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Do minimum wages improve early life health? Evidence from developing countries

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ABSTRACT

The impact of legislated minimum wages on the early-life health of children living in low and middle-income countries has not been examined. For our analyses, we used data from the Demographic and Household Surveys (DHS) from 57 countries conducted between 1999 and 2013. Our analyses focus on height-for-age z scores (HAZ) for children under 5 years of age who were surveyed as part of the DHS. To identify the causal effect of minimum wages, we utilized plausibly exogenous variation in the legislated minimum wages during each child's year of birth, the identifying assumption being that mothers do not time their births around changes in the minimum wage. As a sensitivity exercise, we also made within family comparisons (mother fixed effect models). Our final analysis on 49 countries reveal that a 1% increase in minimum wages was associated with 0.1% (95% CI = −0.2, 0) decrease in HAZ scores. Adverse effects of an increase in the minimum wage were observed among girls and for children of fathers who were less than 35 years old, mothers aged 20–29, parents who were married, parents who were less educated, and parents involved in manual work. We also explored heterogeneity by region and GDP per capita at baseline (1999). Adverse effects were concentrated in lower-income countries and were most pronounced in South Asia. By contrast, increases in the minimum wage improved children's HAZ in Latin America, and among children of parents working in a skilled sector. Our findings are inconsistent with the hypothesis that increases in the minimum wage unconditionally improve child health in lower-income countries, and highlight heterogeneity in the impact of minimum wages around the globe. Future work should involve country and occupation specific studies which can explore not only different outcomes such as infant mortality rates, but also explore the role of parental investments in shaping these effects.

1. Introduction

Early life environmental conditions play a critical role in shaping well-being over the life-course. Most studies have treated extreme and less commonly observed shocks, such as famines, as natural experiments to study the causal impact of early life conditions (Almond, and Currie, 2011). Recently, a small literature has been exploring the impact of policies targeting social determinants, including cash or educational interventions, on early life health in both developing and developed countries (Bhutta et al., 2008; Engle et al., 2011; Owusu-Addo and Cross, 2014). Cash transfers have received much attention and have been shown to improve health services utilization, with mixed effects on early life health outcomes (Fiszbein et al., 2009). However, little attention is paid to the potential of labor market institutions, specifically income protection legislation, in shaping opportunities for investing in early life health and the subsequent impact on early life health outcomes.

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Given this, we pose the following question: Do minimum wages improve early life health?

To the extent that minimum wages influence parental wage income, they might affect parental investments in child health. For example, if wages were to increase, families might be more likely to avail themselves of health services and engage in other salutary behaviors which may be particularly effective around the time of birth. However, parents may also be more likely to spend additional time in the labor market at the expense of care-giving activities. The time around birth is widely understood to be a critical period in shaping child nutrition and stunting levels; therefore, changes in parental economic conditions in the pre- and post-natal periods may have particularly large effects on child health and nutrition (Bhutta et al., 2008; Engle et al., 2011).

The large literature on economics of minimum wages finds that minimum wages can increase the earnings of low-income workers without causing job losses as wage increases improve workers' productivity, particularly for workers in large firms (Card and Krueger, 1994; Levine, 1992). However, theory and empirical findings have also suggested that higher minimum wages lead to lower employment (especially for workers in smaller firms) as costs of production increase and firms respond by laying off workers (Neumark and Wascher, 2008).

The limited but growing literature from developing countries generally finds highly heterogeneous effects of minimum wage policies on employment and poverty (Betcherman, 2012). Studies from Latin America suggest that higher minimum wages can lead to increases in wages for workers earning near the minimum wage, although those most in need may not benefit (Bhorat, 2014). Studies in Sub-Saharan Africa find that increases in minimum wages have a small negative impact, or no measurable impact on employment (Bhorat et al., 2015). Whereas there is very limited evidence from South Asia on minimum wages, generally rigid labor regulations have been found to have adverse effects on employment (Djankov and Ramalho, 2009; Besley and Burgess, 2004).

Apart from regional heterogeneity, a second level of heterogeneity is due to economic conditions of the country. The same increase in income may have greater effect in poorer countries (Ferreira and Schady, 2009), however poor countries may also have lower compliance to minimum wage laws due to weak enforcement of laws (Bhorat et al., 2015) which may make the overall effect of minimum wages on poor countries ambiguous.

A third level of heterogeneity relates to the socio-demographic and economic characteristics of workers, including their occupation, age, gender, income, and skill level. Most of the research in poor countries find adverse effects of minimum wages on employment, particularly among the younger adults and those in their prime working ages, as well as those working in manual and less skill-intensive sectors, many of whom tend to be disproportionality women (Betcherman, 2012; Neumark and Wascher, 2008).

In general, both theory and evidence from the economics of minimum wage literature suggest that the mean effects of minimum wages are not a sufficient statistic to summarize the distribution of treatment effects of minimum wages. The effects vary depending on the level of heterogeneity, and for a given level of heterogeneity, the type of sub-group considered.

Ferreira and Schady (2009) develop a simple conceptual framework, building on the insights from Preston (1975) and Deaton (2003), which highlights that an additional dollar in a poor and malnourished context may be used to buy more nutritious and healthy goods, than in richer and healthier settings, where the same dollar may be spent on less essential (even unhealthy) commodities. In our setting, this suggests that effects of minimum wages on child nutrition may be greater in regions, such as Sub-Saharan Africa and South Asia, where malnutrition is a bigger problem than in Latin America (Black et al., 2008) and in countries which are poorer; households which are poorer and whose members work in manual-unskilled sectors may also register stronger adverse effects. Furthermore, to the extent there is gender discrimination, we may expect parents to invest less in girls specially when faced with adverse economic circumstances (Maccini and Yang, 2009; Behrman and Anil Deolalikar, 1990).

Ultimately, whether minimum wage laws lead to improvements or deterioration in child health, through changes in parental economic conditions, is an open empirical question. To the best of our knowledge, this is the first study to explore the causal impact of minimum wage laws on early life health in low and middle-income countries (LMICs).

To identify the effect of minimum wage laws, we exploit plausibly exogenous variation in minimum wages during each child's year of birth, the identifying assumption being that mothers do not time their births around changes in the minimum wage. Our identification strategy uses children born at different times from the same country as controls, rather than exclusively relying on comparisons with children born in different countries which are more likely to be confounded. We strengthen our identification strategy by carrying out a difference-in difference estimation that utilizes not only within country cohort variation in exposure to minimum wages (over more than decade), but also spatial variation in the intensity of the increases in minimum wages (through cohort fixed effects) across countries to control for time varying changes in economic conditions across cohorts. As part of our sensitivity analyses, we also utilize mother fixed effect models to exploit cohort variation in exposure to different levels of minimum wages across *biological siblings*, allowing us to control for family-level time invariant unobservables which may be potentially biasing our results. Furthermore, based on the insights of the economics of minimum wage literature, we hypothesize that certain subgroups (poor, less skilled, and young for example) will demonstrate stronger effects than others (those in the skilled sector, richer countries or regions where malnutrition is less of a problem such as Latin America), which helps us generate placebos and infer which mechanisms might be at play.

For our analysis, we merged longitudinal cross-country data on minimum wage levels with child-level health data from 57 countries surveyed by the Demographic and Health Surveys (DHS), covering the period between 2000 and 2013. Using height for age z-scores (HAZ) as a measure of child nutrition, our analysis addresses the following questions: First, does exposure of parents to increases in the minimum wage (MW) around the time of birth improve child nutrition? Second, do these effects vary by parental and child SES, by income level of the country and by the geographical regions? Third, what are the potential channels that explain observed effects?

2. Methods

2.1. Sample

The minimum wage data for this study comes from the Minimum Wage Policy Database constructed by McGill University's Maternal and Child Health Equity Research (MACHEquity) research program in collaboration with UCLA's WORLD Policy Analysis Center. The database consists of country-year observations of minimum wage levels, as set by policy between 1999 and 2013, for 121 LMICs surveyed by the Demographic and Health Surveys (DHS) and/or by UNICEF's Multiple Indicator Cluster Surveys (MICS) up to 2013. In Appendix C we provide more details about our minimum wage data set.

To estimate the impact of MW on health outcomes, we used the Demographic and Health Surveys (DHS) from 57 countries in Asia, Africa, Europe and the Americas, spanning more than a decade between 2000 and 2013. The DHS are nationally representative household surveys conducted in LMICs and are designed to collect health and sociodemographic information on women of reproductive age (15–49 years), men (usually aged 15–54 or 15–59), and children ever born (Corsi et al., 2012). The DHS asks women about their birth history, in addition to their socio-economic background, among other topics. Regarding birth history, information about date of birth (month and year) and child's gender is available for all births.

Our original data set contained 748,320 observations on HAZ scores for children 0–5 years old alive at the time of interview from 57 countries with survey years ranging from 2000 to 2013. To ensure that minimum wage effects are identified and estimated on a relevant population, we restricted our sample to residents of urban areas, reducing our sample to 250,268 observations (64% of sample is rural). We excluded those children whose mothers were widowed, divorced or not living with their partner (8% of the sample), and those whose parents were both working in agriculture or self-employed. Finally, we extracted the subset of children whose mothers were between 14 and 39 years of age and whose fathers were between 20 and 50 years of age. These restrictions led to a sample size of 179,148. After accounting for missing values in minimum wage data and parental characteristics, our final sample consisted of 139,824 children born between 1999 and 2012 in 49 countries.

2.2. Measures

Our exposure was the latest monthly minimum wage rate in place at the end of every calendar year for workers in the formal, non-public sector. For those countries where the minimum wage was sector-specific or occupation-specific, the level applicable to the manufacturing sector or unskilled workers was recorded. We used PPP conversion and inflation factors from the World Bank Development Indicators (WDI) to create a minimum wage series in PPP constant 2011 US dollars. Appendix Table A3 lists the original 57 DHS countries in our data set and highlights considerable variation in legislated nominal minimum wages over time, across countries and regions.

For children born in the five years prior to the survey and alive at the time of interview, the DHS provides anthropometric measures constructed using 2006 WHO child growth standards. Our primary outcome was children's height-for-age anthropometric scores, which are widely regarded as an important predictor of long-run health and economic well-being (Behrman and Deolalikar, 1988; Hoddinott et al., 2013a,b; Victora et al., 2008).

We accounted for potential confounding by individual and household characteristics posited to influence the relationship between minimum wages and child height for age z-scores. Children's covariates included gender, age in months, age squared, birth order; mother's covariates included age at birth in months, age at birth squared, year of birth dummies, marital status, total children under 5, total number of children born, occupation and educational attainment; and father's covariates consisted of age in years at time of survey, occupation, and educational attainment. Parental educational attainment was coded as follows: 0 - education; 1-incomplete primary; 2-compete primary; 3-incomplete secondary, 4-secondary, and 5- higher education. To account for household SES, we controlled for quintiles of the DHS wealth index, which is based on ownership of specific assets (e.g. radio and television), environmental conditions, and housing characteristics (e.g., materials used for housing construction and sanitation facilities), and constructed using a method developed by Filmer and Pritchett (Filmer and Pritchett, 2001, 1999).

3. Empirical strategy

The following reduced form equation was used to model the impact of minimum wages on child health:

$$Y_{imct} = \alpha + \beta_1 \, logMW_{ct} + \beta_2 X_{imct} + g(c,t) + U_{imct}, \quad (1)$$

where Y_{imct} is the outcome of interest for child i born in year t belonging to mother m in country c. β_1 is the parameter of interest as it measures the impact of a 1% increase in constant, PPP-adjusted minimum wages in a given country c at time t (for cohort t). Data on MW was matched to the year of birth of each child, so that cohort variation in exposure to MW is exploited for identification of causal effects.

To deal with factors that may confound the relation between minimum wages and child health, we flexibly controlled for X_{imct}, which is a vector containing child, parental, and household characteristics.

Our identification strategy exploits arguably exogenous timing of changes in minimum wages with the timing of births. This suggests that our control group is not a different country, but children within the same country at different times. We complement our identification strategy with controls for g(c,t)–country fixed effects and time trends (child's year of birth fixed effects). Country fixed effects control for any time invariant differences between countries that may bias the effects of MW, whereas the time trends control for unobservable changes in economic conditions over time.

In stratified models, we also examined heterogeneous effects of MW by child gender, child age, parental age, maternal marital status, and economic background of the household (wealth quintiles, parental education and employment), as well as the region and level of economic development of the country at baseline.

Last, we explored the sensitivity of our results to unobserved family heterogeneity by comparing biological siblings through a mother fixed effects model. This model allows us to control for any unobservable factors common between siblings, which may bias our estimates of β_1 in model (1). As we are using a select sample of urban families working in the formal sector, we did not use DHS country weights in our analyses.

4. Results

Table 1 shows summary statistics for the key variables used in our analyses. The mean HAZ scores were negative, suggesting that the average country in our sample has an undernourished sample of children (relative to WHO standards) aged zero to five. The mean value of our minimum wage exposure was US $278 per month, however there was significant variation in minimum wage values as reflected in the standard deviation of US $149 and its wide range of US $7 per month to US $633 per month.

Table 2A shows the β_1 estimates from equation (1). For the purpose of this paper, we will be reporting effects of a 1% increase in real minimum wages (given by ~ $\beta_1/100$). To be consistent in the discussion of our estimates, we have rounded our estimates to the nearest 3 decimal places. We find that a 1% increase in minimum wages was associated with a decrease in HAZ (for children 0–5 years of age) of 0.001 standard deviations (95% CI = −0.002, 0.000). Given the mean HAZ of ~ −1 SD, a −0.001 SD effect translates into a −0.1% (0.001 SD/1 SD) change in HAZ scores or an elasticity of HAZ with respect to minimum wages of 0.1. The overall estimate, however, may hide the presence of heterogeneous effects by child

Table 1
Sample characteristics for 57 LMIC countries in the demographic and health surveys 1999–2012.

	Total	Mean	SD	Min	Max
Height-for-age z scores	179,148	−0.97	1.55	−6	6
Minimum wages (PPP, constant 2011 USD)	153,339	278.05	148.62	7.2	632.91
Log minimum wages	153,339	5.44	0.71	1.97	6.45
Log GDP per capita (PPP, constant 2011 USD)	179,148	8.25	0.85	6.09	9.81
Log GDP per capita in 1999	177,142	8.08	0.84	5.98	9.81
Child's year of birth	179,148	2005.2	3.58	1999	2012
Child's age (in months)	179,148	27.94	16.99	0	59
Male child	179,148	0.51	0.5	0	1
Mother employed	170,802	0.5	0.5	0	1
Mother's age at child birth (in years)	179,148	25.8	5.56	14	39
Mother's year of birth	179,148	1979.4	6.47	1960	1998
Wealth Index	179,148	3.72	1.23	1	5
Children under age 5	179,148	1.79	0.96	1	14
Total children born	179,148	2.78	1.75	1	17
Mother married	179,148	0.67	0.47	0	1
Mother's educational attainment	177,079	2.63	1.64	0	5
Mother works in agriculture	179,148	0.02	0.15	0	1
Father's age (in years)	169,133	33.74	6.74	20	50
Father works in agriculture	179,148	0.07	0.25	0	1
Father's educational attainment	164,133	2.87	1.58	0	5

Notes: Sample is restricted to those residing in urban areas and excludes those children whose parents are both working in agriculture or are self-employed. Mother's age at birth is restricted to be between 14 and 39, father's age is restricted to between 20 and 50.

Table 2A
Minimum wage effects on HAZ by child gender (country fixed effects).

Variables	(1)	(2)	(3)
	Overall	Female	Male
	HAZ	HAZ	HAZ
Log MW	−0.086	−0.092*	−0.077
	(−0.206, 0.034)	(−0.191, 0.006)	(−0.248, 0.093)
Observations	139,824	68,693	71,131
R-squared	0.151	0.159	0.145

Notes: Robust 95% CI in parentheses.***p < 0.01, **p < 0.05, *p < 0.1.

Table 2B
Minimum wage effects on HAZ by child gender (mother fixed effects).

Variables	(1)	(2)	(3)
	Overall	Female	Male
	HAZ	HAZ	HAZ
Log MW	−0.078	−0.112	−0.049
	(−0.206, 0.050)	(−0.498, 0.275)	(−0.381, 0.283)
Observations	76,769	37,901	38,868
R-squared	0.809	0.902	0.906

Notes: Robust 95% CI in parentheses.***p < 0.01, **p < 0.05, *p < 0.1.

gender. We found that an increase in the minimum wage reduced HAZ for girls by −0.001 SD (95% CI = −0.002, 0.000); as shown in Table 2A, the effect was is similar for boys with a wide CI (95% CI = −0.002, 0.001).

A second level of heterogeneity may be due to parental characteristics. Table 3A shows the estimates on children according to whether their mothers were in their prime childbearing age (19–29) at the time of birth, as well as whether their fathers (mothers' current partners) were 35 years of age or less at the time of survey. We found that a 1% increase in minimum wages reduced HAZ scores by 0.001 for children whose mothers were between 19 and 29 years of age, whereas the effects on children whose mothers gave birth when they were older than 29 or younger than 19 were smaller. Appendix Table A1* shows that the HAZ for children of mothers between ages 19 and 29 years compared to other mothers were lower by 0.001 SD (95% CI = −0.002, −0.000). Similarly, the adverse effects of minimum wage increases were driven by children of young fathers—a 1% increase in minimum wages reduced HAZ scores by 0.001 SD.

Results in Table 4A reveal that minimum wage laws register adverse effects for mothers who are married in particular: −0.001 SD (95% CI = −0.003, 0.000). As shown in Appendix *, the difference between married and non-married mothers was −0.001 SD (95% CI = −0.003, 0.000).

Table 4A also shows heterogeneity across wealth quintiles. For those in the poorest quintile, where one might expect the greatest effect of minimum wage laws, a 1% increase in minimum wages decreased the mean HAZ score by 0.004 (95% CI = −0.007, −0.000) standard deviations. Appendix Table A1* shows that the estimates for the lowest quintile were lower than those registered in the higher quantiles: −0.003 SD (95% CI = −0.006, 0.000).

Table 3A
Minimum wage effects on HAZ by parental age (country fixed effects).

Variables	(1)	(2)	(3)	(4)
	Prime aged Mothers	Other Mothers	Younger father	Older father
	HAZ	HAZ	HAZ	HAZ
Log MW	−0.126*	−0.0392	−0.0986	−0.0637
	(−0.254, 0.003)	(−0.150, 0.072)	(−0.231, 0.034)	(−0.180, 0.053)
Observations	73,160	66,664	89,937	49,887
R-squared	0.147	0.158	0.158	0.141

Notes: Robust 95% CI in parenthesis.***p < 0.01,**p < 0.05,*p < 0.1. Prime aged are those mothers who were 19–29 at the time of birth. Young fathers are 35 or less at the time of survey.

Table 3B
Minimum wage effects on HAZ by parental age (mother fixed effects).

Variables	(1)	(2)	(3)	(4)
	Prime aged Mothers	Other Mothers	Younger father	Older father
	HAZ	HAZ	HAZ	HAZ
Log MW	−0.165*	0.0914	−0.133*	0.0231
	(−0.350, 0.020)	(−0.133, 0.316)	(−0.286, 0.021)	(−0.210, 0.256)
Observations	42,665	34,104	49,292	27,477
R-squared	0.818	0.841	0.804	0.818

Notes: Robust 95% CI in parenthesis.***p < 0.01,**p < 0.05,*p < 0.1. Prime aged are those mothers who were 19–29 at the time of birth. Young fathers are 35 or less at the time of survey.

Table 4A
Minimum wage effects on HAZ by SES (country fixed effects).

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Married	Single	Cohabitating	Poorest	Poor	Middle	Rich	Richest
	HAZ	HAZ	HAZ	HAZ	HAZ	HAZ	HAZ	HAZ
Log MW	−0.128*	−0.005	−0.013	−0.353**	−0.081	−0.012	−0.034	−0.124
	(−0.272, 0.017)	(−0.128, 0.119)	(−0.143, 0.117)	(−0.694, −0.013)	(−0.252, 0.090)	(−0.253, 0.229)	(−0.164, 0.0962)	(−0.276, 0.028)
Observations	94,383	8793	45,441	8671	18,333	29,093	36,453	47,274
R-squared	0.158	0.134	0.136	0.199	0.188	0.158	0.157	0.124

Notes: Robust 95% CI in parenthesis.***p < 0.01,**p < 0.05,*p < 0.1. First three columns show effects by marital status for mothers. Next five columns show effects by household wealth quintiles.

Table 4B
Minimum wage effects on HAZ by SES (mother fixed effects).

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Married	Single	Cohabitating	Poorest	Poor	Middle	Rich	Richest
	HAZ	HAZ	HAZ	HAZ	HAZ	HAZ	HAZ	HAZ
Log MW	−0.096	0.688	−0.055	−0.445**	0.024	0.011	−0.033	−0.193*
	(−0.241, 0.050)	−1.524, 2.899)	(−0.331, 0.222)	(−0.887, −0.004)	(−0.413–0.460)	(−0.279, 0.301)	(−0.265–0.199)	(−0.422, 0.037)
Observations	54,832	3748	21,937	6034	10,483	15,468	19,636	25,148
R-squared	0.810	0.925	0.812	0.787	0.805	0.804	0.809	0.817

Notes: Robust 95% CI in parenthesis.***p < 0.01,**p < 0.05,*p < 0.1. First three columns show effects by marital status for mothers. Next five columns show effects by household wealth quintiles.

Table 5A
Minimum wage effects on HAZ by parental education (country fixed effects).

Variables	(1)	(2)	(3)	(4)
	Less educated mothers	More educated mothers	Less educated fathers	More educated fathers
	HAZ	HAZ	HAZ	HAZ
Log MW	−0.082	−0.081	−0.076	−0.110
	(−0.189, 0.025)	(−0.270, 0.109)	(−0.196, 0.045)	(−0.250, 0.030)
Observations	93,746	44,054	89,760	45,860
R-squared	0.150	0.078	0.154	0.109

Notes: Robust 95% CI in parenthesis.***p < 0.01,**p < 0.05,*p < 0.1.Less Educated are those who have completed less than secondary schooling.

Table 5B
Minimum wage effects on HAZ by parental education (mother fixed effects).

Variables	(1)	(2)	(3)	(4)
	Less educated mothers	More educated mothers	Less educated fathers	More educated fathers
	HAZ	HAZ	HAZ	HAZ
Log MW	−0.133*	0.172	−0.152*	0.121
	(−0.279, 0.013)	(−0.097, 0.441)	(−0.307, 0.002)	(−0.114, 0.356)
Observations	56,732	19,211	53,091	21,677
R-squared	0.805	0.807	0.801	0.823

Notes: Robust 95% CI in parenthesis.***p < 0.01,**p < 0.05,*p < 0.1.Less Educated are those who have completed less than secondary schooling.

Table 5A explores heterogeneity by parental education. Results showed adverse effects on children across educational levels for both parents, with adverse effects of −0.001 SD (95% CI: −0.002, 0.000) among children whose mothers were less educated (those who have completed less than secondary schooling).

A third level of heterogeneity may be related to the level of economic development of the country: Table 6A explores effects on "poorer" countries with low levels of GDP per capita (below the median GDP per capita in 1999) versus those with relatively higher GDP per capita (above the median GDP per capita in the sample). We found that adverse effects were primarily driven by low-income countries, where we observed a 0.002 standard deviation (95% CI: −0.003, −0.000) reduction in mean HAZ scores in response to a 1% increase in minimum wages. Appendix Table A2* shows that the estimate in the poorest countries was lower than in richer countries: −0.002 SD (95% CI = −0.004, 0.000).

Given that our analyses included countries from very diverse regions of the world, with different socio-economic conditions, we explored heterogeneity by region in Table 7A. We found that adverse effects were particularly large in South Asian region, where a 1% increase in minimum wage levels led to a 0.007 standard deviation (95% CI = −0.011, −0.003) decrease in HAZ scores.

In order to examine potential mechanisms, we next explored if increases in minimum wages affected maternal employment status. Table 8 suggests that minimum wages negatively affected maternal employment in poorer countries. In Appendix Table A2* we explored the impact of this change on children's HAZ scores. A 1% increase in minimum wages reduced mean HAZ scores by −0.002 SD (95% CI = −0.004, −0.001), among children whose mothers from poor countries were not working at the time of survey (relative to their counterparts in richer countries).

We next analyzed whether the sector/occupation of work matters. Table 9A shows that children of mothers working in the manual sector were most adversely affected by increases in minimum wages. Interestingly, we find positive effects of minimum wage increases for children of mothers working in the sales sector. Results from analyses stratified by the occupation of fathers (Table 10A) showed a similar story: positive effects on child HAZ for fathers working in sales, but adverse effects for fathers working in the manual sector. Results from Appendix Table A2* further suggest that the children of parents in sales occupations fare better than parents in other occupations, and those in manual work are more adversely affected.

4.1. Sensitivity analyses

Tables 2B–10B compare changes in HAZ among biological siblings who were exposed to changes in minimum wages, by carrying out a mother fixed effects model on families with two or more children under 5. The results are robust overall, with effect sizes increasing in many cases (more adverse effects). However, we do find some interesting differences: children of less educated mothers and less educated fathers were adversely affected; the effects on children of married mothers were attenuated; and children in the richest families were also adversely affected. Perhaps the most interesting differences are in terms of region: adverse effects were concentrated in South Asia and Sub-Saharan Africa, with positive effects in Latin America. Furthermore, Table A6 explores sensitivity of our mother fixed effects to clustering at the country and mother levels for a few of our key estimates and found results to be robust.

We carried out a range of other sensitivity tests. For our full sample and the sample from poorest households, we explored lags of 1 and 2 years and a lead of 1 year for the year of the MW. Appendix Table A4* shows some evidence of adverse effects on the poorest households in the year prior to birth, but smaller and noisier effects with lag of 2 years and a lead of 1 year (second year of birth). This provides suggestive evidence of the importance of the year of birth as a crucial year in shaping HAZ for children.

Another concern is that the sample we have chosen for our analysis (those living in urban areas who have at least one parent not working in agriculture) may be systemically related to certain omitted variables which are correlated with increases in minimum wages as well as changes in HAZ. In Table A5* we show little evidence of such a selection at play, even if we restrict our sample to South Asia or Latin America (where we were finding some of the largest and contrasting effects).

In Appendix B we list and discuss in greater detail a broad list of potential concerns to our identification strategy (e.g. biases due to time varying unobservable, lack of compliance of laws, etc.).

Table 6A
Minimum wage effects on HAZ by Country's economic development (country fixed effects).

Variables	(1)	(2)
	Poorest countries	Richer countries
	HAZ	HAZ
Log MW	−0.155**	0.027
	(−0.294, −0.017)	(−0.132, 0.186)
Observations	70,473	69,351
R-squared	0.145	0.133

Notes: Robust 95% CI in parenthesis.***p < 0.01,**p < 0.05,*p < 0.1.Poorest countries are those with below median GDP per capita measured at baseline (1999).

Table 6B
Minimum wage effects on HAZ by Country's economic development (mother fixed effects).

Variables	(1)	(2)
	Poorest countries	Richer countries
	HAZ	HAZ
Log MW	−0.121	−0.000
	(−0.286, 0.044)	(−0.209, 0.208)
Observations	43,718	33,051
R-squared	0.814	0.798

Notes: Robust 95% CI in parenthesis.***p < 0.01,**p < 0.05,*p < 0.1.Poorest countries are those with below median GDP per capita measured at baseline (1999).

5. Discussion

This is the first paper, which we are aware of, to analyze the causal relation between minimum wages and early life health of children in low and middle-income countries. We exploit plausibly exogenous variation in minimum wages with respect to timing of births of children born to parents who were affected by these laws. We merged data on minimum wage levels for 57 countries to data on height-for-age (HAZ) scores for children under 5 available from DHS surveys between 1999 and 2013. Overall, a 1% increase in minimum wages led to a 0.001 standard deviation decrease in HAZ scores (95% CI = −0.002, 0.000). Given that the mean HAZ score is −1 SD, a 1% increase in minimum wages is associated with 0.1% decrease in HAZ scores. The effect sizes rise to about 0.8% decrease in HAZ for a 1% increase in minimum wages when only South Asia is studied (mother fixed effects model). These estimates correspond to elasticities of 0.1–0.8, which are remarkably similar in magnitude to elasticities from the literature exploring the impact of minimum wages on employment (Neumark and Wascher, 2008).

Overall our estimates cannot reject the null of no effects of minimum wages on child HAZ. This is consistent with findings from

Table 7A
Minimum wage effects on HAZ by region (country fixed effects).

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Sub-Saharan	Latin	South	Middle East &	Europe &	MENA &	Africa &
	Africa	America	Asia	North Africa	Central Asia	Asia	Asia
	HAZ	HAZ	HAZ	HAZ	HAZ	HAZ	HAZ
Log MW	−0.058	0.066	−0.676**	−2.426	0.053	−0.476**	−0.127
	(−0.183, 0.067)	(−0.042, 0.174)	(−1.062, −0.289)	(−56.19, 51.33)	(−0.220, 0.327)	(−0.899, −0.052)	(−0.292, 0.037)
Observations	45,748	57,476	18,854	8149	8274	28,326	74,074
R-squared	0.129	0.143	0.170	0.077	0.110	0.204	0.151

Notes: Robust 95% CI in parenthesis.***p < 0.01,**p < 0.05,*p < 0.1. MENA: Middle East and North Africa; Asia: South Asia and East Asia and Pacific; Africa: MENA and Sub-Saharan Africa.

Table 7B
Minimum wage effects on HAZ by region (mother fixed effects).

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Sub-Saharan	Latin	South	Middle East &	Europe &	MENA &	Africa &
	Africa	America	Asia	North Africa	Central Asia	Asia	Asia
	HAZ	HAZ	HAZ	HAZ	HAZ	HAZ	HAZ
Log MW	−0.273**	0.241**	−1.136***	−11.72	0.071	−1.024***	−0.252**
	(−0.506, −0.040)	(0.009, 0.474)	(−1.819, −0.452)	(−26.69, 3.248)	(−0.558, 0.700)	(−1.496, −0.551)	(−0.444, −0.060)
Observations	30,644	25,574	10,305	5435	4128	16,423	47,067
R-squared	0.818	0.822	0.808	0.723	0.775	0.799	0.810

Notes: Robust 95% CI in parenthesis.***p < 0.01,**p < 0.05,*p < 0.1. MENA: Middle East and North Africa; Asia: South Asia and East Asia and Pacific; Africa: MENA and Sub-Saharan Africa.

Table 8
Minimum wage effects on Mother's employment (country fixed effects).

Variables	(1)	(2)	(3)
		Poorest country	Richer country
	Mother employed	Mother employed	Mother employed
Log MW	−0.005	−0.024*	0.026
	(−0.033, 0.022)	(−0.051, 0.003)	(−0.016, 0.067)
Observations	133,542	70,442	63,100
R-squared	0.192	0.251	0.132

Notes: Robust 95% CI in parenthesis.***p < 0.01,**p < 0.05,*p < 0.1. Mother's employment status is measured at the time of survey.

the economics of minimum wage literature, which often finds that minimum wages cannot reject the null of no effects on employment and income (Betcherman, 2012; Neumark and Wascher, 2008). However, the global intent to treat estimate may be biased downwards for various reasons: a lack of policy compliance, the very local nature of the effects of minimum wage laws on certain subpopulations, and counteracting effects in different world regions. We find particularly large and adverse effects in the poorest countries and in the South Asian region. These findings echo results from studies that have highlighted the adverse impacts of labor market regulation in India (Djankov and Ramalho, 2009; Besley and

Table 9A
Minimum wage effects on HAZ by Mother's occupation (county fixed effects).

Variables	(1)	(2)	(3)	(4)
	Sales	Manual	Domestic	Clerical
	HAZ	HAZ	HAZ	HAZ
Log MW	0.112*	−0.286**	−0.272	−0.130
	(−0.020, 0.244)	(−0.541, −0.030)	(−0.709, 0.165)	(−0.599, 0.340)
Observations	25,823	10,191	3414	3479
R-squared	0.123	0.164	0.192	0.110

Notes: Robust 95% CI in parenthesis.***p < 0.01,**p < 0.05,*p < 0.1.

Table 9B
Minimum wage effects on HAZ by Mother's occupation (mother fixed effects).

Variables	(1)	(2)	(3)	(4)
	Sales	Manual	Domestic	Clerical
	HAZ	HAZ	HAZ	HAZ
Log MW	0.167	−0.631*	0.000	−0.001
	(−0.163, 0.497)	(−1.263, 0.000)	(−1.041, 1.041)	(−1.050, 1.049)
Observations	14,261	5560	1743	1287
R-squared	0.817	0.824	0.810	0.840

Notes: Robust 95% CI in parenthesis.***p < 0.01,**p < 0.05,*p < 0.1.

Table 10A
Minimum wage effects on HAZ by Father's occupation (country fixed effects).

Variables	(1)	(2)	(3)	(4)
	Sales	Manual	Domestic	Clerical
	HAZ	HAZ	HAZ	HAZ
Log MW	0.163**	−0.065	0.058	−0.003
	(0.026, 0.301)	(−0.186, 0.055)	(−0.397, 0.512)	(−0.265, 0.258)
Observations	19,541	48,244	1462	5544
R-squared	0.148	0.160	0.224	0.156

Notes: Robust 95% CI in parenthesis.***p < 0.01,**p < 0.05,*p < 0.1.

Table 10B
Minimum wage effects on HAZ by Father's occupation (mother fixed effects).

Variables	(1)	(2)	(3)	(4)
	Sales	Manual	Domestic	Clerical
	HAZ	HAZ	HAZ	HAZ
Log MW	0.319*	−0.0774	−0.394	−0.395
	(−0.011, 0.649)	(−0.283, 0.128)	(−2.251, 1.463)	(−1.207, 0.417)
Observations	11,435	27,673	774	2826
R-squared	0.815	0.806	0.879	0.801

Notes: Robust 95% CI in parenthesis.***p < 0.01,**p < 0.05,*p < 0.1.

Burgess, 2004). We also find that increases in the minimum wage increased rates of maternal unemployment. The fact that we do not find adverse effects of minimum wages on HAZ scores or on maternal employment in richer countries further suggests that unemployment may be a relevant mechanism through which adverse health effects are materialized.

The literature on minimum wage effects on employment also suggests that the most severe effects are to be expected on those who are in their prime ages and are less skilled (Betcherman, 2012). Consistent with this, we find that the adverse effects of minimum wage laws are concentrated among children of parents in their prime age and families in the lowest wealth quintile. And among those who work, the children of those working in less skilled occupations (manual work) experienced the most adverse effects.

Interestingly, we find that increases in minimum wage laws also benefit some sub-groups. Those residing in Latin America and those working in sales (a relatively more skilled occupation) actually register positive effects. This may be partly due to malnutrition being a much less serve issue in Latin America but also because minimum wages have been found to have positive effects on wages and employment. Studies on Latin America have documented "lighthouse effects" whereby the informal sector benefits from increased employment and higher wages as the formal sector wage levels serve as reference for these sectors (Maloney and Mendez, 2004).

Our results question the hypothesis that increases in minimum wages improve child health for the marginalized. Although there is evidence of positive effects for those working in a more skilled sector and for those born in Latin America, the overall estimates are suggestive of adverse effects on a wide range of less well-off sub-groups which are often of interest to policy makers.

Our analysis is not without limitations. First, we do not have data on parental wages, so we could not limit our analyses to parents who earned a wage likely to have been impacted by changes in minimum wages. As a result, we limited our analyses to subgroups most likely to have been affected. To the extent that many among our treatment group are not directly affected by minimum wages and to the extent that there may be weak compliance to minimum wage legislation even within relevant sub-groups, our estimates are biased downwards. Second, our results suggest that it is changes in minimum wages around birth that mattered most for a child's height for age in their first five years of life. However, with annual minimum wage data, it was not possible to accurately capture the relative importance of conditions in narrow windows of exposure. This creates measurement error in our treatment variable which may be biasing our estimates downwards. Third, because we estimated effects retrospectively up to five years after birth, we were not able to explore effects on employment status and utilization of health services before, during, and immediately after the birth of sampled children. Consequently, we are not able to comprehensively analyze the pathways through which minimum wage shocks impact child height for age z scores. Fourth, we did not formally carry out a test of multiple hypotheses given the large number of sub-groups analyzed. However, we may not have been adequately powered to examine effects within these subgroups and correcting for multiple testing may have further accentuated this problem. To indirectly deal with this, in our appendix, we provided an alternate way of assessing heterogeneity with smaller sub-groups (binary terms) and we still found similar patterns. Nevertheless, our results indicate that shocks to aggregate wages, through minimum wage changes, can have important and heterogeneous consequences for an important marker of early child nutrition, which is predictive of later life changes in health and economic well-being.

Given that this topic has not been studied much before, we think of this paper as scratching the surface on an important, yet under-researched topic. There is a need for country and occupation specific studies which can explore not only different outcomes such as infant mortality rates, but also explore the role of parental investments in shaping these effects.

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Appendices. Supplementary data

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References

Almond, Douglas, Currie, Janet, 2011. Killing me softly: the fetal origins hypothesis. J. Econ. Perspect. a J. Am. Econ. Assoc. 25 (no. 3), 153.
Behrman, Jere R., Deolalikar, Anil B., 1988. Health and Nutrition. In: Handbook of Development Economics, vol. 1, pp. 631–711.
Behrman, Jere R., Deolalikar, Anil B., 1990. The intrahousehold demand for nutrients in rural south India: individual estimates, fixed effects, and permanent income. J. Hum. Resour. 665–696.
Besley, T., Burgess, R., 2004. Can labor regulation hinder employment performance? Evidence from India. Q. J. Econ. 17 (no. 3), 91–134.
Betcherman, Gordon, 2012. Labor Market Institutions: a Review of the Literature. World Bank Policy Research Working Paper 6276.
Bhorat, H., 2014. Compliance with Minimum Wage Laws in Developing Countries. IZA World of Labor.
Bhorat, H., Kanbur, Ravi, Stanwix, Benjamin, August 2015. Minimum Wages in Sub-saharan Africa: a Primer. CEPR Discussion Paper No. DP10760.
Bhutta, Zulfiqar A., Ahmed, Tahmeed, Black, Robert E., Cousens, Simon, Dewey, Kathryn, Elsa Giugliani, Haider, Batool A., et al., 2008. What works? Interventions for maternal and child undernutrition and survival. Lancet 371 (no. 9610), 417–440.
Black, R.E., Allen, L.H., Bhutta, Z.A., Caulfield, L.E., De Onis, M., Ezzati, M., Maternal and Child Undernutrition Study Group, 2008. Maternal and child undernutrition: global and regional exposures and health consequences. Lancet 371 (9608), 243–260.
Card, David, Krueger, Alan B., 1994. Minimum wages and employment: a case study of the fast-food industry in New Jersey and Pennsylvania. Am. Econ. Rev. 772–793.
Corsi, Daniel J., Neuman, Melissa, Finlay, Jocelyn E., Subramanian, S.V., 2012. Demographic and health surveys: a profile. Int. J. Epidemiol. 41 (no. 6), 1602–1613.
Deaton, Angus, 2003. Health, inequality, and economic development. J. Econ. Lit. XLI, 113–158. March.
Djankov, Simeon, Ramalho, Rita, 2009. Employment laws in developing countries. J. Comp. Econ. 37 (no. 1), 3–13.
Engle, Patrice L., Fernald, Lia CH., Alderman, Harold, Behrman, Jere, O'Gara, Chloe, Yousafzai, Aisha, de Mello, Meena Cabral, et al., 2011. Strategies for reducing inequalities and improving developmental outcomes for young children in low-income and middle-income countries. Lancet 378 (no. 9799), 1339–1353.
Ferreira, F.H., Schady, N., 2009. Aggregate economic shocks, child schooling, and child health. World Bank Res. Obs. 24 (2), 147–181.
Filmer, Deon, Pritchett, Lant, 1999. The effect of household wealth on educational attainment: evidence from 35 countries. Popul. Dev. Rev. 25 (no. 1), 85–120.
Filmer, Deon, Pritchett, Lant H., 2001. Estimating wealth effects without expenditure Data—Or tears: an application to educational enrollments in states of India*. Demography 38 (no. 1), 115–132.
Fiszbein, Ariel, Schady, Norbert Rüdiger, Ferreira, Francisco HG., 2009. Conditional Cash Transfers: Reducing Present and Future Poverty. World Bank Publications.
Hoddinott, John, Alderman, Harold, Behrman, Jere R., Haddad, Lawrence, Horton, Susan, 2013a. The economic rationale for investing in stunting reduction. Matern. Child Nutr. 9 (no. S2), 69–82.
Hoddinott, J., Behrman, J.R., Maluccio, J.A., Melgar, P., Quisumbing, A.R., Ramirez-Zea, M., Martorell, R., 2013b. Adult consequences of growth failure in early childhood. Am. J. Clin. Nutr 98 (5), 1170–1178.
Levine, David I., 1992. Can wage increases pay for themselves? Tests with a productive function. Econ. J. 1102–1115.
Maccini, Sharon, Yang, Dean, 2009. Under the Weather: health, schooling, and economic consequences of early-life rainfall. Am. Econ. Rev. 1006–1026.
Maloney, William, Mendez, Jairo, 2004. Measuring the impact of minimum wages. Evidence from Latin America. In: Law and Employment: Lessons from Latin America and the Caribbean. University of Chicago Press, pp. 109–130.
Neumark, David, Wascher, William L., 2008. Minimum Wages. MIT Press.
Owusu-Addo, Ebenezer, Cross, Ruth, 2014. The impact of conditional cash transfers on child health in low-and middle-income countries: a systematic review. Int. J. Public Health 59 (no. 4), 609–618.
Preston, Samuel H., 1975. The changing relation between mortality and level of economic development. Popul. Stud. 29, 231–248.
Victora, Cesar G., Adair, Linda, Fall, Caroline, Hallal, Pedro C., Martorell, Reynaldo, Richter, Linda, Sachdev, Harshpal Singh, Maternal and Child Undernutrition Study Group, 2008. Maternal and child undernutrition: consequences for adult health and human capital. Lancet 371 (no. 9609), 340–357.