Another strength of the methodology used in this paper is the inclusion of a fixed effect for each country, which controlled for any time invariant factors that influence stunting such as intergenerational stunting and residual stunting as well as resources, institutions, infrastructure, and cultural practices.

The analysis and results presented above are not without limitations. First, the analysis used only national level data for all of the indicators. The results would be stronger if individual level data could be used from original surveys (DHS, MICS, etc). This would increase the sample size and allow for additional measurements of error and increased variance. Second, while our model attempted to include as many of the variables that had been identified in the literature as important predictors of stunting, data limitations did not allow for the inclusion of any immediate drivers of stunting such as nutrient intake of mother and child or fetal growth. Another limitation was that stunting prevalence measured in the population under two years of age, rather than five years of age, is the best indicator of childhood nutritional levels; however, due to larger data availability for stunting prevalence in children under five year of age, this measure was used in our analysis. Finally, while the analysis controlled for fixed effects and time trends, the estimated coefficients may still suffer from bias due to reverse causality that can only be eliminated with additional, more sophisticated modeling or by conducting the analysis at the level of the individual.

Despite including a number of different variables that capture underlying and basic socioeconomic drivers of stunting, GDP/capita of the country still remains the most significant and largest driver of stunting, especially in low-income countries. This is discouraging as this is probably the hardest indicator for countries to control and those countries that have low levels of GDP/capita will most likely continue on this trajectory in the future. In addition, at the individual country level, there are examples of countries (i.e., Nigeria and Indonesia) that have not reduced their stunting prevalence despite an increase in GDP. For this reason, we also included in the model a measure of purchasing power for countries' poorest families, captured as the income share of each population quintile. Including this measure of purchasing power showed that expanding the income share for the poorest is important for stunting but most important when the income share increases for the third quintile.

5. Conclusion

This paper is an important platform from which to begin to think in more depth about strategies for reducing stunting. The paper demonstrates interesting results with respect to country level stunting prevalence and the importance of investing in the appropriate health care financing and reducing income inequality on stunting prevalence. The results also suggest that government commitment to health, especially through a formal mechanism such as social health insurance, and expanding the wealth potential of specific poorer income groups can have a significant reduction of stunting in low and low-income countries.

Conflicts of Interest Disclosure

The authors declare no conflict of interest.

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