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Income Inequality and Individual Health: Exploring the Association in a Developing Country

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Abstract

We use individual and multi-level data from Zambia on child nutritional health to test the absolute income hypothesis (AIH), the relative income hypothesis (RIH) and the income inequality hypothesis (IIH). The results confirm a non-linear positive relation between economic resources and health, confirming the AIH. For the RIH we find sensitivity to what reference group is used. Most interestingly, while the IIH predicts that income inequality, independent from individual income, will affect health negatively, we find higher income inequality to robustly associate with better child health. The results suggest that the relationship between inequality and health in developing contexts might be very different from the predominant view in the existing literature mainly based on developed countries, and that alternative mechanisms might mediate the relationship in poor countries.

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INTRODUCTION

There is an on-going debate as to whether health is negatively affected by income inequality within a society. This issue has received abundant research interest in several disciplines (cf. Rodgers 1979, Wilkinson 1992, Kawachi and Kennedy 1997, Mellor and Milyo 2001, Deaton 2003, Ram 2006, Babones 2008 and Karlsson et al. 2010).

The idea that inequality causes poor health originates from an often noted negative correlation between various income inequality measures and the average health status of a population (e.g. Babones 2008, Ram 2006, Waldman 1992). From Rodgers (1979) and Gravelle (1998) we know that such aggregate associations might stem from a non-linear relationship between income and individual health, making it vital to use individual or household level data. Such data enable the separation between different theoretical hypotheses, all consistent with a negative aggregate association between inequality and population health (Wagstaff and van Doorslaer 2000).

Empirical studies using individual level data have produced largely contradictory conclusions. Consistent evidence of a negative association between income inequality and individual health is found in the United States (e.g. Kennedy et al. 1998, Subramanian et al. 2001, Lopez 2004). In contrast, data from other developed countries often find no such correlation (e.g. Shibya et al. 2002 on Japan, Gerdtham and Johannesson 2004 on Sweden, Jones et al. 2004, Gravelle and Sutton 2009 on the UK), suggesting that a general association between inequality and health does not exist. However, we have limited knowledge of the relationship between inequality and individual health in low-income countries.

This article examines the relationship between income inequality and individual health in a less developed context. Using data from Zambia we test three hypotheses: *the absolute income hypothesis* (AIH) – stating that individual health is determined by individual income and that the positive effect from higher income is subject to diminishing return;

the relative income hypothesis (RIH) – assuming that health is influenced by the relation of individual income to the average income in a reference group; and *the income inequality hypothesis* (IIH) - emphasizing that individual health status is impacted by inequality in the distribution of income.

Our dependent variable is child nutritional status expressed by height-for-age. Research increasingly emphasizes the important role of child health as a major factor influencing future economic outcomes (cf. Currie 2009, Bengtsson and Lindström 2000, Maluccio et al. 2006). Moreover, anthropometrical indicators are objective, relatively precise, and consistent across subgroups (Heltberg 2009).

We test the RIH and the IIH by using average household expenditures and expenditure Gini coefficients calculated at three geographical levels; provincial, district and constituency. Taking complex survey design into account and using different econometric techniques we confirm the AIH, and also find some for the RIH at the constituency level. In contrast to the IIH, we find a positive association between contextual inequality and child health, robust to measuring inequality at different geographical levels, to alternative inequality measures and alternative specifications.

The next section reviews suggested theoretical relationships between income, income inequality and individual health and shortly reviews existing empirical evidence. The third section describes the data and discusses methodological choices. The fourth section presents the empirical results, while the final section interprets the findings and concludes.

THEORY AND PREVIOUS EMPIRICAL FINDINGS

As shown by Wagstaff and Van Doorslaer (2000) various theoretical hypotheses are consistent with a negative correlation between income inequality and population health. Below we discuss the proposed mechanisms through a child health perspective.

Absolute income, relative income, income inequality and health

The *absolute income hypothesis* (AIH) states that economic resources improve health with diminishing marginal impact. It is generally assumed that higher income improves health as more resources can be devoted to health service or goods that are beneficial to one's well-being. Rich households are generally thought to be more efficient at producing child health because of their ability to purchase greater quantities and quality of health inputs and provide healthier environments, (Khanam et al. 2009).[1] Naturally, as poor health will restrict the individual's ability to earn income, the causality is likely to be bidirectional (c.f. Deaton 2003, Smith 1999).

The literature examining the health-inequality relationship using individual level data generally confirm the AIH (Mellor and Milyo 2002, Karlsson et al. 2010). A positive relationship between household income and child health is also well documented, particularly in poor countries where malnutrition is a phenomenon, although the precise mechanisms by which income transmits to better health remain unresolved (Khanam et al. 2009).

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[1] Moreover education may mediate the household income-child health relationship. Education might also be an unobserved factor that makes people both healthier and wealthier. If education and not income matters to health, correlation between income and health is induced by effects of education on income (Grossman, 1975, 2000).

The *relative income hypothesis* (RIH) states that individual health is affected by the individual's economic situation relative to others in some reference group. Holding individual income constant, higher average income in the reference group will through *psychosocial* mechanisms translate to worse health. Wilkinson (1996) emphasizes that health status is determined by perceptions of place in the social hierarchy. Poorer individuals feel stress, loss of respect, distrust and shame when comparing themselves to their richer counterparts. These perceptions could translate directly into physical afflictions through biochemical responses to stress and anxiety, increasing the probability of disease (Brunner and Marmot 1999), or into unhealthy behavior such as smoking (Lynch et al. 2000). Psychosocial stress may also indirectly influence child health negatively through household income, or through lower levels of stimulation to the child and decreased capacity for supportive parenting (Wachs, 2000, Olivius et al. 2004).

The RIH has mainly been tested by examining the individual health impact of average incomes in the geographical area where the individual reside, but many scholars note that the reference group to which the individual compare could differ (Deaton 2003, Miller and Paxon 2006, Karlsson et al. 2010). The empirical evidence for the RIH is relatively weak, with several studies finding virtually no such effects (Lorgelly and Lindley 2008, Li and Zhu 2006), with scattered evidence of both negative effects (Luttmer, 2005) and positive effects (Gerdtham and Johanesson 2004, Miller and Paxson 2006).

Finally, the *income inequality hypothesis* (IIH) posits a direct negative effect on individual health from income inequality, independent of individual income. Several mechanisms may cause this effect. One relates to trust and *social capital* , as inequality may create distrust at the individual level, translating to antisocial behavior and reduced civic participation at the societal level.[2] Low social capital or lack of social connectedness may in turn have health consequences (Durkheim 1897, Putnam 2000, Kawachi et al. 2007).[3] For example, socially integrated people have been shown to display greater immunological resistance to certain diseases while social isolation correlates with unhappiness (Grant 2000). Social capital may also promote child health (Morrow 2002, Berkman and Kawachi 2000). In particular, higher levels of maternal social capital may improve child nutritional status by permitting mothers greater access to more services and assets, improving maternal health and promoting health awareness (Baum 1999, De Silva et al. 2007) or by providing protection in times of crisis (Harpham et al 2006, Cuny 1994).[4]

A second mechanism potentially underlying the IIH is *political.* Greater differences between rich and poor are assumed to coexist with less common resources (e.g. public health care) in turn affecting individual health (Kaplan et al. 1996, Lynch et al. 2000). Inequality may translate into less public spending as large income differences often reflect heterogeneity in interests between the rich and the poor (Krugman 1996, Alesina et al. 1999). In developing contexts, public hospitals and a public infrastructure are generally found to be important determinants of child health (c.f. Rajkumar and Swaarop 2008). Underinvestment in common resources, in particular, can affect child nutrition as

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2 Several empirical studies find income inequality to display a strong, negative correlation with the extent to which people trust each other (see e.g. Knack and Keefer 1997, Gustavsson and Jordahl 2008).

3 Social capital is defined differently in various paradigms. In general social capital can however be defined as the sum of trust and respect of individuals in a society and by the features of social organization that facilitate cooperation of mutual benefit (c.f. Putnam (2000) and Bourdieu (2007)).

4 Crisis protection is likely of great importance to the physical condition of young children and infants who rely on household's strategies to ensure basic health needs.

it may affect maternity care, the number of child medical check-ups performed and immunization rates.[5]

As empirical evidence shows that income inequality and violence are positively correlated (Demombynes and Özler 2005) *violent crime* is a third factor potentially mediating the relationship between income inequality and health status. Obviously, violence can directly affect health, and it could increase stress among those worrying about violence. For child health, violence is a likely mechanism if violence triggers higher parental stress.

Only a few scholars have discussed the relationship between income, inequality and health in relation to development levels. Wilkinson (1996) states that income should have a stronger association with health in less developed countries, while economic inequalities should be relatively more important in developed ones. In contrast, Deaton (2003) concludes that many of the arguments that income inequality is a health risk are plausible for both and rich countries. Deaton (2003) also suggests that income inequality, is related to poor health outcomes because inequality is effectively a measure of poverty.

Several articles review the existing literature in this research field (Wagstaff and van Doorslaer 2000, Deaton 2003, Submaranian and Kawachi 2004 and Wilkinson and Picket 2007). The survey by Subramanian and Kawachi (2004) review the literature using individual level data, and reveal that the results are mixed. Studies testing the IIH in the United States often find that income inequality correlates with adverse health impacts (Kennedy et al. (1998), Lopez (2004) and Subramanian and Kawachi (2001). For example, there is evidence that individuals living in states with higher income inequality are at increased risk of mortality, hypertension and having harmful levels of BMI (Lochner et al. 2001, Diaz-Roux et al. 2000). On the other hand, Chang and Christiakis

[5] The WHO (2007) states that poor feeding practices and infections often undermine child nutritional status. These outcomes likely correlate with the access to and quality of maternity care and to whether children are immunized.

(2005) find an inverse association between inequality and weight status, and controlling for state-specific effects Mellor and Milyo (2002) do not find a significant association between income inequality and self-assessed heath in the US. Studies within other developed countries seem more prone to rejecting the IIH. For example, Shibya et al. (2002) conclude that income inequality does not have a detrimental effect on self-rated health in Japan. Blakely et al (2006), Gerdtham and Johannesson (2004) and Jones et al. (2004) come to similar in studies of mortality within New Zealand, Sweden and the UK, respectively. Moreover, Lorgelly and Lindeley (2008) and Gravelle and Sutton (2009) reject the IIH using panel data on SAH in Britain. Using a cross-national individual level panel, however, Hildebrand and van Kerm (2009) find consistent evidence of a negative effect from income inequality on good SAH in Europe. For self-assessed health, support of the IIH in richer countries is also found by Karlsson et al. (2010).

A couple of studies test the IIH using data within middle-income countries. In Chile, community inequality is found to have an independent impact on the probability of reporting poor health (Subramanian et al. 2003). Similar results are also confirmed among men in Russia (Carlson 2005). Studying child health in Ecuador, Larrea and Kawachi (2005) find support for IIH using when income inequality is measured at the provincial level, but not for smaller geographical areas. For China, Li and Zhu (2006) find a negative effect in high inequality communities. However, neither Bobak et al. (2000), nor Karlsson et al. (2010) find any negative health impact from inequality on individuals residing in middle-income countries. To our knowledge, the poorest country in which the IIH has been tested using individual level data is India. Using information on state level income inequality and the body mass index of ever married women, Subramanian et al. (2007) find that state level inequality relate to both under- as well as over-nutrition.

DATA AND EMPIRICAL MODEL

Country background

Despite considerable efforts to improve the health situation over the past decade, key health indicators in Zambia are very poor. Life expectancy at birth decreased from 45.8 years in 1990 to 38.4 years in 2005 and the mortality rate of children under five increased from 180 to 182 (per 1000 individuals) in the same time period (WDI, 2008). As in many developing countries, household per capita expenditures are on average low and monetary poverty levels high. 68 per cent of the Zambian population has a consumption level below the national poverty line. Economic resources are also unequally distributed. With a national Gini coefficient of 0.54 Zambia is classified as one of the most unequal societies in the world.

Data and Variables

Data come from the 2004 Zambian Living Condition Monitoring Survey (LCMS IV), carried out from October 2004 to January 2005. The survey provides nationwide reporting on indicators such as health, education, consumption and expenditures and food production for individuals in 19340 households.[6]

Dependent variable: Health Status

Using data on physical body measurement for all children aged 0-59 months in surveyed households, we derive the anthropometric measure *height-for-age*, usually referred to as stunting. Reflecting the accumulation of health and nutrition over a child's entire lifetime, height-for-age is generally not affected by acute episodes of poor nutritional intake or

[6] The survey was conducted by the Zambian Central Statistical Office (CSO) using a multiple stage sample selection survey design, where clusters and households within clusters are randomly selected, and a stratified survey sample.

sickness (Falkner and Tanner, 1986). The measure is acknowledged as a good, objective indicator of children's general health and house-hold well-being (Mosley and Chen 1984, Thomas et al. 1991, Zere and McIntyre, 2003).[7]

From individual height-for-age measures we compute z-scores, which compares the height of a child with that of a child of the same age and gender from a healthy reference population consisting of healthy individuals (WHO, 1995).[8] The height-for-age z-score (*HAZ*) for individual *i* is formulated as:

$$HAZ_i = \frac{x_i - x_{median}}{\sigma_x}$$

where x_i is the height for child *i;* x_{median} is the median height for a healthy and well-nourished child from a reference population of the same age and gender, and σ_x is the standard deviation from the mean of the reference population. Following WHO (1995) recommendations we exclude observations with a z-score lower than -6 or larger than +3. Children younger than three months are also excluded as their health status might be explained by the weight of the mother (Skoufias, 1998). Our final sample contains health status for 10,316 children.[9]

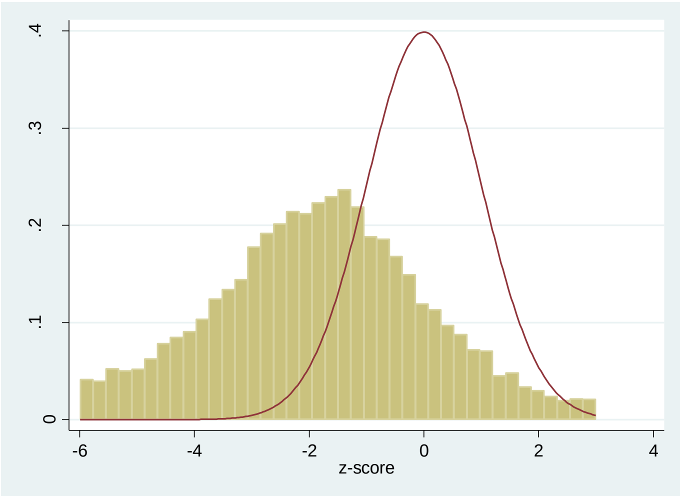
Figure 1 illustrates a histogram of the HAZ distribution and the corresponding distribution for the healthy reference group. The average value is -1.88, significantly lower than the mean value of the healthy population which is 0.

[7] As height, length and weight are measured by survey enumerators, anthropometric indices are not susceptible to self-reported bias. Errors in measurement, therefore, are unlikely to be correlated with socio-economic characteristics of the household where children reside.

[8] The dependent variable was derived by using the anthropometric statistical software Epi-Info. We use the sex specific 2000 CDC normalized version of the NCHS reference.

[9] In all, the original sample is reduced by 14.8 percent due to exclusions or missing data.

Figure 1 The HAZ distribution



Income, Mean Income and Income Inequality

To test the AIH we include the log of *household monthly per capita expenditures* in our estimations. To test the RIH we include a log of *average expenditures* per capita in the geographical area where respondents reside. To test the IIH, our primary inequality measure is the *Gini* coefficient, increasing with higher inequality.

Zambia is demarcated into nine provinces, which are further divided into 72 districts and 155 constituencies. We test the RIH and the IIH at three different aggregation levels – province, district and constituency. As changes in income distributions are unlikely to have an instantaneous health impact we examine the association between inequality and health under different lag lengths, using both current and past inequality levels (from the 1998 LCMS II survey). The variables *average per capita expenditures* and *expenditure inequality* are calculated from the full data set. To correct for differential representation, sample weights are applied in these calculations.

Additional Control Variables

All specifications control for *gender* (1 if female) and *age* (measured in months). As stunting may be more prevalent during the first two years of life, we also include *age square*. Because children with a higher birth order are generally at higher risk of being malnourished (Behrman 1988), we derive and include the *birth order* of the children in each household. We also include the maximum *level of education of any person in the household* older than 12, as education is related to family decision-making processes and child feeding practices (Mosley, 1984). The variable is categorized into one of four levels corresponding to the Zambian education system: none (no years of schooling), primary (1-7 years of schooling), secondary (8-12 years of schooling) and higher education (>12 years of schooling).

In line with theories on household economics (Becker 1965, Behrman et. al. 1986), variables for household composition and characteristics are included: *female household head* (1 for female-headed households), and *female household share*, measuring the percentage of female household members older than 12 years.[10] We also include *household size*, and an indicator for households in *rural* areas.

As sanitary standards might affect nutritional status we include two dummy variables for access to *piped water* and *toilet facilities*. Furthermore, as malnutrition is commonly caused by insufficient energy and proteins, we include *meals* (1 if the household normally have more than two meals a day excluding snacks) and *animal products* (1 if the household eats fish, poultry or animal products more than once a week). Table 1 provides summary statistics for variables in our analysis.

[10] Previous studies contrasting child malnutrition in male- and female-headed households provide contradictory evidence (Thomas, 1994).

Table 1 Summary statistics

Variable	Mean	sd	Min	Max	Obs
Individual level					
HAZ	-1,79	1,82	-5,99	3	10316
Gender	0,50	0,50	0	1	10316
Age	28,80	15,81	3	59	10316
Age^2	1079,19	963,63	9	3600	10316
Birth order	2,84	1,51	1	18	10316
Household level					
HH expenditure per capita	94468	102995	286	1967600	10316
Rural	0,60	0,49	0	1	10316
HH head female	0,15	0,35	0	1	10316
HH gender share	0,54	0,18	0	1	10316
HH size	6,81	3,12	2	33	10316
HH edu 0	0,03	0,16	0	1	10316
HH edu 1	0,36	0,48	0	1	10316
HH edu 2	0,52	0,50	0	1	10316
HH edu 3	0,10	0,29	0	1	10316
Meals	0,47	0,50	0	1	10316
Animal products	0,49	0,50	0	1	10316
Water	0,38	0,49	0	1	10316
Toilet facility	0,84	0,36	0	1	10316
Contextual level					
Gini province	0,51	0,04	0,47	0,59	10316
Gini district	0,51	0,05	0,43	0,68	10316
Gini constituency	0,49	0,06	0,31	0,70	10316
Average expenditures province	121708	35709	78300	204000	10316
Average expenditures district	117806	41118	51700	227000	10316
Average expenditures constituency	118818	52423	37700	439000	10316

Empirical model and estimation methods

The empirical model, where individuals are indexed by *i*, the households by *j*, and geographical level by *g*, is formulated as:

$$HAZ_i = \alpha + v_i'\beta_i + x_j'\beta_j + z_g'\beta_g + \varepsilon$$

The dependent variable height-for-age z-score (HAZ) is increasing with better child health. The vector *v* contains individual characteristics of children, the vector *x* features of households where children live, and *z* contains contextual factors. The residual term ε captures unobserved child, household and community characteristics.

EMPIRICAL RESULTS

Baseline results

We first examine the relationships using *OLS*. Importantly, the hypotheses AIH, RIH and IIH are not mutually exclusive, and can all be tested in the same specification. Each one could be a partial explanation of the aggregate relationship between inequality and population health. As clustering and stratification may skew standard errors, complex survey design features are accounted for.[11] Table 2, 3 and 4 present baseline results when inequality and average expenditures are aggregated at the provincial, the district and the constituency level, respectively.

[11] We make use of the Stata command *svyset*, which allows for specification of stratification scheme and primary sampling unit (the LCMS IV has eight strata and sample size of 1048 PSUs). While clustering likely reduces the precision of sampling estimates, as households living in the same cluster usually are more similar to another in behavior and characteristics, stratification will likely enhance it (Deaton, 2000).

Table 2 Regression estimates - provincial level – OLS

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Gender	0.204***	0.203***	0.200***	0.199***	0.200***	0.201***	0.201***
	[0.035]	[0.035]	[0.035]	[0.034]	[0.034]	[0.034]	[0.034]
Age	-0.050***	-0.051***	-0.051***	-0.053***	-0.053***	-0.053***	-0.053***
	[0.005]	[0.005]	[0.005]	[0.005]	[0.005]	[0.005]	[0.005]
Age^2	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Birth order	0.010	0.006	0.006	-0.067***	-0.069***	-0.067***	-0.068***
	[0.014]	[0.014]	[0.014]	[0.018]	[0.018]	[0.018]	[0.018]
Female household head				-0.012	0.010	-0.015	0.005
				[0.064]	[0.065]	[0.064]	[0.065]
Female HH share (adult)				0.242**	0.227*	0.244**	0.230*
				[0.120]	[0.120]	[0.120]	[0.120]
HH size				0.046***	0.044***	0.044***	0.043***
				[0.009]	[0.009]	[0.009]	[0.009]
Rural				-0.229***	-0.197***	-0.204***	-0.177***
				[0.060]	[0.059]	[0.061]	[0.060]
HH edu1				0.280**	0.269**	0.256**	0.249**
				[0.124]	[0.123]	[0.125]	[0.124]
HH edu2				0.379***	0.340***	0.338***	0.305**
				[0.128]	[0.127]	[0.129]	[0.128]
HH edu3				0.609***	0.516***	0.589***	0.504***
				[0.145]	[0.145]	[0.147]	[0.147]
Water				0.008	-0.012	-0.012	-0.027
				[0.046]	[0.046]	[0.045]	[0.045]
Toilet facility				0.008	-0.004	0.006	0.000
				[0.065]	[0.065]	[0.064]	[0.064]
Meals					0.182***		0.171***
					[0.044]		[0.043]
Animal products					0.118***		0.110**
					[0.045]		[0.045]
HH expenditures per capita	0.168***	0.124***	0.130***	0.071***	0.045*	0.076***	0.051**
	[0.024]	[0.025]	[0.025]	[0.025]	[0.026]	[0.025]	[0.025]
Average province expenditures		0.650***	0.636***	0.485***	0.494***	0.588***	0.583***
		[0.094]	[0.094]	[0.098]	[0.101]	[0.099]	[0.102]
Gini province			1.784**	2.400***	1.947**		
			[0.744]	[0.759]	[0.775]		
Gini province t-1						3.648***	3.263***
						[0.706]	[0.708]
Constant	-1.854***	-9.228***	-10.020***	-8.739***	-8.592***	-10.534***	-10.273***
	[0.142]	[1.083]	[1.163]	[1.214]	[1.256]	[1.254]	[1.290]
Observations	10316	10316	10316	10316	10316	10316	10316
R-squared	0.03	0.04	0.04	0.05	0.06	0.06	0.06

Complex survey design accounted for. Standard errors in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%

Table 3 Regression estimates – district level – OLS

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Gender	0.204***	0.204***	0.205***	0.205***	0.205***	0.202***	0.203***
	[0.035]	[0.035]	[0.035]	[0.035]	[0.035]	[0.035]	[0.035]
Age	-0.050***	-0.050***	-0.050***	-0.052***	-0.052***	-0.052***	-0.052***
	[0.005]	[0.005]	[0.005]	[0.005]	[0.005]	[0.005]	[0.005]
Age^2	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Birth order	0.010	0.008	0.007	-0.070***	-0.071***	-0.069***	-0.070***
	[0.014]	[0.014]	[0.014]	[0.018]	[0.018]	[0.018]	[0.018]
Female household head				-0.013	0.010	-0.018	0.004
				[0.065]	[0.065]	[0.065]	[0.065]
Female HH share (adult)				0.243**	0.215*	0.245**	0.221*
				[0.121]	[0.120]	[0.121]	[0.120]
HH size				0.049***	0.046***	0.049***	0.046***
				[0.009]	[0.009]	[0.009]	[0.009]
Rural				-0.258***	-0.222***	-0.254***	-0.220***
				[0.063]	[0.063]	[0.063]	[0.063]
HH edu1				0.305**	0.297**	0.298**	0.292**
				[0.126]	[0.124]	[0.126]	[0.125]
HH edu2				0.405***	0.363***	0.397***	0.358***
				[0.130]	[0.129]	[0.130]	[0.129]
HH edu3				0.638***	0.540***	0.621***	0.526***
				[0.147]	[0.147]	[0.148]	[0.147]
Water				0.021	0.003	0.021	0.005
				[0.046]	[0.046]	[0.046]	[0.046]
Toilet facility				-0.083	-0.075	-0.062	-0.055
				[0.063]	[0.063]	[0.064]	[0.063]
Meals					0.248***		0.233***
					[0.043]		[0.043]
Animal products					0.064		0.074
					[0.045]		[0.045]
HH expenditures per capita	0.168***	0.140***	0.136***	0.086***	0.059**	0.092***	0.065**
	[0.024]	[0.025]	[0.025]	[0.026]	[0.026]	[0.025]	[0.026]
Average district expenditures		0.244***	0.254***	0.075	0.071	0.085	0.079
		[0.079]	[0.079]	[0.084]	[0.085]	[0.085]	[0.087]
Gini district			-0.618	-0.404	-0.584		
			[0.520]	[0.512]	[0.507]		
Gini district t-1						0.771**	0.680**
						[0.314]	[0.310]
Constant	-1.854***	-4.562***	-4.345***	-2.520**	-2.369**	-3.246***	-3.131***
	[0.142]	[0.897]	[0.917]	[0.985]	[1.007]	[1.018]	[1.043]
Observations	10316	10316	10316	10316	10316	10316	10316
R-squared	0.03	0.03	0.03	0.05	0.05	0.05	0.05

Complex survey design accounted for. Standard errors in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%

Table 4 Regression estimates – constituency level – OLS

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Gender	0.204***	0.203***	0.204***	0.204***	0.205***	0.203***	0.203***
	[0.035]	[0.035]	[0.035]	[0.035]	[0.035]	[0.035]	[0.035]
Age	-0.050***	-0.050***	-0.050***	-0.052***	-0.052***	-0.052***	-0.052***
	[0.005]	[0.005]	[0.005]	[0.005]	[0.005]	[0.005]	[0.005]
Age^2	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Birth order	0.010	0.007	0.006	-0.069***	-0.071***	-0.069***	-0.070***
	[0.014]	[0.014]	[0.014]	[0.018]	[0.018]	[0.018]	[0.018]
Female household head				-0.015	0.008	-0.018	0.004
				[0.065]	[0.065]	[0.065]	[0.065]
Female HH share (adult)				0.244**	0.217*	0.248**	0.222*
				[0.121]	[0.121]	[0.121]	[0.120]
HH size				0.049***	0.047***	0.049***	0.046***
				[0.009]	[0.009]	[0.009]	[0.009]
Rural				-0.265***	-0.228***	-0.266***	-0.232***
				[0.063]	[0.062]	[0.063]	[0.062]
HH edu1				0.309**	0.302**	0.309**	0.303**
				[0.125]	[0.124]	[0.126]	[0.124]
HH edu2				0.409***	0.368***	0.410***	0.370***
				[0.129]	[0.128]	[0.130]	[0.129]
HH edu3				0.638***	0.541***	0.629***	0.535***
				[0.148]	[0.147]	[0.148]	[0.147]
Water				0.026	0.009	0.023	0.007
				[0.046]	[0.046]	[0.046]	[0.046]
Toilet facility				-0.080	-0.071	-0.056	-0.048
				[0.063]	[0.063]	[0.064]	[0.064]
Meals					0.248***		0.239***
					[0.043]		[0.043]
Animal products					0.060		0.062
					[0.045]		[0.045]
HH expenditures per capita	0.168***	0.140***	0.133***	0.089***	0.063**	0.092***	0.067**
	[0.024]	[0.026]	[0.025]	[0.026]	[0.026]	[0.026]	[0.026]
Average constituency expen		0.185***	0.194***	0.021	0.018	0.031	0.025
		[0.069]	[0.070]	[0.073]	[0.073]	[0.073]	[0.073]
Gini constituency			-0.649	-0.280	-0.388		
			[0.435]	[0.428]	[0.426]		
Gini constituency t-1						0.673***	0.620**
						[0.245]	[0.243]
Constant	-1.854***	-3.869***	-3.631***	-1.981**	-1.881**	-2.578***	-2.478***
	[0.142]	[0.777]	[0.794]	[0.845]	[0.845]	[0.866]	[0.865]
Observations	10316	10316	10316	10316	10316	10316	10316
R-squared	0.03	0.03	0.03	0.05	0.05	0.05	0.05

Complex survey design accounted for. Standard errors in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%

Results confirm the AIH by showing that the log of household expenditure is an important determinant of child health. Without confounding with other household characteristics, a 10 percent increase in household per capita expenditures would increase HAZ by more than 1, a substantial improvement. Controlling for additional household variables somewhat decreases the magnitude of the association, suggesting that the relationship between household expenditures and child health is partially mediated through for example food consumption.

The baseline analysis provides no support for the RIH. In fact, holding household and individual characteristics constant, children in households residing in richer provinces are less malnourished, in line with for example the findings for Sweden by Gerdtham and Johannesson (2004). A possible explanation is that any negative health effects are dominated by positive spill-over effects on disadvantaged children from living among richer households, for example better environment and better provision of public goods in general. The positive relationship remains when evaluating expenditures at the district and constituency level, but these results are not robust to the inclusion of household characteristics, suggesting that the positive spill-over effects are mainly local.

For the IIH, we find that both present and lagged inequality levels at the provincial level associate with better, rather than worse, child health. At the district and constituency level, lagged inequality correlates positively with child health, whereas present levels of inequality are negative but not statistically significant. These results are surprising both because we find a positive effect of inequality on health, because the positive effect seem to be stronger when using lagged inequality, and because inequality matters also at lower geographical levels.

Most control variables have the expected sign. The relation between the age of children and height-for-age seems to be convex, suggesting that average health status decreases sharply with age. The female dummy is positive and significant, supporting the results in Madise et al. (1999). Female children appear to be better nourished than male, a result compatible with gender discrimination in the allocation of food, but also with recent findings that boys are more vulnerable to health shocks early in life. Higher birth order is significantly associated with worse health. This could for example be explained by behavioral factors, with younger children in the company of older siblings receiving benign neglect from parents, or by competition between children within the same household (Behrman, 1988). Education has the expected positive sign.

Children in the countryside have on average worse health, and household size is positive and significant, possibly capturing an effect of child care within the extended family. Children in households having more meals per day are less malnourished, but the intake of animal products does not seem to matter. Also, the gender of the household head has no significant impact on child nutritional status.

Controlling for endogeneity of income

If households spend more money on health care, medicines or food consumption when children are ill, the effect of household expenditure on health will be biased downwards. The opposite bias occurs if bad child health causes low parental incomes (Attanasio et al. 2004).[12] To avoid biased estimates, we follow Skoufias (1998) and Lawson (2004) in using the *value of electrical goods* (excluding radio and TV) and the type of energy used for *lighting* in the household as instrument for household income. These instruments work because these factors correlate with income but are uncorrelated with child health.[13]

Re-estimating the full model using a two stage procedure with the *value of electrical goods* and *type of energy used for lighting* as instruments for household expenditure, table 5

[12] A Durbin-Wu-Hausman test indicates that baseline results could be biased due to such endogeneity.
[13] Standard testing confirm the validity of the instruments: The Anderson canonical correlation LR test is rejected in all specifications. The instruments are uncorrelated with the error term and excluded instruments are correctly excluded as p-values of Sargan's test of overidentifying restrictions are large.

shows that the effect of household expenditures per capita remains significantly positive and similar across specifications. The IV-estimates are in general larger than OLS estimates suggesting that the latter are biased downward. The baseline results regarding inequality and child health are robust to this exercise.

Controlling for endogeneity produces marginally more support for the RIH with the constituency level as reference group, but the negative association is not robust to the inclusion of lagged inequality. The positive relationship between provincial level average expenditures and better health in baseline estimations remains robust (column 1 and 2).

Table 5 Regression estimates – 2SLS

	(1)	(2)	(3)	(4)	(5)	(6)
Gender	0.205***	0.206***	0.214***	0.211***	0.216***	0.214***
	[0.035]	[0.035]	[0.035]	[0.035]	[0.036]	[0.036]
Age	-0.053***	-0.053***	-0.052***	-0.052***	-0.052***	-0.052***
	[0.005]	[0.005]	[0.005]	[0.005]	[0.005]	[0.005]
Age^2	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Birth order	-0.058***	-0.059***	-0.054**	-0.054**	-0.049**	-0.052**
	[0.021]	[0.021]	[0.021]	[0.021]	[0.021]	[0.021]
Female household head	0.048	0.036	0.063	0.053	0.061	0.059
	[0.073]	[0.072]	[0.074]	[0.073]	[0.075]	[0.074]
Female HH share (adult)	0.192	0.200	0.165	0.172	0.181	0.17
	[0.125]	[0.124]	[0.127]	[0.127]	[0.129]	[0.127]
HH size	0.058***	0.054***	0.067***	0.066***	0.075***	0.069***
	[0.015]	[0.015]	[0.016]	[0.015]	[0.015]	[0.016]
Rural	-0.138*	-0,127	-0.162**	-0.163**	-0.187**	-0.173**
	[0.077]	[0.078]	[0.073]	[0.074]	[0.073]	[0.073]
HH edu1	0.260**	0.239*	0.290**	0.280**	0.301**	0.298**
	[0.126]	[0.127]	[0.129]	[0.130]	[0.131]	[0.129]
HH edu2	0.293**	0.264*	0.299**	0.293**	0.316**	0.305**
	[0.136]	[0.137]	[0.138]	[0.140]	[0.140]	[0.139]
HH edu3	0.380**	0.388**	0.341*	0.339*	0.358*	0.340*
	[0.190]	[0.192]	[0.195]	[0.196]	[0.196]	[0.193]
Water	-0.05	-0.06	-0.048	-0.046	-0.047	-0.049
	[0.057]	[0.056]	[0.056]	[0.056]	[0.057]	[0.057]
Toilet facility	-0.025	-0.015	-0.102	-0.084	-0.113*	-0.079
	[0.070]	[0.067]	[0.068]	[0.069]	[0.068]	[0.069]
Meals	0.140**	0.133**	0.183***	0.173***	0.178***	0.174***
	[0.058]	[0.058]	[0.060]	[0.058]	[0.060]	[0.059]
Animal products	0.059	0.061	-0.029	-0.012	-0.037	-0.035
	[0.068]	[0.068]	[0.073]	[0.072]	[0.074]	[0.074]
HH expenditures per capita	0.317*	0.240*	0.403*	0.382*	0.513**	0.430**
	[0.181]	[0.127]	[0.207]	[0.203]	[0.200]	[0.215]
Average province expenditures	0.401***	0.509***				
	[0.129]	[0.127]				
Gini province	1.960**					
	[0.784]					
Gini province t-1		3.440***				
		[0.737]				
Average district expenditures			-0.136	-0.101		
			[0.149]	[0.142]		
Gini district			-0.189			
			[0.579]			
Gini district t-1				0.838**		
				[0.335]		
Average constituency expenditures					-0.247*	-0.196
					[0.148]	[0.146]
Gini constituency					0.245	
					[0.503]	
Gini constituency t-1						0.678***
						[0.249]
Constant	-8.484***	-10.318***	-1.639	-2.467**	-0.998	-1.496
	[1.276]	[1.305]	[1.107]	[1.133]	[1.003]	[1.037]
Observations	10302	10302	10302	10302	10302	10302

Complex survey design accounted for. Standard errors in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%

Sensitivity analysis

We conduct an extensive series of sensitivity tests of our main results. Detailed regression output is available from the authors. The main results – support for AIH, no or very weak support for RIH and a positive correlation between lagged inequality and child health, rejecting the IIH, are robust to the following changes:

Using alternative inequality indices: Using the generalized entropy measures GE(0) and GE(1) instead of the Gini coefficient. GE(0) gives more weight to distances between incomes in the lower tail, while GE(1) applies equal weights across the distribution (cf. Cowell 1995).

Removing outliers: Re-estimating results excluding the lowest and then the highest deciles in the expenditure distribution, and also excluding constituencies with fewer than 50 and 100 observations.

Using alternative explanatory variables: Replacing *animal products* with a proxy for the *proportion of high protein foods in diet*. Replacing the indicator on the standard of a household's toilet facility with information on its method of *garbage disposal*.

Using alternative instruments: Replacing the set of instruments used in the two stage estimations with information on housing conditions (type of *floor* and *roof*) and type of *energy* used in cooking. Doing this, results with respect to the AIH, RIH and IIH are confirmed, but some covariates such as household education and the rural dummy become insignificant, suggesting a correlation with these alternative instruments.

Including weights in regressions: Following Deaton's (2000) and Korn and Graubard's (2003) recommendations on regression analysis of survey data, we initially do not apply weighting procedures in the econometric modelling. As a sensitivity test we take them into account, with no change in baseline results.

Alternative estimation techniques: Running a two-level random intercept model including individual characteristics, household expenditures as well as the contextual variables.[14]

[14] Multilevel models are also referred to as variance-component models. We use the Stata command xtmixed and let the random part at level 2 households and at level 1 the geographical area of interest.

DISCUSSION AND CONCLUDING REMARKS

The relationship between income inequality and individual health is well tested in high-income contexts and to some extent within middle-income countries. Our study, however, is one of the first analyzing the relationship in a less developed context. Testing three suggested hypotheses using Zambian data, we arrive at several findings.

First, as expected in a setting with high poverty, household monetary means is an important determinant of child nutritional status. Furthermore, consistent with the AIH, the protective health effect from more household economic resources appears non-linear. This finding is in line with previous research, but we have also shown that the effect is stronger when accounting for reverse causality.

Second, we find no or only weak evidence of the RIH. There is some evidence that relative expenditures correlates negatively with poorer child health when the reference group is households in the local geographic area, but the correlation is positive when testing the association between average provincial economic expenditures and child health status. The former result is reasonable since day-to-day comparisons are likely to exist in neighboring contexts. The protective health impact of living in a richer province suggests there might be spill-over effects. A positive RIH is also compatible with ideas of Senik (2004) who suggest that individuals form their expectations based on reference group average incomes and that average income could exert a positive influence on individual satisfaction.

Third, in contrast to the traditional view in the inequality – health literature and to previous empirical findings, we find that greater inequality correlates with better nutritional status. Allowing for some time of inequality exposure this finding appears regardless of whether inequality is measured at the provincial, the district or the constituency level, suggesting that mechanisms mediating the relationship between inequality and child health are similar at all levels. The positive correlation is robust to using alternative inequality indicators, alternative specifications and different estimations techniques.

As the proposed theoretical pathways from inequality to health predominantly have been formulated to account for adversity in health outcomes, our findings require a different framework for interpretation. There are several possibilities that all deserve to examined in further research in low income countries.

First, if higher inequality means less social capital, a possible explanation of our result is that less social interaction and weaker social networks are associated with better health. Less connected households may for example have children with better health than their more socially integrated equals as they have lower risk of being contaminated by infections.

Second, we note that although overall inequality is high in a society, within-group inequality may still be low. For example, table 3 indicates that differences at the bottom of the expenditure distribution in Zambia are smaller than overall expenditure differences, when every observation in the distribution is given an equal weight. As evidence suggests that income differences among people in the bottom half of the distribution are particularly strongly negatively associated with trust (Gustavsson and Jordahl 2008), trust and social capital may still be important factors to better nutrition in unequal contexts if income differences among the poor are relatively small.

A third possibility is inequality is negatively associated with any of the suggested mediators in less developed contexts. For example, along the lines of the Meltzer-Richard theorem, greater inequality among voters may increase government spending as the median voter is inclined to support large public expenditures when a majority of the population is poor.

A fourth possible explanation is that in the presence of social food sharing (cf. Gurven 2004, Kaplan and Hill 1985), the distribution of actual consumption will be more equal than the distribution of expenditure. If growth come as the expense of higher inequality, but those who benefit from growth share with those who do not benefit, the marginal health gain in poor households is likely to exceed the health losses for those who share voluntarily. Evidence in developing contexts indicate that some consumption sharing among households is taking place (Udry 1995) and also that households have a better ability to insure caloric consumption than total consumption (Deininger et al. 2007).

Finally, various agricultural production shocks, in turn generating higher income inequality, could also stimulate more formal solutions to the consumption smoothing problem. If formal insurance and credit markets are imperfect or non-existent, households may instead protect their consumption and health by relying on friends and village networks.

Altogether, our findings merit further research on the relationship between inequality and health in developing contexts. A possible direction for further studies is to include proxies for various mediators in order to determine through what linkages the positive income inequality-health relationship mediates. It is also desirable to move beyond the correlation strategy used in this analysis to enable an identification of causal effects. Ideally, the relationship between income inequality and individual health would be analyzed in a panel data setting. In addition, the theoretical aspects on the relationship between inequality and health need to be revisited with the above results in mind.

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