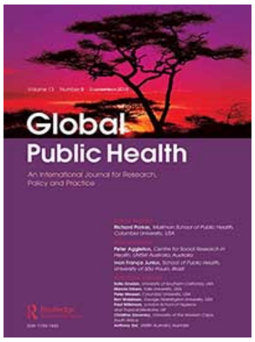

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The association of minimum wage change on child nutritional status in LMICs: A quasi-experimental multi-country study*

Ninez Ponce [a], Riti Shimkhada [b], Amy Raub[c], Adel Daoud[d,e], Arijit Nandi[f], Linda Richter[g] and Jody Heymann[h]

[a]Center for Global and Immigrant Health, Center for Health Policy Research & Department of Health Policy and Management, Fielding School of Public Health, University of California Los Angeles, Los Angeles, CA, USA; [b]Center for Global and Immigrant Health, Center for Health Policy Research, Fielding School of Public Health, University of California Los Angeles, Los Angeles, CA, USA; [c]WORLD Policy Center, Fielding School of Public Health, University of California Los Angeles, Los Angeles, CA, USA; [d]Department of Sociology and Work Science, Gothenburg University, Goteborg, Sweden; [e]Centre for Business Research, Cambridge Judge Business School, University of Cambridge, Cambridge, UK; [f]Department of Epidemiology, Biostatistics and Occupational Health & Institute for Health and Social Policy, McGill University, Quebec, ON, Canada; [g]Centre of Excellence in Human Development, University of the Witwatersrand, Johannesburg, South Africa; [h]WORLD Policy Analysis Center, Fielding School of Public Health, University of California, Los Angeles, CA, USA

ABSTRACT

There is recognition that social protection policies such as raising the minimum wage can favourably impact health, but little evidence links minimum wage increases to child health outcomes. We used multi-year data (2003–2012) on national minimum wages linked to individual-level data from the Demographic and Health Surveys (DHS) from 23 low- and middle-income countries (LMICs) that had least two DHS surveys to establish pre- and post-observation periods. Over a pre- and post-interval ranging from 4 to 8 years, we examined minimum wage growth and four nutritional status outcomes among children under 5 years: stunting, wasting, underweight, and anthropometric failure. Using a differences-in-differences framework with country and time-fixed effects, a 10% increase in minimum wage growth over time was associated with a 0.5 percentage point decline in stunting (−0.054, 95% CI (−0.084, −0.025)), and a 0.3 percentage point decline in failure (−0.031, 95% CI (−0.057,−0.005)). We did not observe statistically significant associations between minimum wage growth and underweight or wasting. We found similar results for the poorest households working in non-agricultural and non-professional jobs, where minimum wage growth may have the most leverage. Modest increases in minimum wage over a 4- to 8-year period might be effective in reducing child undernutrition in LMICs.

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Minimum wage; child; undernutrition; social protection policy; stunting; anthropometric failure

Introduction

Social protection policies such as a minimum wage that aim to raise income for low-wage workers are gaining attention as a lever for improving population health. Even though income is one of the

CONTACT Ninez Ponce nponce@ucla.edu
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strongest social determinants of health (World Health Organization [WHO], 2013), it remains controversial how best to address low income through policy (Osypuk, Joshi, Geronimo, & Acevedo-Garcia, 2014). While there is a body of observational research on the income–nutrition gap and evidence to show that household economic insecurity is associated with household food insecurity (Sahn, 2015), to date, only a few studies have examined the associations between the level of minimum wage and nutritional health outcomes (Conklin et al., 2016; Majid, Mendoza Rodriguez, Harper, Frank, & Nandi, 2016; Meltzer & Chen, 2009). Evidence of minimum wage's effect on nutritional status among children is sparse in low- and middle-income countries (LMICs), where child undernutrition continues to be a major cause of child death and poor development.

Globally, among children under 5 years old, 45% of deaths are linked to undernutrition (Black et al., 2013; UNICEF-WHO-The World Bank, 2014). In 2015, 23% of all children globally were stunted (156 million), 7% were wasted (50 million), and 14% were underweight (95 million) (WHO, 2016). The global trends are steadily improving: child stunting and underweight have declined over the past two decades and reduction in poverty has been attributed as a key driver in these declines (Smith & Haddad, 2000). Income-related policies such as minimum wage could have a significant effect on accelerating improvements in child nutritional status.

Minimum wage as a poverty reduction policy is contested and highly politicised. There is debate about the extent to which employers may cut jobs to avert paying higher wages. For LMICs, a further issue is whether minimum wage policies reach workers in the informal sector, many of whom are poor. In some LMICs, the informal sector is estimated at about two-thirds of employment (non-agricultural) (International Labor Organization [ILO], 2012). Related to the first argument, there is also concern that a rise in the minimum wage in the formal economy would displace workers, pushing them into the informal economy where wages are lower. Disputing this, some research from different LMIC settings finds that minimum wage has essentially no effect on employment (Bell, 1997; Lemos, 2009). There is no consensus, however, because a number of studies do suggest adverse, albeit modest, employment effects of minimum wage in LMICs (Alaniz, Gindling, & Terrell, 2011; Del Carpio, Nguyen, & Wang, 2012; Lemos, 2004). What appears clearer, however, is that overall wages do in fact rise with higher minimums and can have positive spillovers into the informal economy (Gindling & Terrell, 2004; ILO, 2012; Maloney & Nunez Mendez, 2004). Evidence from Latin American countries find a 'lighthouse effect', whereby the minimum wage serves as a benchmark wage for unskilled labour throughout the economy, including the informal sector (Betcherman, 2014).

Building on the evidence of poverty's adverse effect on child health, and minimum wage as a possible means to reduce poverty, we investigate the link between minimum wage and child nutrition. We focus on the per cent change in minimum wage levels for 23 low- to middle-income countries between 2003 and 2012. We use a unique multi-country, multi-year data set of national minimum wage growth linked to data on individual characteristics and nutritional outcomes.

Methods

Conceptual framework

Well-established research demonstrates that household economic insecurity – due to unemployment, low wages, or lack of education – is associated with household food insecurity (Black et al., 2008; Black et al., 2013). We hypothesise that macroeconomic income policies such as minimum wage policies are linked to child nutritional status via promotion of household economic security (Web Supplement/Appendix; Figure 1). Within households, allocation of food resources may be determined by child characteristics, such as child age, gender and birth order, shaped by maternal characteristics, and constrained by household wealth and living conditions (Reinhardt & Fanzo, 2014). Moreover, the wider socio-economic, demographic, political, environmental, cultural, and technological conditions in a country have been shown to be powerful drivers of the root cause of child undernutrition (Smith & Haddad, 2015); these are also highlighted in UNICEF's conceptual framework of the determinants of nutritional status (Benson & Shekar, 2006; Reinhardt & Fanzo, 2014). These contextual forces that differ across countries and over time are distal factors, but may substantially contribute to the change in child undernutrition prevalence over time.

Data sources

Minimum wage data came from Maternal and Child Health Equity (MACHEquity) research program, a global initiative based at McGill University which examines how social policies focused on reducing poverty, income and gender inequality have an impact on the health of women and children; UCLA's WORLD Policy Analysis Center is a partner in the MACHEquity program. To construct the minimum wage policy database, MACHEquity built on the data collected by the International Labour Organization (ILO) Global Wage Database, which contains information on annual minimum wage levels up to 2011. Data gaps were filled by (a) Human Rights Reports published annually by the U.S. Department of State, (b) labour and/or wage legislation collected through ILO's NATLEX database of national labour, social security and related human rights legislation), (c) ILO's TRAVAIL legal database and official ILO memoranda, and (d) official government legislation, databases, and announcements from online, country-specific government websites. When the sources outlined above did not yield minimum wage information, data from business and labour organisations on the minimum wage were used. Other macroeconomic indicators were supplied by the World Bank International Comparison Program database (World Bank).

The Demographic and Health Survey (DHS) was used to obtain individual-level and maternal/household data for children under 5 years. The DHS is a representative cross-sectional survey conducted by ICF International in LMIC at varying intervals since 1985 (Corsi, Neuman, Finlay, & Subramanian, 2012). For the analysis, we included surveys that collected both child height and weight, measured between 1 January 2003, and 31 December 2012. We only included countries for which there were at least two DHS survey rounds between 2003 and 2012. Where there were more than two surveys for a country conducted during the 2003–2012 timeframe, the earliest survey and the latest survey were chosen to minimise the risk of overlapping household samples and to increase the potential to observe change over time.

This study builds on previous studies using global policy data linked to individual outcomes in a quasi-experimental design to deepen our understanding of how social policy may affect health outcomes (Conklin et al., 2016; Hajizadeh, Heymann, Strumpf, Harper, & Nandi, 2015; Nandi et al., 2016; Quamruzzaman, Mendoza Rodriguez, Heymann, Kaufman, & Nandi, 2014).

Sampling

Using the 2003–2012 timeframe, we identified 29 countries where at least two DHS surveys per country with child height and weight were available. Of these countries, three had missing minimum wage-level data for at least 1 year: Congo, Rwanda, and Zimbabwe. An additional two countries did not have a legislated minimum wage for at least 1 year: Egypt (includes a framework but no set level) and Ethiopia. Lastly, one country, Armenia, had missing maternal height data – an important determinant/covariate in our regression model – and was dropped from the full sample. This study sample thus consisted of a sample of 281,268 observations of children in 23 countries: Bangladesh, Benin, Bolivia, Burkina Faso, Cambodia, Cameroon, Colombia, Ghana, Haiti, Honduras, Jordan, Kenya, Lesotho, Malawi, Mali, Mozambique, Nepal, Niger, Nigeria, Peru, Senegal, Tanzania, and Uganda.

Exposure

Our exposure of interest was the per cent change in minimum wage for a country over the 2003–2012 study time frame, where the minimum wage data were observed 1 year before the DHS date of interview (e.g. 2007 minimum wage data paired with DHS data collected in 2008). Monthly minimum wage levels were converted to hourly rates following country-specific formulae established by the ILO where available. To provide cross-country and longitudinal minimum wage comparisons, purchasing power parity (PPP) conversion factors and inflation-adjusters (standardised to 2011 year) from the World Bank were merged with the minimum wage database and utilised to create a real PPP-adjusted hourly wage measure. Minimum wage change between the two time periods within the 2003–2012 time frame was estimated for each country in the study as the per cent change in minimum wage.

Outcomes

We selected four anthropometric indicators of undernutrition as outcomes: (1) stunting, (2) underweight, (3) wasting, and (4) a composite index of anthropometric failure (CIAF). Anthropometry, as a measure of a set of health outcomes, represents objective measures of health and nutritional status. Three Z scores were calculated: HAZ = height-for-age Z-score; WAZ = weight-for-age Z-score; WHZ = weight-for-height Z-score. WHO (2006) defines undernutrition as follows: stunting: HAZ < – 2SD (standard deviation); underweight: WAZ < – 2SD; Wasting: WHZ < – 2SD. As per WHO guidelines, values outside the plausible values were excluded (HAZ below –6 or above +6, WAZ below –6 or above + 5, WHZ below –5 or above +5). We include the CIAF (Nandy, Irving, Gordon, Subramanian, & Smith, 2005) because separately, indicators of stunting, wasting, and underweight do not offer a comprehensive estimate of the number of undernourished children in a population. For example, children who are stunted may also be wasted and/or underweight (Nandy et al., 2005). Our measure dichotomises the CIAF ('failure') equal to 1 if children are stunted or underweight or wasted, and their combination, and 0 otherwise.

The impact of an increase in the minimum wage on each of these anthropometric measures may vary. Stunting, which is indicative of long-term nutritional status of children has been associated with longer term factors affecting food accessibility, such as food prices and wages (Benson & Shekar, 2006; Christian, 2010). On the other hand, wasting, which captures acute child undernutrition, and underweight, a general indicator of both acute and to some extent chronic undernutrition as well as acute illness, are well-suited to capture factors affecting food accessibility over the short term (Benson & Shekar, 2006). The CIAF has been used to examine the synergistic impact on population health and mortality of different combinations of stunting, wasting, and underweight. At the population health level, stunting and 'failure' are likely to be the most sensitive to long-term macro-level social determinants (Nandy et al., 2005).

Covariates

We draw on our conceptual framework (see Web Supplement/Appendix; Figure 1) and several past empirical studies on child nutrition to select covariates at the child, parent, and household level (Alderman, Haddad, Headey, & Smith, 2014; Ponce, Gertler, & Glewwe, 1998; Subramanyam, Kawachi, Berkman, Subramanian, & Byass, 2011; Vollmer et al., 2014). At the child level, covariates included: child age in years, gender, an interaction term of child age and gender, and birth order. Maternal/household variables included: number of children under age 5, mother's education, age at delivery (squared to account for higher risks at the extreme ends of the age spectrum), relationship status, and whether the household was situated in an urban or rural setting. We also used the DHS household wealth index (Rutstein & Johnson, 2004) – created by and used as a standard by the DHS and UNICEF Multiple Indicator Cluster Surveys, to capture the within-country relative wealth standing of each household.

To minimise confounding of country-level indicators that may affect child nutritional status, we included relevant macroeconomic indicators. Health expenditures in the public sector commonly include investments in maternal and child health services to promote children's health (Bhutta et al., 2013). Country decision-makers who choose to enhance the healthcare safety net may also be open to legislating income support programmes such as raising the minimum wage; alternatively, they may see a trade-off between investing in wage policy and health care. Thus, if these health sector investments are unmeasured, then our estimated effect of minimum wage growth on child nutritional status may be biased. For health expenditures, we used logged values to address its skewed distribution. We also considered country-level income as measured gross domestic product (GDP) because it both bounds minimum wage levels, and is strongly linked to child nutritional status (Smith & Haddad, 2015) and health expenditures in the public sector. As GDP affects both the setting of minimum wage levels and the health of children, excluding GDP could result in omitted variable bias. To account for variations by country in formal/salaried employment, country-level data from the ILO on the per cent of workers who obtain wage and salary were used as a control variable in the regression model.

In addition to macroeconomic indicators, the wider demographic, political, environmental, cultural, and technological context may contribute to the root cause of child undernutrition (Smith & Haddad, 2015). These wider determinants may all impact child undernutrition outcomes and impact the propensity of governments to adopt and implement changes in policies, such as raising the minimum wage. As with the macroeconomic indicators, we considered a set of country-level covariates to account for important confounders of minimum wage growth's effect on child undernutrition. Fertility and urbanisation are two important demographic phenomena that may impact child undernutrition in LMICs and female labour market participation. The fertility rate, measured as the number of children born per 1000 women, is associated with prevalence rates of child undernutrition; especially in poorer countries, lower birth rates and longer birth spacing may increase the nutrition-specific resources for each child (Gribble, Murray, & Menotti, 2009). Urbanisation, measured as the per cent of the population living in urban areas, could positively or negatively impact child nutritional status. Cities may provide increased economic opportunities for parents, and greater access to health services, but may also raise the risk of child infectious diseases due to poor housing, poor sanitation, and increased exposure to pollution (Katz, 2013). The health environment conditions the exposure to pathogens that compromise child nutritional status. We include a measure of access to safe water as an environmental indicator that affects child health. Our models also include measures of communications infrastructure – mobile subscribers and internet users that signal the level of digital technology in a country. This technology may manifest in both increased access and connections to health information and healthcare systems, which could promote child health, as well as an indicator of amplified labour market opportunities for parents. We obtained complete data for country and matching DHS year from World Bank (World Development Indicators) for: fertility rate, urbanisation, per cent of the population with access to safe water, mobile subscribers per 100 people, and internet users per 100 people.

Statistical analysis

We estimated the effect of minimum wage growth for each anthropometric outcome – stunting, wasting, underweight, and the composite indicator of nutritional failure. We employed a two-way fixed-effects model also referred to as generalised difference-in-differences (DID) (Angrist & Pischke, 2008; Bertrand, Duflo, & Mullainathan, 2004; Hansen, 2007; Wooldridge, 2010).

$$Y_{\mathrm{ict}} = (\mathrm{Post} \times \mathrm{Treat_c})\beta_1 + X_{\mathrm{ict}}\beta_2 + X_{\mathrm{ct}}\beta_3 + \theta_{\mathrm{c}} + \lambda_{\mathrm{t}} + \varepsilon_{\mathrm{ict}},$$

where Y is the anthropometric outcome, Post = 1 if last year of observation and 0 if first year of observation, Treat is the minimum wage growth for each country, X_{ict} is a set of child, parent/household covariates that vary by country and survey year, X_{ct} corresponds to a set of country covariates that vary by survey year, θ is the country-fixed effect; λ is the time- (survey year) fixed effect and ε is the random error term. The (Post × Treat) interaction estimates whether higher minimum wage growth in countries is associated with a stronger decline in child undernutrition over the study period; this is given by the coefficient $\beta_{1,}$ the DID parameter. We estimated linear probability models to facilitate interpretation of β_1, with robust standard errors to address heteroscedasticity.

The regressions control for a set of child (age, gender, birth order) and household/maternal covariates (education, maternal age-squared, marital status, wealth quintile, rural, maternal height, number of children in household under 5 years of age), and a set of country-year covariates (log of GDP per capita, log of real per capita health expenditures, per cent of population who are wage and salary workers, fertility rate, urban population, access to safe water source, internet and mobile phone penetration in a country).

As minimum wage growth may have the most leverage on the poorest households of low-wage working parents, we also estimated models subsetted to a sample of children in the poorest wealth quintile, with the mother or mother's partner working in the non-agricultural sector or in non-professional/technical/managerial jobs. For all analyses, associations with a p-value less than 0.05 were regarded as statistically significant. All statistical analyses were done with Stata 14.

Results

In the full sample of children in this study, 35% were stunted, 17% underweight, 8% wasted, and 41% in failure. The mean age of children in the sample was about 2 years, and 27 years for mothers. On average, there were 2 children under 5 years of age living in the households in the sample. Over 42% of children in the study were considered poor based on the wealth quintile; 22% were in the poorest quintile (Table 1).

Minimum wage ranged from 0.06 PPP (Uganda) to 2.71 PPP (Jordan) in 2003–2007 and 0.04 PPP (Uganda) to 3.16 PPP (Honduras) in 2008–2012 (see Web Supplement File/Appendix Table 1 for all countries). Some countries exhibited a decline in minimum wage over this time period – for example, a 40% decline in Nigeria – and others exhibited an increase – for example a 140% increase in Honduras. On average, minimum wage growth was 12.3% over a 5.6-year interval (Table 1 and Web Supplement File/Appendix: Table 1).

Table 2 presents the full sample estimates. The interaction term between 'post' and minimum wage change offers the estimate of minimum wage change over time on the outcome of interest. Controlling for all other covariates, for this sample of countries minimum wage growth over time was associated with decreased stunting (−0.054, 95% CI (−0.084,−0.025)), and failure (−0.031, 95% CI (−0.057,−0.005)). Minimum wage growth's associations with underweight (−0. 026, 95% CI (−0.040, 0.034)) and wasting (0.025, 95% CI (−0.016, 0.066)) were not statistically significant (Table 2). Among the country-year level variables, per capita real health expenditures in the public sector, fertility rate, mobile users, and per cent of urban population were all associated with stunting and failure; the per cent share of wage and salary workers was associated with failure and wasting, but not the other outcomes. At the maternal and household level, we detected associations between maternal age, height, and number of children under 5 years living in the home, mother's education and household wealth with stunting and failure. Compared to children in urban areas, children in rural households had a higher probability of stunting and failure, as did boys versus girls, and younger versus older children. Table 3 presents the estimates for the sample of children in the poorest wealth quintile, with the mother or mother's partner working in the non-agricultural sector or in non-professional/technical/managerial jobs.

We performed a series of alternative modelling and specification approaches, including a multilevel random-effects model, and varying inclusion and exclusion of covariates. Across specifications, we consistently found that with increases in minimum wage growth, there were significant associations with stunting and anthropometric failure.

Table 1. Characteristics of the study sample, 2003–2012, $N = 281,268$.

	Mean	Std. dev
Dependent variables		
Stunting (%)	34.66	47.59
Underweight (%)	17.39	37.90
Wasting (%)	7.97	27.08
Failure (%)	40.97	49.18
Independent variables		
Country variables		
Minimum wage growth (%)	12.32	43.55
Log real per capita health expenditures, public sector (PPP[a])	4.20	1.07
Log per capita real GDP (PPP[a])	7.89	0.82
% wage and salary workers	29.20	18.53
Fertility rate	4.49	1.60
% Urban population	42.43	20.44
% Population with access to water	72.40	14.33
Internet users per 100 people	9.02	11.13
Mobile phone users per 100 people	40.80	34.36
Child/parent/household variables		
Child age (yrs)	1.95	1.41
Girl (%)	49.49	50.00
Birth order (no.)	3.41	2.36
Mother's education (%)		
Unknown, none, incomplete	59.00	49.18
Completed primary	28.11	44.95
Completed secondary	7.38	26.14
Higher than secondary	5.51	22.82
Maternal age (yrs)	26.73	6.77
Marital status (%)		
Never married	3.44	18.22
Currently married	90.35	29.52
Formerly married	6.20	24.13
Wealth quintile (%)		
Poorest	25.30	43.47
Poorer	22.50	41.76
Middle	20.37	40.28
Richer	17.50	38.00
Richest	14.32	35.03
Rural (%)	64.79	47.76
Maternal height (cm)	156.45	7.16
Number of children living in household aged under 5 yrs	2.01	1.16
Survey interval (time between DHS surveys)	5.62	0.99

Data sources: Maternal and Child Health Equity (MACHEquity)/UCLA World Policy Analysis Center, DHS, and ILO data sets.
Note: minimum wage data from year prior to DHS interview year included here; for 2003 DHS interview year, 2002 minimum wage data are used.
[a]PPP = purchasing power parity.

Limitations

A major limitation of our study is omitted variable bias. That is, that the associations we are reporting on – minimum wage growth's association with child nutritional status outcomes – may be attributed to a different and unmeasured factor that is associated with both minimum wage growth and child nutritional status. However, we have specified a comprehensive set of covariates at the child, household and country level. Our country-fixed effects specification with robust standard errors further minimises the unobserved heterogeneity that may bias our measurement of minimum wage growth's effect on child stunting, underweight, wasting, and anthropometric failure. Also, causal interpretation of estimates from the DID approach assumes parallel trends, which we could not evaluate in this case with only two survey time periods per country (Angrist & Pischke, 2008).

In an LMIC setting, the informal economy could comprise greater than half of the non-agricultural sector (International Labour Organization (ILO), 2013) such that a minimum wage policy for the formal sector may have little effect on a sizeable population of the working poor. We attempted

Table 2. Association of minimum wage change on child nutritional status, children under 5 years of age, 23 countries, fixed-effects models with robust standard errors ($n = 281{,}268$; full sample).

Variable	Stunting	Underweight	Wasting	Failure
Post*Min wage change (DID estimator)	−0.0543***	−0.00258	0.0248	−0.0307*
	[−0.0839,−0.0247]	[−0.0396,0.0344]	[−0.0161,0.0657]	[−0.0566,−0.00483]
Country characteristics				
Log per capita GDP (PPP[a])	0.0200	−0.120	−0.00119	0.0232
	[−0.0700,0.110]	[−0.254,0.0138]	[−0.144,0.142]	[−0.0958,0.142]
Log per capita health expenditures, public (PPP[a])	−0.126***	−0.0234	−0.0127	−0.129***
	[−0.172,−0.0799]	[−0.0656,0.0189]	[−0.0576,0.0322]	[−0.175,−0.0816]
% share of wage and salary workers	0.00192	0.00330	0.00472*	0.00579**
	[−0.00154,0.00537]	[−0.00173,0.00833]	[0.000289,0.00916]	[0.00224,0.00934]
Fertility	0.1313***	0.119*	0.1381**	0.233***
	[0.0693,0.193]	[0.0222,0.216]	[0.0457,0.231]	[0.156,0.310]
% Urban population	0.0136***	−0.00141	−0.0000968	0.0143***
	[0.00646,0.0208]	[−0.00718,0.00436]	[−0.00512,0.00492]	[0.00678,0.0219]
Water access	−0.00104	−0.00104	−0.00217	−0.00270
	[−0.00316,0.00108]	[−0.00364,0.00155]	[−0.00511,0.000770]	[−0.00548,0.0000851]
Internet	0.00123	−0.000147	−0.000711	0.000471
	[−0.000742,0.00321]	[−0.00232,0.00203]	[−0.00249,0.00107]	[−0.00115,0.00209]
Mobile	0.00112***	0.000899***	0.000420	0.00140***
	[0.000690,0.00155]	[0.000464,0.00133]	[−0.000226,0.00107]	[0.000911,0.00189]
Maternal/household characteristics				
Maternal age-squared	−0.0000669***	−0.0000248**	−0.00000268	−0.0000651***
	[−0.0000763,−0.0000575]	[−0.0000407,−0.00000886]	[−0.0000122,0.00000686]	[−0.0000762,−0.0000539]
Maternal height	−0.0120***	−0.00572***	−0.000188	−0.0115***
	[−0.0146,−0.00944]	[−0.00701,−0.00444]	[−0.000478,0.000102]	[−0.0141,−0.00894]
Mother's education (referent: none, incomplete primary, unknown)				
Completed primary	−0.0574***	−0.0446***	−0.0201**	−0.0673***
	[−0.0735,−0.0412]	[−0.0657,−0.0235]	[−0.0339,−0.006128]	[−0.0873,−0.0472]
Completed secondary	−0.0946***	−0.0423*	−0.0211*	−0.108***
	[−0.115,−0.0737]	[−0.0753,−0.00934]	[−0.0403,−0.00194]	[−0.135,−0.0808]
Higher than secondary	−0.0829***	−0.0318	−0.0186	−0.0970***
	[−0.114,−0.0516]	[−0.0710,0.00747]	[−0.0377,0.000490]	[−0.136,−0.0584]
Mother's marital status (referent: never married)				
currently married	−0.0175*	−0.0104	0.00267	−0.0151
	[−0.0310,0.00400]	[−0.0210,0.0000835]	[−0.00285,0.00818]	[−0.0310,0.000907]
Formerly married	−0.0130	−0.00811	0.00193	−0.0132
	[−0.0314,0.00529]	[−0.0200,0.00382]	[−0.00564,0.00951]	[−0.0343,0.00788]
Number of children under age 5 years living in household	0.00998**	0.00726***	0.00210**	0.0113***
	[0.00431,0.0156]	[0.00431,0.0102]	[0.000651,0.00356]	[0.00564,0.0170]
Wealth quintile (referent: poorest)				
poorer	−0.0420***	−0.0278***	−0.00683*	−0.0445***
	[−0.0562,−0.0278]	[−0.0352,−0.0204]	[−0.0127,−0.000955]	[−0.0583,−0.0308]

middle	−0.0667***	−0.0466***	−0.0126**	−0.0730***
	[−0.0896,−0.0439]	[−0.0576,−0.0356]	[−0.0217,−0.00347]	[−0.0957,−0.0502]
richer	−0.105***	−0.0685***	−0.0153**	−0.111***
	[−0.129,−0.0805]	[−0.0845,−0.0525]	[−0.0250,−0.00562]	[−0.135,−0.0862]
richest	−0.158***	−0.110***	−0.0281***	−0.169***
	[−0.180,−0.136]	[−0.127,−0.0931]	[−0.0382,−0.0180]	[−0.188,−0.151]
Rural (referent: not rural)	0.0238***	0.00174	−0.00152	0.0216**
	[0.0109,0.0367]	[−0.00843,0.0119]	[−0.00676,0.00372]	[0.00825,0.0349]
Child characteristics				
Child age (years)	0.0304***	0.000556	−0.0189***	0.0132***
	[0.0215,0.0393]	[−0.00495,0.00606]	[−0.0264,−0.0113]	[0.00673,0.0197]
Girl	−0.0731***	−0.0472***	−0.0172***	−0.0769***
	[−0.0802,−0.0661]	[−0.0579,−0.0366]	[−0.0230,−0.0113]	[−0.0855,−0.0684]
Girl × child Age	0.0160***	0.0150***	0.00371***	0.0188***
	[0.0138,0.0183]	[0.0121,0.0178]	[0.00195,0.00547]	[0.0157,0.0219]
Birth order	0.0126***	0.00547***	0.000671	0.0127***
	[0.00941,0.0158]	[0.00355,0.00738]	[−0.000896,0.00224]	[0.00954,0.0158]
Constant	1.486**	1.648***	−0.384	1.001
	[0.409,2.562]	[0.965,2.332]	[−1.088,0.319]	[−0.201,2.203]

Notes: 95% confidence intervals in brackets. All models include survey year indicators.
*$p < .05$; **$p < .01$; ***$p < .001$.
[a]PPP = purchasing power parity.

Table 3. Association of minimum wage change on child nutritional status, children under 5 years of age, 23 countries, fixed-effects models with robust standard errors (*n* = 20,831; poorest quintile, mother or mother's partner employed, in non-agricultural job, in non-professional/technical/managerial job).

Variable	Stunting	Underweight	Wasting	Failure
Post*Min wage change (DID estimator)	−0.101**	−0.0512	0.0324	−0.0697*
	[−0.157,−0.0447]	[−0.140,0.0375]	[−0.00854,0.0734]	[−0.138,−0.00127]
Country characteristics				
Log per capita GDP (PPP[a])	−0.279*	−0.276	−0.0840	−0.241
	[−0.502,−0.0563]	[−0.627,0.0760]	[−0.256,0.0878]	[−0.521,0.0399]
Log per capita health expenditures, public (PPP[a])	−0.0206	0.109	0.0528	0.0164
	[−0.0888,0.0476]	[−0.0403,0.259]	[−0.0177,0.123]	[−0.0806,0.113]
% share of wage and salary workers	0.00340	−0.00127	0.000440	0.00155
	[−0.00263,0.00942]	[−0.00946,0.00693]	[−0.00522,0.00610]	[−0.00779,0.0109]
Fertility	0.245***	0.246**	0.229***	0.376***
	[0.132,0.359]	[0.0663,0.425]	[0.129,0.328]	[0.226,0.526]
% Urban population	0.0147***	−0.00797	−0.00421	0.00887
	[0.00778,0.0216]	[−0.0193,0.00332]	[−0.0110,0.00257]	[−0.000716,0.0185]
Water access	0.00273	0.000586	0.00235	0.00166
	[−0.000935,0.00640]	[−0.00706,0.00823]	[−0.00325,0.00795]	[−0.00377,0.00709]
Internet	0.00183	−0.00177	−0.000546	0.000126
	[−0.000736,0.00439]	[−0.00615,0.00261]	[−0.00303,0.00193]	[−0.00390,0.00415]
Mobile	0.00123***	−0.000549	−0.000279	0.000670
	[0.000779,0.00169]	[−0.00217,0.00107]	[−0.00120,0.000641]	[−0.000187,0.00153]
Maternal/household characteristics				
Maternal age-squared	−0.0000752***	−0.0000382**	0.00000619	−0.0000718***
	[−0.000101,−0.0000493]	[−0.0000618,−0.0000145]	[−0.0000215,0.0000338]	[−0.0000983,−0.0000454]
Maternal height	−0.0132***	−0.00670***	−0.0000840	−0.0124***
	[−0.0167,−0.00972]	[−0.00929,−0.00412]	[−0.000858,0.000690]	[−0.0158,−0.00903]
Mother's education (referent: none, incomplete primary, unknown)				
Completed primary	−0.0523***	−0.0429***	−0.0161**	−0.0627***
	[−0.0793,−0.0252]	[−0.0623,−0.0235]	[−0.0274,−0.00486]	[−0.0912,−0.0341]
Completed secondary	−0.0950***	−0.0359**	−0.0187*	−0.104***
	[−0.127,−0.0630]	[−0.0560,−0.0158]	[−0.0344,−0.00288]	[−0.138,−0.0699]
Higher than secondary	−0.108**	−0.0594***	−0.0236*	−0.116***
	[−0.171,−0.0444]	[−0.0809,−0.0378]	[−0.0410,−0.00625]	[−0.177,−0.0559]
Mother's marital status (referent: never married)				
Currently married	−0.0151	−0.00264	0.00613	−0.0169
	[−0.0416,0.0113]	[−0.0267,0.0214]	[−0.0109,0.0232]	[−0.0479,0.0142]
Formerly married	−0.0361	−0.0197	−0.00471	−0.0460
	[−0.0802,0.00803]	[−0.0538,0.0143]	[−0.0214,0.0120]	[−0.0935,0.00144]
Number of children under age 5 years living in household	0.0147*	0.00281	−0.00196	0.0125
	[0.000726,0.0286]	[−0.00408,0.00969]	[−0.00547,0.00155]	[−0.00148,0.0265]
Rural (referent: not rural)	−0.000754	−0.00287	−0.00137	0.00215
	[−0.0168,0.0153]	[−0.0167,0.0110]	[−0.0124,0.00964]	[−0.0125,0.0168]

Child characteristics				
Child age (years)	0.0370**	0.00181	−0.0159**	0.0199**
	[0.0158,0.0583]	[−0.00846,0.0121]	[−0.0265,−0.00528]	[0.00648,0.0333]
Girl	−0.0535***	−0.0517***	−0.0181	−0.0576***
	[−0.0703,−0.0368]	[−0.0723,−0.0312]	[−0.0364,0.000262]	[−0.0785,−0.0367]
Girl × child age	0.00895*	0.0171**	0.00284	0.0131*
	[0.00110,0.0168]	[0.00617,0.0280]	[−0.00396,0.00964]	[0.00125,0.0249]
Birth order	0.0157***	0.00937***	−0.000364	0.0160***
	[0.0106,0.0207]	[0.00433,0.0144]	[−0.00498,0.00425]	[0.0103,0.0217]
Constant	2.704***	2.505**	−0.237	2.162**
	[1.819,3.588]	[0.990,4.019]	[−1.301,0.828]	[0.892,3.432]

Notes: 95% confidence intervals in brackets. All models include survey year indicators.
*$p < .05$; **$p < .01$; ***$p < .001$.
[a]PPP = purchasing power parity.

to identify the low-wage workers sector as the poorest parents working in the non-agricultural sector and who do not hold professional/technical/managerial jobs. While this identification also characterises workers in the informal sector, it is still an imprecise measure in determining whether and to what extent there are spillover effects of policies that raise the minimum wage on the informal sector. Thus, a direct test of this spillover effect was not possible in this study.

We were not able to collect information on other potentially important variables, such as how well the minimum wage policy is enforced nationally or whether there are variations within regions in a country. Our scope of identification of root causes of child undernutrition was, of course, limited by available data. For example, climate changes and civil conflict may have threatened food security in some countries in our sample during the study observation period, but we were not able to identify a country-year measure applicable for all of the countries in our sample. However, volatility in climate and conflict may be reflected in our set of country covariates measuring economic and infrastructure stability. Country-level cultural variation, such as the level of women's empowerment, was also not measured, but partially accounted for in the fixed-effects specification, which purges the model from unobserved time-invariant heterogeneity at the country level. Lastly, our 23 countries are only a subset of all LMIC countries. This group may not be a representative sample of all LMICs but do represent a mix of countries in Asia, Africa, and Latin America, and includes countries where high child undernutrition rates wield a public health burden.

Discussion

This quasi-experimental study that examines multi-year data offers new evidence on how social protection policies such as minimum wage legislation could favourably contribute to reducing child undernutrition in LMICs. We found statistically significant decreases in the probability of stunting and failure in minimum wage over an average of about five and a half years. A 10% increase in minimum wage growth over time is predicted to be associated with a 0.5 percentage point decline in stunting and failure; at a mean stunting prevalence of 35% globally, this translates into a 1.4% decline in stunting prevalence. And with larger increases, such as a 20% rise in minimum wage growth, we expect a 1 percentage point decline in stunting and failure. While these average marginal associations are modest, a 1 percentage point decline in stunting from a worldwide population estimate of 156 million stunted children under age 5, could have tangible global public health impact.

Our findings for underweight and wasting were not statistically significant. This may be due to the sample size limitations. Wasting has a considerably lower prevalence in the population (about 8%) compared to the other outcomes, and thus models may be underpowered to detect change in probability with increasing wage. It may also be due to the greater effect of acute illness on these outcomes.

Some argue that even if minimum wage accrues national benefits to social well-being, the impact of minimum wage is not meaningful for the poor, many of whom work in the informal economy where wage regulation does not directly apply (Lustig & McLeod, 1997). However, other studies have demonstrated that the shadow minimum wage in the informal economy rises when the minimum wage in the formal economy is increased (Boeri, Garibaldi, & Ribeiro, 2011). Our data cannot precisely identify workers in the informal economy. Our study does, however, suggest that the reach of an increase in minimum wage extends to children in each country's poorest households where mothers or their partners work in non-agricultural and non-professional/technical/managerial jobs. Compared to the full sample, we observed significant declines in stunting and failure for this subsample. In particular, for stunting, the association between minimum wage growth and outcomes was about twice the association detected in the full sample, providing some evidence that raising minimum wage may help narrow child undernutrition inequities by wealth and occupation in LMICs. Our results contribute to the growing evidence that structural and social determinants account for a major part of child social well-being and health inequities (WHO, 2013). Over a 4- to 8-year period, a modest increase in minimum wage growth by 10% reduced child undernutrition in LMICs. On a population scale, policies that raise minimum wage could have considerable health impact in low-resource settings, especially for children of the poorest wage earners in those settings.

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NP, Corresponding Author, affirms that the manuscript is an honest, accurate, and transparent account of the study being reported. No important aspects of the study have been omitted; there are no discrepancies from the study as planned.

The UCLA Office of Human Research Protection Program (UCLA OHRPP) determined this study, which uses secondary data analysis, did not meet the definition of human subjects research, defined by federal regulations for human subject protections (45 CFR 46.102(d) - http://www.hhs.gov/ohrp/humansubjects/guidance/45cfr46.html#46.102). Therefore, neither certification of exemption from IRB review nor IRB approval of the study was required.

Disclosure statement

No potential conflict of interest was reported by the authors.

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ORCID

Ninez Ponce http://orcid.org/0000-0001-5151-6718
Riti Shimkhada http://orcid.org/0000-0002-5177-4853

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