Iran J Public Health, Vol. 49, No.9, Sep 2020, pp.1709-1717

Original Article

The Power of Multidimensional Poverty in Explaining Life Expectancy: Empirical Evidence from Cross-Sectional Data of 62 Developing Countries

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(Received 09 Feb 2019; accepted 25 May 2019)

Abstract

Background: We examined whether multidimensional poverty index (MPI) explained variations in life expectancy (LE) better than income poverty; and assessed the relative importance of MPI indicators in influencing LE.

Methods: Cross-sectional data from 62 developing countries were used to run several multivariate linear regressions. R^2 was used to compare the powers of MPI with income-poverties (income poverty gaps [IPG] at 1.9 and 3.1 USD) in explaining LE.

Results: Adjusting for controls, both MPI (β =-0.245, *P*<0.001) and IPG at 3.1 USD (β=-0.135, *P*=0.044) significantly correlates with LE, but not IPG at 1.9 USD (β=-0.147, *P*=0.135). MPI explains 12.1% of the variation in LE compared to only 3.2% explained by IPG at 3.1 USD. The effect of MPI on LE is higher on female (β=-0.210, *P*<0.001) than male (β=-0.177, *P*<0.001). The relative influence of the deprivation indictors on LE ranks as follows (most to least): Asset ownership, drinking water, cooking fuel, flooring, child school attendance, years of schooling, nutrition, mortality, improved sanitation, and electricity.

Conclusion: Interventions to reduce poverty and improve LE should be guided by MPI, not income poverty indices. Such policies should be female-oriented and prioritized based on the relative influence of the various poverty deprivation indicators on LE.

Keywords: Multidimensional poverty; Life expectancy; Inequality; Income; Developing countries

Introduction

Socioeconomic variables are key determinants of health (1). Increased income improves individuals' access to healthier food and drinks, healthier living environments, and healthcare. Therefore, increased income is associated with better health status and longer life expectancy (LE) (2–5). However, at an aggregate level, the effects of increased income on health depend on how equal income is distributed (2).

The effect of income inequality on health has been very controversial, which argued that income inequality undermines LE (6). However, evidence shows negative effects of inequality on health. In a comprehensive and highly cited 2006 review of 168 analyses, more than 70% of these analyses linked inequality to negative health outcomes (7). This conclusion was reinforced in another review paper (8).

Besides income and inequality, poverty is a key socioeconomic determinant of health and longevity (1, 2, 6, 9). The WHO named poverty as "the world's biggest killer and the greatest cause of ill-health (10)." At a country level, the effects of increased income on health depends on the extent to which this increase translates to lower levels of poverty (2). When an increase in a country's income is associated with an increase in poverty, the correlations between income and health indicators life expectancy and mortality become insignificant (2).

Although cross-country research has provided strong evidence of the negative effects of poverty on LE (2, 6), such research has relied on the concept of "income poverty," a narrow measurement that does not consider other aspects of poverty and therefore might underestimate the magnitude of its effect. Moreover, this research suggests eradicating poverty as a method to improve health, without defining the aspects of poverty to target first. A more comprehensive measure of poverty that considers multiple aspects could avoid this limitation.

A shift from single-dimensional to multidimensional indicators of poverty has gained momentum recently (11–13). The Oxford Poverty and Human Development Initiative introduced the Multidimensional Poverty Index (MPI), which comprises ten indicators of household deprivation. These ten indicators assess whether households are deprived in terms of: (a) years of schooling, (b) child school attendance, (c) nutrition, (d) electricity, (e) improved sanitation, (f) drinking water, (g) flooring, (h) cooking fuel, (i) mortality, and (j) asset ownership. These deprivation indicators were used to construct the MPI for more than 100 developing countries; details on how MPI is constructed can be found elsewhere (13).

Evidently, MPI is a more plausible proxy of poverty than conventional measures of income poverty. Therefore, the question arises, does MPI better explain variations in life expectancy than income poverty? And what relative importance do the deprivation indicators of MPI have in explaining LE? Moreover, though the MPI is constructed at the household level, when considering individuals, gender differences in multidimensional poverty have been documented (14). This raises another question: Does the magnitude of the effect of MPI on LE vary between genders? This study answers these three questions using data from 62 developing countries.

Materials and Methods

The outcome variable in this study was life expectancy at birth, and the main independent variables of interest were multidimensional poverty and income poverty. Two main control variables were proposed based on the literature: income and income inequality.

Some research suggests health expenditure as a predictor of life expectancy. However, income and volume of health spending are highly correlated, and most studies have used income, not health spending (4–6, 15), because controlling for income captures the effects of health spending but the flip-side does not necessarily do so.

We used Alkire and Robles' MPI (2017) as a proxy for multidimensional poverty (13). We tried to establish a time-variant dataset using the few available versions of MPI. However, the data was not harmonized for time comparison, as explained by the source itself. Moreover, in the most updated release of the MPI, time-variant data were available for only 34 countries, and some of these countries should be eliminated from the analyses, as will be explained in the next section, resulting in insufficient number of observations. Therefore, we used the latest available dataset of MPI released in 2017.

Income poverty gaps at 3.1 and 1.9 USD a day (percentage, at 2011 purchasing power poverty), as defined by the World Bank (16), were used as proxies of income poverty. Countries' levels of income were measured by their Gross Domestic Product (GDP), adjusted for purchasing power

parity (2011 international USD). We used the Gini coefficient as a proxy for income inequality.
Data on life expectancy, income poverty, GDP, and income inequality were taken from the World Development Indicators of the World Bank (16). Data on the MPI and its contributing indicators were taken from the database of the Oxford Poverty and Human Development Initiative (13).
Since our observations vary across time from 2006 to 2015, we proposed a time dummy (1 = 2013–2015 and 0 = 2012–2006). However, statistical tests revealed no significant changes in LE over time in the sample. Therefore, this dummy was later dropped from the multivariate regressions.
To control for regional differences in LE, we proposed a dummy variable for Sub-Saharan African countries (SSA), as has previous research (17). However, this dummy was later dropped from the multivariate regressions, as it highly correlates with other independent variables.

Sample selection

Alkire and Robles' 2017 dataset on multidimensional poverty (13) includes data on 103 developing countries, the starting point for our sample selection. Of these 103 countries, 41 were excluded for the following reasons: (i) incomplete indicators of multidimensional poverty (16 countries), (ii) un-availability of data on GDP, income poverty, or inequality (24 countries), and (iii) extremely high per capita GDP (outlier, Kazakhstan). The other 62 countries were included in the analyses; i.e. Albania, Armenia, Benin, Bhutan, Bolivia, Burkina Faso, Cambodia, Cameroon, Central African Republic, Chad, Colombia, Congo, Democratic Republic of the Congo, Republic of the Cote d'Ivoire, Djibouti, Ecuador, El Salvador, Ethiopia, Guatemala, Guinea, Guinea-Bissau, Haiti, India, Kyrgyzstan, Lao People's Democratic Republic, Lesotho, Madagascar, Malawi, Maldives, Republic of Mali, Mauritania, Mexico, Moldova, Republic of Mongolia, Montenegro, Morocco, Mozambique, Namibia, Nepal, Nicaragua, Niger, Nigeria, Pakistan, Peru, Rwanda, Sao Tome and Principe, Senegal, Serbia, South Africa, South Sudan, Sudan, Swaziland, Tajikistan, Tanzania, Thailand, Togo, Tunisia, Uganda, Uzbekistan, Vanuatu, Zambia, and Zimbabwe.
All variables were measured at yearly bases. As in their original source, the time points of the MPI vary across countries. We thus tried to match the time points for the other variables with the MPI. For LE and GDP, we matched exact years, but data on the Gini coefficient and income poverty were not available for some countries in the exact year of the MPI. In those cases, we used the closest available observation within a maximum of five years.

Statistical analyses

Bivariate Pearson correlations across all variables were computed in the first stage. Next, life expectancy was regressed against the independent variables in multivariate OLS regressions, with 5% set as a significance criterion. Statistical analyses were performed using SPSS 20 (Chicago, IL, USA).
Regarding the selection of the regression technique, we first planned to use fixed effect panel data analysis to control for possible heterogeneity across the studied countries. However, the nature of the available data did not allow this type of analysis, since only one time-point was available for each country. Since testing for cross-country heterogeneity was not possible, alternatively, we tested for regional heterogeneity by introducing a dummy variable representing Sub-Saharan African countries. However, the analysis revealed no evidence for such heterogeneity.
We also considered squared and logarithmic functional forms for the regressions models, as suggested in some previous research (17). However, we found that the data best fit the linear forms. Therefore, the final selection of the regression models were linear OLS regressions.
We proposed four models to compare the power of multidimensional poverty and income poverty in explaining LE. The first model (the base model) included only control variables in the multivariate regression. The second, third, and fourth models each included one poverty variable, namely multidimensional poverty, income pov-

erty at 3.1 USD, and income poverty at 1.9 USD, respectively.

To determine which poverty measure better explains life expectancy, we observed the improvement in the coefficient of determination (R^2) that resulted from including the respective poverty variables in the second, third, and fourth models as compared to the base model.

Two additional multivariate regressions were constructed to test if the effect of multidimensional poverty on life expectancy varies between genders. The regressions models are as follows:

As mentioned above, the MPI is constructed using ten indicators of deprivation. The percentage contribution of these indicators to the MPI sums to 100%. Therefore, we could not include all indicators in one regression, as this would result in a singular matrix, so we omitted one indicator (Access to Electricity) and regressed the other nine indicators along with control variables against life expectancy (dependent variable). For this type of multivariate regression, the coefficients of the nine indicators of the MPI are interpreted relative to the omitted indicator (as they all sum to a fixed number). This technique allows assessment of the relative importance of the ten indicators of MPI in influencing LE.

Results

Table 1 presents the variables used in this study, along with their measurements and descriptive statistics. The upper part of the table presents the main study variables, while the lower part illustrates the contributions of the ten indicators of deprivation to MPI.

Table 1: Descriptive statistics of the studied variables

Variable	*Minimum*	*Maximum*	*Mean*	*St.D.*
Life expectancy at birth, Total; Yr.	48.21	79.80	66.16	8.88
Life expectancy at birth, Male; Yr.	46.10	74.97	62.39	7.39
Life expectancy at birth, Female; Yr.	47.63	76.92	64.23	8.07
Multidimensional Poverty Index (0–100 scale).	0.10	60.50	19.97	17.32
Poverty gap at 1.9 USD a day (%).	0.01	40.32	10.47	11.47
Poverty gap at 3.1 USD a day (%).	0.19	58.97	20.77	17.36
Gross domestic product, PPP (thousands 2011 international USD).	0.71	16.67	4.98	4.07
Gini coefficient of income inequality (0–100 scale).	26.82	63.40	41.44	8.89
Sub-Saharan African dummy variable.	0.00	1.00	0.50	0.50
Time dummy variable: 1 for 2013 and thereafter (n = 27) and 0 for 2012 and before (n = 35).	0.00	1.00	0.44	0.50
Years of Schooling, contribution to MPI (%).	0.00	35.30	14.23	7.89
Child School Attendance, contribution to MPI (%).	2.30	30.70	13.72	6.29
Mortality, contribution to MPI (%).	3.70	42.50	17.54	7.52
Nutrition, contribution to MPI (%).	0.00	40.20	12.99	7.37
Electricity, contribution to MPI (%).	0.00	12.20	6.87	3.56
Improved Sanitation, contribution to MPI (%).	0.30	13.50	7.97	2.85
Drinking Water, contribution to MPI (%).	0.70	11.20	5.64	2.40
Flooring, contribution to MPI (%).	0.00	11.90	6.25	3.17
Cooking Fuel, contribution to MPI (%).	0.20	13.40	9.66	2.65
Asset Ownership, contribution to MPI (%).	0.40	12.60	5.13	2.37

Notes: St.D., Standard Deviation; USD, United States Dollar; PPP, Purchasing Power Parity; MPI, Multidimensional Poverty Index

Table 2 presents the bivariate correlations among the main variables. Life expectancy variables were significantly correlated with MPI, income poverty (at 1.9 and 3.1 USD), GDP, Gini, and the SSA variable ($P < 0.001$). The time variable did not correlate with the LE variables and thus was dropped from the multivariate analyses. Since the correlation coefficient of the SSA variable and MPI was greater than 0.70 ($r = 0.716$, $P < 0.001$), this variable was dropped from the multivariable analyses.

Table 2: Bivariate Pearson correlations across the studied main variables

	LET	*LEM*	*LEF*	*MPI*	*Pov 1.9*	*Pov 3.1*	*GDP*	*Gini*	*Time*
LEM	0.978	1.000							
	(0.000)								
LEF	0.995	0.994	1.000						
	(0.000)	(0.000)							
MPI	-0.713	-0.685	-0.704	1.000					
	(0.000)	(0.000)	(0.000)						
Pov 1.9	-0.603	-0.606	-0.608	0.530	1.000				
	(0.000)	(0.000)	(0.000)	(0.000)					
Pov 3.1	-0.655	-0.646	-0.654	0.615	0.968	1.000			
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)				
GDP	0.605	0.607	0.609	-0.676	-0.534	-0.624	1.000		
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)			
Gini	-0.359	-0.397	-0.379	0.084	0.425	0.346	0.066	1.000	
	(0.004)	(0.001)	(0.002)	(0.519)	(0.001)	(0.006)	(0.608)		
Time	-0.004	-0.026	-0.014	-0.129	0.144	0.116	0.148	0.166	1.000
	(0.976)	(0.839)	(0.911)	(0.319)	(0.263)	(0.371)	(0.252)	(0.196)	
SSA	-0.790	-0.779	-0.789	0.716	0.617	0.677	-0.513	0.331	0.163
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.009)	(0.207)

Notes: Figures in parentheses are *P*-values. LET = Life expectancy for both genders; LEM = Life expectancy for men; LEF= Life expectancy for women; MPI = Multidimensional Poverty Index; Pov 1.9 = Poverty gap at 1.9 USD; Pov 3.1 = Poverty gap at 3.1 USD; GDP =Gross domestic Product; SSA = Sub-Saharan African (dummy); Time = Yearly dummy variable

Table 3 presents the results of the four multivariate regressions. The first model (the base model) included only control variables; both income and income inequality were significantly related to LE ($P < 0.001$). These two variables explained 52.7% (R^2 = 0.527) of variation in LE. The second model included MPI, which was negatively and significantly associated with LE (β = -0.245, $P <$ 0.001). The inclusion of MPI improved the explanatory power of the model (R^2) by 22.9%, from 0.527 (as in the base model) to 0.648. In other words, MPI explained about 12.1% of the variation in LE. The third model included income poverty at 3.1 USD, and this variable was fairly significant (β = -0.135, $P = 0.044$); however, it explained only 3.2% of the variation in LE and improved the model's explanatory power by only 6.1%. Income poverty at 1.9 USD was insignificant, as shown in the fourth model (β = -0.147, $P = 0.135$).

As shown in Table 4, the effect of multidimensional poverty is higher on female LE (β = -0.210, $P < 0.001$) than on male LE (β = -0.177, P < 0.001). One-unit reduction in MPI (on a 1–100 scale) is associated with 76.8 days higher female LE, but only 64.7 days higher male LE (Table 5). Income has a slightly greater effect on female LE (β = 0.651, $P = 0.003$) than on male LE (β = 0.638, $P = 0.002$). Similarly, the effect of income inequality is higher on female LE (β = -0.330, P < 0.001) than on male LE (β = -0.321, $P < 0.001$) (Tables 4 and 5).

Table 6 illustrates the result of regressing the deprivation indicators of MPI along with the control variables against LE (for both genders). As mentioned in the Methods section, deprivation of electricity was omitted from the regression, so it serves as a reference for interpreting the coefficients of the other indicators. Regarding their effect on LE, the ten deprivation indicators rank as follows, from most to least influential: (a) asset ownership, (b) drinking water, (c) cooking fuel, (d) flooring, (e) child school attendance, (f) years of schooling, (g) nutrition, (h) mortality, (i) improved sanitation, and (j) electricity. The relative, numeric, importance of the MPI indicators can be derived from Table 6.

Table 3: Explanatory power of multidimensional poverty for life expectancy in contrast to income poverty; multivariate OLS regressions of 62 countries

Variable	*Base model*	*Poverty model*		
		Multidimensional poverty	*Income poverty at 3.1 USD*	*Income poverty at 1.9 USD*
	β [S.E.] (Prob.)	*β [S.E.] (Prob.)*	*β [S.E.] (Prob.)*	*β [S.E.] (Prob.)*
Poverty variable	_	-0.245	-0.135	-0.147
	_	[0.055]	[0.066]	[0.097]
	_	(0.000)	(0.044)	(0.135)
Income	1.378	0.663	1.003	1.145
	[0.196]	[0.234]	[0.264]	[0.247]
	(0.000)	(0.006)	(0.000)	(0.000)
Inequality	-0.401	-0.339	-0.298	-0.313
	[0.090]	[0.079]	[0.101]	[0.106]
	(0.000)	(0.000)	(0.004)	(0.004)
Constant	75.893	81.803	76.316	74.969
	[3.857]	[3.610]	[3.761]	[3.864]
	(0.000)	(0.000)	(0.000)	(0.000)
R^2	0.527	0.648	0.559	0.545
Improvement in R^2 value	-	0.121	0.032	0.018
% Improvement in R^2	-	22.9%	6.1%	3.4%
Adjusted- R^2	0.511	0.629	0.536	0.521
F-statistic	32.849	35.523	24.517	23.146
Prob. (F-statistic)	0.000	0.000	0.000	0.000
Observations	62	62	62	62

Notes: S.E., Standard error; Prob., Probability

Table 4: Comparison by gender of the magnitude of the effect of multidimensional poverty on life expectancy; multivariate OLS regressions of 62 developing countries

Variable	*Type of life expectancy (Dependent Variable)*		
	Both genders	*Female*	*Male*
	β [S.E] (Prob.)	*β [S.E] (Prob.)*	*β [S.E] (Prob.)*
Multidimensional poverty	-0.245	-0.210	-0.177
	[0.055]	[0.049]	[0.046]
	(0.000)	(0.000)	(0.000)
Income	0.663	0.651	0.638
	[0.234]	[0.210]	[0.194]
	(0.006)	(0.003)	(0.002)
Inequality	-0.339	-0.330	-0.321
	[0.079]	[0.071]	[0.066]
	(0.000)	(0.000)	(0.000)
Constant	81.803	78.851	76.039
	[3.610]	[3.243]	[2.988]
	(0.000)	(0.000)	(0.000)
R^2	0.648	0.656	0.651
Adjusted-R^2	0.629	0.638	0.633
F-statistic	35.523	36.834	36.125
Prob. (F-statistic)	0.000	0.000	0.000
Observations	62	62	62

Notes: S.E., Standard error; Prob., Probability

Table 5: Estimated improvement in life expectancy associated with changes in multidimensional poverty index, income, and income inequality

Change in variable	*Increase in life expectancy (Days)*[a]		
	Both genders	*Female*	*Male*
One-unit reduction in multidimensional poverty (0–100 scale).	89.6	76.8	64.7
100 USD increase in per capita income.[b]	24.2	23.7	23.3
One-unit decrease in income equality (0–100 scale).	123.7	120.3	117.0

Notes: [a] Increased life expectancy [ILE] is calculated based on the formula, ILE = C * β * 365, where C is the unit change in the independent variable, β is the respective coefficient of the independent variable (as presented in Table 4), and 365 is the number of days in a single year. [b] The initial unit of measurement for income in the regressions (Table 3) is thousands; however, to better illustrate the magnitudes of the effect, this table uses 100 USD changes in income [C = 0.1]

Table 6: The relative importance of the ten indicators of multidimensional poverty in influencing life expectancy (both genders)

Variable	*β*	*[S.E]*	*(Prob.)*
Asset ownership	1.645	[0.551]	(0.004)
Drinking water	1.452	[0.566]	(0.013)
Cooking fuel	1.448	[0.628]	(0.025)
Flooring	1.211	[0.460]	(0.011)
Child school attendance	1.091	[0.426]	(0.013)
Years of Schooling	1.077	[0.408]	(0.011)
Nutrition	1.049	[0.409]	(0.013)
Mortality	1.044	[0.401]	(0.012)
Improved sanitation	0.733	[0.654]	(0.268)
Electricity	Ref.		
Income	1.047	[0.265]	(0.000)
Inequality	-0.278	[0.111]	(0.016)
Constant	-33.803	[41.197]	(0.416)
R^2	0.642		
Adjusted-R^2	0.563		
F-statistic	8.137		
Prob. (F-statistic)	0.000		
Observations	62		

Notes: S.E., Standard error; Prob., Probability; Ref, reference

Discussion

MPI is a more powerful proxy than income poverty in explaining variations in LE in developing countries. Although this result seems intuitive, it has important implications. First, where data is available, future studies in this area should rely on MPI, not income poverty. Second, policymakers in developing countries should move from income to multidimensional poverty when monitoring and predicting the poverty and health statuses of their populations.

Although, to our knowledge, this study is the first to link multidimensional poverty with LE at the country level, there is some supporting empirical research for these findings. In novel work in Japan, the effects of four dimentions of poverty (income, housing conditions, education, and social protection) on self-rated health (SRH) were studied,which concluding that "multiple poverty dimensions were more useful for identifying individuals in poor SRH or psychological distress than a single dimension such as income" (18). Compared to single-dimension measures, multidimensional poverty better explained perceived happiness in China, Korea, and Japan (19).

Using multidimensional poverty instead of income poverty has the additional advantage of providing information regarding which aspect of poverty to first target to better improve longevity. Given the limited resources available in developing countries and the relatively large portion of people in poverty and thus suffering from poor health, interventional policies to eradicate multidimensional poverty with the aim to prolong LE should be prioritized according to the relative influence of deprivation indicators on LE. According to the results of this study, priority should be given to eradicating households' deprivation in terms, from most to least important; asset ownership, drinking water, cooking fuel, flooring, child school attendance, years of schooling, nutrition, mortality, improved sanitation, and electricity.

Although the MPI was constructed at the household level, a study in India documented higher multidimensional poverty among women than men (14), highlighting the importance of prioritizing women in poverty-reduction policies. The higher contribution of female poverty to overall MPI may explain the greater influence of MPI on female LE found in this study. In fact, empowering poor women in developing countries has the double benefit of eliminating disparities in income between genders while improving public-health outcomes (20, 21).

Limitations

This research provides a correlational analysis which may not necessarily reflect causation. The limited available data does not allow for establishing time-variant dataset. Future studies may utilize the new releases of the MPI to compile a panel dataset and reexamine the results of this research using causal approaches.

Conclusion

In explaining life expectancy, the MPI is a more relevant and powerful measure of poverty than income poverty. Therefore, future research and interventional policies targeting poverty and improved health should adopt this concept of multidimensional poverty. Importantly, priority should be given to eradicating poverty among women in developing countries. Moreover, with the limited resources available in developing countries, interventional policies to improve health should be prioritized to tackle the most serious elements of multidimensional poverty that undermine health and longevity.

Ethical considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

Acknowledgements

We would like to acknowledge the financial support provided by University of Malaya under the Equitable Society Research Cluster (ESRC) (research grant: RP031C-16SBS).

Conflict of interest

The authors declare that there is no conflict of interest.

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