Urbanization and Child Mortality – Evidence from the Demographic and Health Surveys

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Abstract

Background & Motivation

Rapid population growth and urbanization trends over the past several decades have resulted in a majority of the global population living in urban areas today. Urban population growth has been particularly fast in major (metropolitan) urban settlements in developing countries, generally characterized by high levels of socioeconomic and health inequalities. Relatively little is known about the implications of increased urbanization on the within-country distribution of child mortality and the relative changes in mortality experienced in rural, small urban and major urban areas.

Methods

We combine country-level data on residential population distribution with micro-data on household composition and mortality outcomes from 37 low and middle-income countries. The resulting sample represents 70% of the global population currently living in low-income countries, and 48% of the population in low- and middle-income countries. We separately compute mortality rates and the total number of under-5 deaths in rural areas, small urban areas (<1 Million) and major urban areas (>=1Million) for the 1990-2000 and 2000-2010 periods.

Results

Large differentials in childhood mortality were observed across residential areas throughout the study period. Average under-5 mortality rates observed in the 1991-2000 period were 138, 109 and 91 deaths per 1000 live births for rural, small urban and major urban areas respectively. In the 2001-2010 period, these rates were estimated at 92, 73 and 56 deaths per 1000 live births, respectively. In terms of total mortality burden, the percentage of under-5 deaths occurring in rural areas declined moderately from 82.2% to 77.6%. In comparison, deaths among children residing in large urban areas – accounting for 13% of total sample population – contributed only 6.5% to the estimated total number of child deaths in the 2001-2010 period.

Summary and Conclusions

Despite rapidly increasing urbanization in low- and middle income countries, rural areas continue to account for an overwhelming majority of child deaths in developing countries. While absolute mortality rates have fallen substantially for most countries over the sample period, the mortality gaps between urban and rural children remain large, and are particularly large between rural children and children growing up in major (metropolitan) areas, where mortality rates are substantially lower than in smaller urban centers.

Introduction

According to the latest United Nations (UN) estimates, more than half the world's population lives in urban areas today. If current trends continue, the urban population share is expected to pass 60 percent by 2035 (UNDP, 2012). The growth of urban areas has been particularly fast in low and middle income countries (LMIC), and contributed to increasing land, water, and air pollution (UN-HABITAT/DFID, 2002). Fast population growth in large urban (metropolitan) areas such as Mumbai, Nairobi and Sao Paulo has also resulted in the formation of large and rapidly growing informal settlements generally referred to as "slums". According to the UN, more than 800 million people, or about 11 percent of the total global population, lived in households classified as slums in 2008 (UN-HABITAT, 2008). Characterized by crowding, lack of property rights and poor overall living conditions, poor urban areas illustrate, and struggle with, the large social, economic and health disparities faced by many low and middle income countries (LMIC).

While urban residence is generally presumed to be protective for child mortality, urban mortality differentials were mostly negative in Europe in most of the 19th century (Cain & Hong, 2009; Williamson, 1990; Woods, 2003), before the rollout of public health interventions resulted in healthier urban environments early in the 20th century. In many respects, urban settlements in developing countries today seem comparable to European cities in the late 19th and early 20th century, with a majority of urban settlements struggling with overcrowding, poor hygiene standards, violence, and frequent infectious disease outbreaks, all of which suggest that child mortality will not necessarily be lower than in rural areas. On the other hand, cities offer transport, infrastructure and access to knowledge and technology, all of which are likely to be highly beneficial to children.

In this paper we use household data collected across 37 low- and middle-income countries since 1990 to assess the general relation between child mortality and household residence. Given the increased interest in the large metropolitan areas in developing countries, we separately analyze

rural, small urban and major urban (>1 million) strata, and assess the relative improvements in child health these residential areas have experienced in the period 1990-2010.

Data

The primary data used in this paper are from the Demographic and Health Surveys (DHS). The DHS are population-based nationally representative surveys with a particular focus on fertility and reproductive health. Largely funded by USAID, over 200 DHS surveys have been conducted since 1986 and made publicly available. Since we want to evaluate trends in the distribution of households across types of place of residence, we restrict our analysis to countries with at least one survey allowing us to estimate child mortality in the period 1991-2000, and one survey allowing us to estimate child mortality in the period 2001-2010. This leaves us with a sample of 74 surveys across 37 low- and middle-income countries, covering a population of 2.7 billion, or about 48% of the combined low- and middle income population in 2010. As Figure 1 illustrates, about half the sample countries are in sub-Saharan Africa with the rest distributed among Asian and Latin American countries.

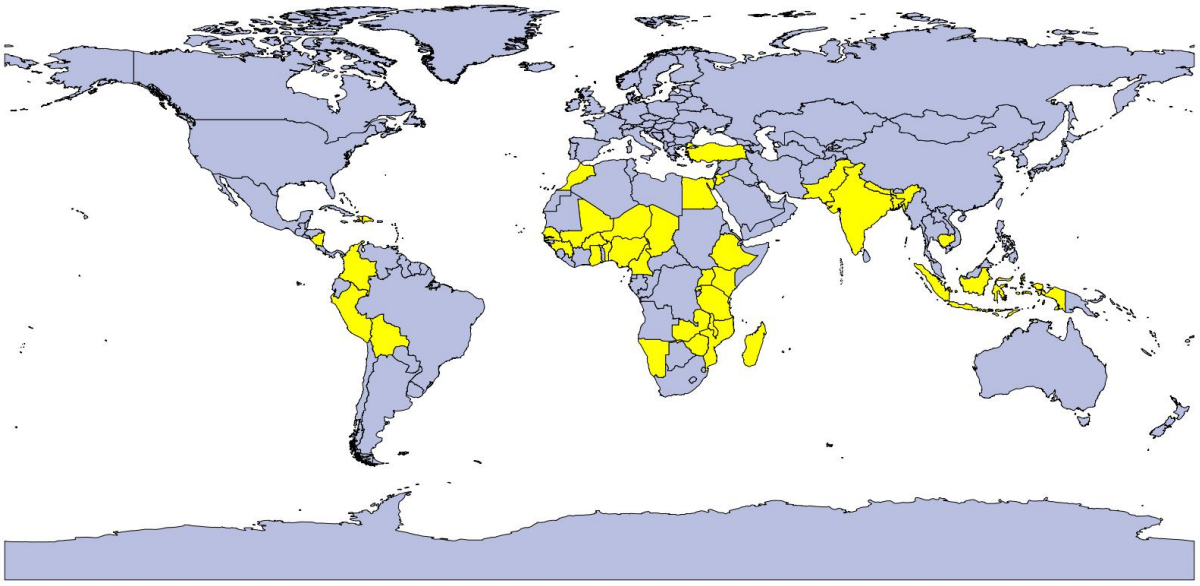


Figure 1: Sample of 37 Countries with Surveys Covering 1991-2000 and 2001-2010 Periods

We complement the DHS data set with country level population statistics on residential population distribution from the World Development Indicators (WDI) 2012 version (World Bank, 2012).

Methods

Our analysis proceeds in 3 steps. We start our analysis by showing aggregate residential trends in the group of countries currently classified as low- or middle income by the World Bank, as well as the 37 LMIC constituting our main sample. The World Bank distinguishes three basic residential areas: rural, (small) urban (<1 million), and large urban (population >=1 million); we follow this definition, and show aggregate statistics for the three main residential areas of interest. In a second step, we estimated survey- and residence-specific mortality rates for the five years before each survey using an adapted version of U5MR software package for Stata.

Following the methodology described in Hill et al. (Hill et al., 1997), the U5MR routine calculates age-period event-exposure mortality rates for chosen periods and age intervals of one month. The combination of date of birth in century-months (CMC) and age at death in CMC is used to locate deaths in particular 12-month periods except for deaths in the first month of life. To deal with ambiguity regarding the month of death for data recorded as CMC for births and age at death recorded in months (from 1 month to 23 months) and then year (2 years and higher), a pseudo-random number between 0 and 1 is added at the beginning and end of the period. Exposure time in a particular month of age and 12-month period is based upon the proportion of a month that each child spends in each cell of the Lexis Diagram. The events and exposure by month of age and reference period are summed for a given age, and event-exposure rates are calculated for each month of age by dividing the events by the exposure. They are then converted into probabilities of dying using the standard life table relationship, chaining together survivorship ratios to obtain probabilities of dying as follows:

$$ {}_nq_x = 1 - \prod_{y=x}^{x+n-1} \left(1 - {}_1q_y\right) $$

The main stratum of interest for the purpose of this paper is household residence. Consistent with the aggregate statistics from the World Bank, we divide survey populations into rural, small urban, and large urban populations. The main geographic information provided by the DHS is

the region (administrative unit) in which a sample household is located (DHS standard recode variable hv024). In addition, DHS surveys provide information on the "type" of residence (urban vs. rural, hv025) as well as the "place" of residence, which is divided into rural, small town, and larger city (hv026). No formal consistent definition of what is large is applied, but generally it is largest (capital) city of the country. In surveys where such information was not available, urban households were divided into small and large urban areas based on the administrative unit (region) provided in the surveys. Surveys were excluded from analysis if insufficient information was available to allow such coding.

In the last step, we combine the estimated stratum-specific mortality rates with survey information on household size and number of children to compute the number of deaths by survey and stratum, and generate aggregate mortality statistics.

Results

Figure 2 summarizes the aggregate trends in population distribution for all 139 LMIC combined (left panel) as well as the 37 countries in our core sample over the period 1990-2010. The overall rates of population growth are rather high, with an aggregate increase of 33% across all LMICs, and 46% for the core sample analyzed in this paper. As shown in Appendix Tables A1 and A2, the majority of the 37 countries in the sample are either classified as "low income" or as "lower-middle income", which explains the slightly faster pace of population growth compared to the larger LMIC group. The global urbanization trends are well represented in both samples, with urban population growth rates 2 to 5 times as high as in rural areas.

Table 1 shows the country-level population distribution for 1990 and 2010, and highlights the heterogeneity with respect to the degree of urbanization. While in some countries like Ethiopia, Niger and Uganda more than 80% of the population reside in rural areas, a majority of the population lives in urban settlements in most middle-income countries, with the highest urban population shares in Peru, Colombia and Jordan. While urban population shares appear to increase at the country level, the patterns are not as clear for the fraction of the urban population living in large cities. Six out of the 37 countries analyzed do not currently have a city larger than one million; the highest concentration of urban population in large cities was observed for

Burkina Faso, where an estimated 57% of the urban population lived in its capital Ouagadougou in 2010.

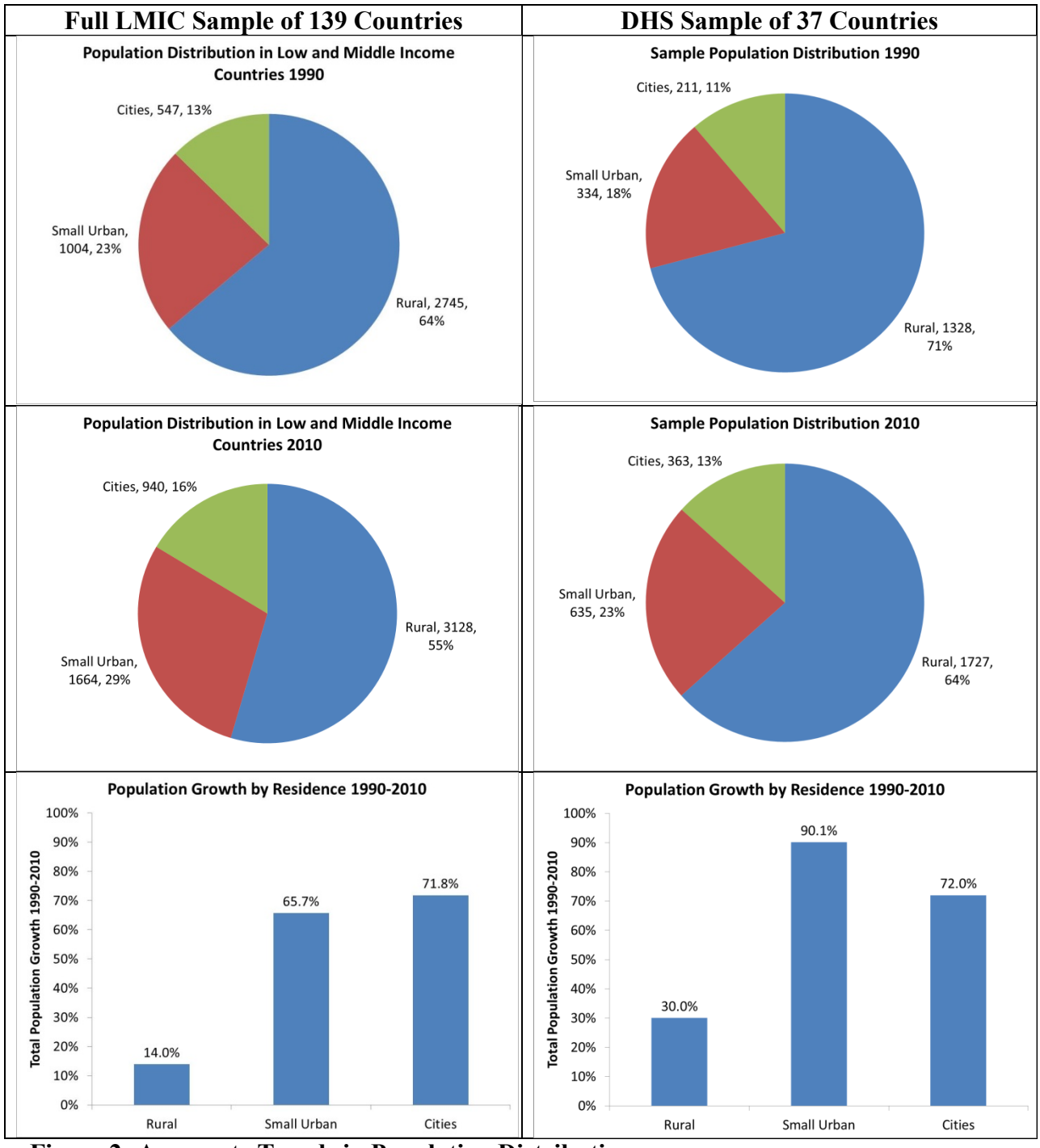


Figure 2: Aggregate Trends in Population Distribution

Table 1: Population Distribution

Country	Population 1990 (millions)	Urban population share 1990	Fraction of urban in cities >= 1 Million 1990	Population 2010 (millions)	Urban population share 2010	Fraction of urban in cities >= 1 Million 2010
Uganda	17.70	11.10	0.38	33.42	13.30	0.36
Niger	7.79	15.40	0.36	15.51	16.70	0.40
Ethiopia	48.33	12.60	0.29	82.95	17.60	0.20
Nepal	19.08	8.90	0.00	29.96	18.20	0.00
Rwanda	7.11	5.40	0.00	10.62	18.90	0.00
Malawi	9.38	11.60	0.00	14.90	19.80	0.00
Burkina Faso	9.32	13.80	0.42	16.47	20.40	0.57
Kenya	23.45	18.20	0.32	40.51	22.20	0.39
Cambodia	9.53	12.60	0.51	14.14	22.80	0.48
Tanzania	25.48	18.90	0.27	44.84	26.40	0.28
Chad	6.01	20.80	0.00	11.23	27.60	0.00
Bangladesh	105.26	19.80	0.46	148.69	28.10	0.51
India	873.79	25.50	0.38	1224.62	30.10	0.41
Madagascar	11.28	23.60	0.36	20.71	30.20	0.30
Mali	8.67	23.30	0.37	15.37	33.30	0.33
Guinea	5.76	28.00	0.55	9.98	35.40	0.47
Zambia	7.86	39.40	0.24	12.93	35.70	0.31
Pakistan	111.84	30.60	0.50	173.59	37.00	0.49
Namibia	1.41	27.70	0.00	2.28	38.00	0.00
Zimbabwe	10.47	29.00	0.35	12.57	38.30	0.34
Mozambique	13.55	21.10	0.27	23.39	38.40	0.18
Benin	4.77	34.50	0.00	8.85	42.00	0.00
Egypt, Arab Rep.	56.84	43.50	0.49	81.12	42.80	0.44
Senegal	7.24	39.00	0.50	12.43	42.90	0.54
Haiti	7.12	28.50	0.56	9.99	49.60	0.43
Nigeria	97.55	35.30	0.35	158.42	49.80	0.30
Ghana	14.79	36.40	0.35	24.39	51.50	0.33
Indonesia	184.35	30.60	0.32	239.87	53.70	0.16
Morocco	24.78	48.40	0.38	31.95	56.70	0.34
Nicaragua	4.12	52.30	0.34	5.79	57.30	0.40
Cameroon	12.18	40.70	0.34	19.60	58.40	0.34
Bolivia	6.66	55.60	0.45	9.93	66.50	0.50
Turkey	54.13	59.20	0.41	72.75	69.60	0.42
Dominican Republic	7.19	55.20	0.38	9.93	70.50	0.31
Peru	21.69	68.90	0.39	29.08	71.60	0.43
Colombia	33.20	68.30	0.45	46.30	75.10	0.50
Jordan	3.17	72.20	0.37	6.05	78.50	0.23

Mortality Estimates

Table 2a summarizes the estimated under-5 mortality rates by residence and survey period. The average improvements in child mortality over the sample period are large, with a decline in average (country-level) rural under-5 mortality from 138 to 91 deaths per 1000, a 34% reduction over an approximately 10 year period. Across both periods, the highest mortality rates were observed in rural areas, followed by small urban and the lowest rates in large urban areas. The only countries where children of large urban areas appear to consistently face higher mortality risk are those with a high prevalence of HIV (Malawi, Tanzania, Zambia and Zimbabwe). Remarkably, in the 1991-2000 period, the average absolute gap between small urban and rural areas (29 deaths per 1000) was virtually identical to the gap between small urban and large urban residences (28 deaths per 1000). For the post-2000 period, the absolute gaps decreased to 19 (small urban vs. rural) and 17 (small vs. large urban), respectively. Compared to large urban residence, this implies an increase in relative mortality risks from 1.2 to 1.3 for small urban areas, and an increase from 1.5 to 1.6 for rural areas.

Table 2b summarizes the estimated neonatal mortality rates by residence and survey period. In relative terms, the gaps for neonatal mortality are much smaller than for all under-5 mortality, with mortality ratios of 1.00 (small vs. large urban) and 1.15 (rural vs. large urban), respectively for the post-2000 period. Average improvements in mortality were also smaller for neonatal than for under-5 mortality, with declines of 23% (rural), 22% (small urban) and 19% (large urban), respectively.

Table 2a: Estimated Under-5 Mortality Rates by Residence: 1990s and 2000s

			Under-5 Mortality Rate (5q0)					
			1991-2000			2001-2010		
	First survey	Last survey	**Rural**	**Small Urban**	**Large Urban**	**Rural**	**Small Urban**	**Large Urban**
Bangladesh	1993	2011	135	110	85	55	53	47
Benin	1996	2006	171	140		130	105	
Bolivia	1998	2008	121	68	63	87	49	37
Burkina Faso	1993	2010	190	137	122	135	81	70
Cambodia	2000	2010	122	118	28	59	34	5
Cameroon	1991	2011	134	106	95	138	99	63
Chad	1996	2004	189	195		187	161	
Colombia	1995	2005	40	34	30	31	22	17
Dominican Republic	1991	2007	71	49	41	35	35	38
Egypt, Arab Rep.	1992	2008	100	56	52	28	24	33
Ethiopia	2000	2011	165	130	106	86	63	40
Ghana	1993	2008	122	94	95	80	76	63
Guinea	1999	2005	179	142	113	166	153	84
Haiti	1994	2005	124	141	126	92	77	37
India	1992	2005	118	78	65	81	54	43
Indonesia	1991	2003	105	80	60	54	33	34
Jordan	1990	2007	45	34	35	21	19	21
Kenya	1993	2008	91	79	75	72	68	57
Madagascar	1992	2008	166	119	125	70	67	38
Malawi	1992	2010	229	201	247	106	110	115
Mali	1995	2006	250	203	141	208	154	92
Morocco	1992	2003	87	55	33	61	34	26
Mozambique	1997	2011	200	161	171	95	86	73
Namibia	1992	2006	84	72		72	59	
Nepal	1996	2006	120	67	35	65	54	5
Nicaragua	1998	2001	55	41	40	48	32	15
Niger	1992	2006	329	215	153	202	124	121
Nigeria	1990	2008	203	138	99	212	145	113
Pakistan	1990	2006	118	87	76	96	76	57
Peru	1991	2000	109	68	28	63	41	20
Rwanda	2000	2010	145	130	161	77	88	49
Senegal	1992	2010	149	97	73	82	49	50
Tanzania	1991	2010	133	156	162	75	81	135
Turkey	1993	2003	77	50	48	47	30	28
Uganda	1995	2011	142	129	119	90	66	54
Zambia	1992	2007	199	164	165	108	123	139
Zimbabwe	1995	2010	81	83	42	80	86	88
Country average	1994	2007	**138**	**109**	**91**	**92**	**73**	**56**

Table 2b: Estimated Neonatal Mortality Rates by Residence: 1990s and 2000s

			Neonatal Mortality Rate					
			1991-2000			2001-2010		
	First survey	Last survey	**Rural**	**Small Urban**	**Large Urban**	**Rural**	**Small Urban**	**Large Urban**
Bangladesh	1993	2011	54	59	27	33	33	30
Benin	1996	2006	38	35		32	29	
Bolivia	1998	2008	46	22	25	37	21	19
Burkina Faso	1993	2010	46	25	28	29	24	18
Cambodia	2000	2010	37	39		30	18	
Cameroon	1991	2011	32	36	32	32	29	31
Chad	1996	2004	47	31		42	27	
Colombia	1995	2005	21	18	17	15	13	10
Dominican Republic	1991	2007	27	22	19	21	23	21
Egypt, Arab Rep.	1992	2008	37	28	21	14	15	24
Ethiopia	2000	2011	49	48	35	36	40	22
Ghana	1993	2008	41	39	40	30	27	28
Guinea	1999	2005	50	38	39	39	44	34
Haiti	1994	2005	33	34	28	23	35	12
India	1992	2005	53	36	32	42	30	23
Indonesia	1991	2003	34	23	26	20	19	16
Jordan	1990	2007	22	19	23	10	13	14
Kenya	1993	2008	25	19	29	30	16	47
Madagascar	1992	2008	39	39	36	24	22	27
Malawi	1992	2010	39	60	53	31	32	35
Mali	1995	2006	66	45	41	51	38	26
Morocco	1992	2003	32	31	20	31	21	18
Mozambique	1997	2011	49	57	117	28	32	32
Namibia	1992	2006	32	29		23	23	
Nepal	1996	2006	50	35		35	31	
Nicaragua	1998	2001	19	14	14	18	15	12
Niger	1992	2006	43	29	25	35	21	26
Nigeria	1990	2008	42	43	26	53	37	29
Pakistan	1990	2006	52	37	36	52	50	39
Peru	1991	2000	40	18	10	23	16	12
Rwanda	2000	2010	37	34	41	27	35	14
Senegal	1992	2010	37	28	25	30	26	25
Tanzania	1991	2010	33	57	61	23	24	59
Turkey	1993	2003	28	29	30	20	16	13
Uganda	1995	2011	29	21	17	28	26	19
Zambia	1992	2007	48	32	42	33	35	43
Zimbabwe	1995	2010	25	39	6	27	23	47
Country average	1994	2007	39	34	32	30	26	26

Table 3a shows the estimated total under-5 mortality burden by country and residence for both periods. Despite the large population growth over the period highlighted in Figure 1, the estimated number of deaths declined by 14% in the aggregate. The overwhelming majority of deaths continue to accrue in rural areas; consistent with the large increases in urbanization documented in Table 1, the proportion of child deaths occurring in small urban areas has increased from 12.0% to 15.7%, while that in large urban areas has increased from 5.5% to 6.7%.

Table 3b shows the same results for neonatal deaths. Consistent with the smaller rate ratios for neonatal deaths, the proportion of neonatal deaths occurring in rural areas is somewhat smaller in both time periods than for all under-5 deaths, though the differences are not large. The fraction of neonatal death occurring in small urban areas increased from 12.8% to 15.9%, while the fraction of neonatal deaths increased from 6.3% to 7.7%. Despite these increases, rural children continued to account for more than three quarters (76.4%) of neonatal death in the post-2000 period. When India - which accounts for nearly half of rural neonatal deaths in the sample – is excluded, the rural neonatal mortality share drops only slightly to 70.9%.

Table 3a: Under-5 Mortality Burden by Residence, 1991-2000, and 2001-2010

			Under-5 Deaths					
			1991-2000			2001-2010		
	First survey	Last survey	**Rural**	**Small Urban**	**Large Urban**	**Rural**	**Small Urban**	**Large Urban**
Bangladesh	1993	2011	363,825	34,290	21,940	141,045	20,962	18,736
Benin	1996	2006	23,972	8,323		26,741	12,504	
Bolivia	1998	2008	13,067	3,846	3,099	8,830	3,734	2,839
Burkina Faso	1993	2010	65,099	3,560	2,074	70,472	3,350	
Cambodia	2000	2010	28,306	1,926	261	16,803	1,035	129
Cameroon	1991	2011	37,961	14,188	6,131	47,168	21,790	6,660
Chad	1996	2004	40,921	9,649		61,160	15,510	
Colombia	1995	2005	13,198	10,999	7,619	9,362	7,349	5,400
Dominican Republic	1991	2007	6,974	3,550	1,620	2,630	3,373	1,656
Egypt, Arab Rep.	1992	2008	117,969	19,341	16,222	34,874	9,853	10,403
Ethiopia	2000	2011	269,346	16,076	3,544	197,995	16,228	1,959
Ghana	1993	2008	50,091	12,179	5,442	31,049	15,098	5,730
Guinea	1999	2005	30,960	3,489	3,031	39,402	7,581	3,405
Haiti	1994	2005	23,018	3,761	3,790	16,093	4,760	1,774
India	1992	2005	2,326,330	271,722	132,933	1,738,740	223,461	116,605
Indonesia	1991	2003	371,610	80,426	25,229	151,560	70,194	16,613
Jordan	1990	2007	1,561	1,734	947	678	1,769	649
Kenya	1993	2008	65,238	7,428	3,081	77,269	10,061	4,741
Madagascar	1992	2008	59,047	6,673	3,257	34,096	6,943	1,637
Malawi	1992	2010	69,888	7,197		46,403	9,143	
Mali	1995	2006	76,995	9,980	3,738	85,233	16,927	4,887
Morocco	1992	2003	39,378	10,841	3,246	22,051	8,102	2,684
Mozambique	1997	2011	82,254	11,586	3,773	55,219	19,022	2,819
Namibia	1992	2006	3,457	812		3,289	1,054	
Nepal	1996	2006	75,478	3,365		45,837	5,977	
Nicaragua	1998	2001	4,166	1,816	828	3,861	1,562	404
Niger	1992	2006	94,379	7,138	2,468	107,484	6,806	3,829
Nigeria	1990	2008	503,631	108,720	38,002	641,020	226,366	74,056
Pakistan	1990	2006	309,244	47,337	44,733	324,858	58,314	49,070
Peru	1991	2000	28,667	17,961	3,212	14,981	10,492	3,176
Rwanda	2000	2010	38,907	1,645		23,136	4,407	
Senegal	1992	2010	28,596	5,200	3,504	22,747	3,470	3,744
Tanzania	1991	2010	110,782	19,545	6,926	93,135	18,825	10,597
Turkey	1993	2003	35,129	20,267	11,042	23,307	17,621	9,955
Uganda	1995	2011	104,349	6,525	3,756	102,030	5,944	2,540
Zambia	1992	2007	38,252	14,914	4,570	36,731	11,392	5,569
Zimbabwe	1995	2010	20,836	4,816	1,116	22,578	7,737	3,790
Total			5,572,878	812,824	371,135	4,379,868	888,717	376,057
Share of deaths			82.5%	12.0%	5.5%	77.6%	15.7%	6.7%
Total excluding India			3,246,548	541,103	238,202	2,641,128	665,256	259,452
Share of deaths excl. India			80.6%	13.4%	5.9%	74.1%	18.7%	7.3%

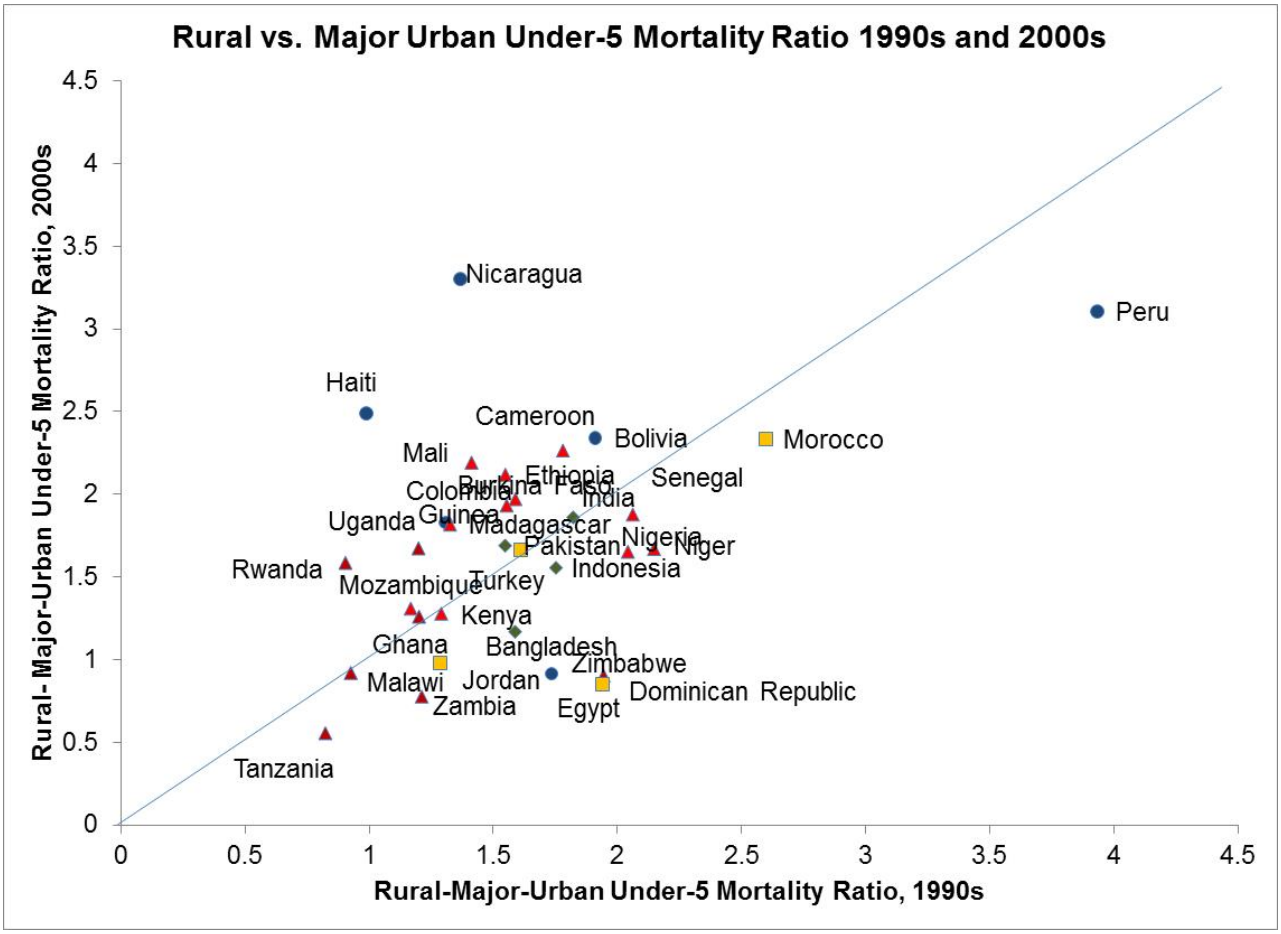
Table 3b: Neonatal Death Burden by Residence, 1991-2000, and 2001-2010

			Neonatal Deaths					
			1991-2000			2001-2010		
	First survey	Last survey	**Rural**	**Small Urban**	**Large Urban**	**Rural**	**Small Urban**	**Large Urban**
Bangladesh	1993	2011	145,431	18,381	6,935	83,887	12,961	11,990
Benin	1996	2006	5,387	2,080		6,613	3,435	
Bolivia	1998	2008	5,011	1,239	1,248	3,716	1,632	1,438
Burkina Faso	1993	2010	15,813	657	469	15,344	1,003	
Cambodia	2000	2010	8,532	636		8,409	538	
Cameroon	1991	2011	8,957	4,810	2,098	10,940	6,405	3,259
Chad	1996	2004	10,121	1,533		13,678	2,584	
Colombia	1995	2005	7,042	5,756	4,359	4,589	4,578	3,129
Dominican Republic	1991	2007	2,684	1,615	759	1,598	2,201	918
Egypt, Arab Rep.	1992	2008	43,337	9,467	6,723	17,936	6,154	7,670
Ethiopia	2000	2011	79,749	5,997	1,181	82,643	10,217	1,047
Ghana	1993	2008	16,611	5,031	2,288	11,577	5,447	2,513
Guinea	1999	2005	8,572	925	1,054	9,252	2,171	1,379
Haiti	1994	2005	6,146	897	839	3,965	2,179	576
India	1992	2005	1,040,340	126,177	64,952	911,794	125,948	61,662
Indonesia	1991	2003	120,211	23,599	10,991	55,310	39,610	7,924
Jordan	1990	2007	774	953	620	330	1,189	439
Kenya	1993	2008	17,904	1,766	1,172	32,598	2,317	3,927
Madagascar	1992	2008	13,896	2,209	935	11,621	2,322	1,138
Malawi	1992	2010	11,965	2,156		13,468	2,678	
Mali	1995	2006	20,180	2,221	1,078	20,998	4,134	1,399
Morocco	1992	2003	14,324	6,009	1,965	11,199	4,976	1,853
Mozambique	1997	2011	20,065	4,130	2,572	16,225	7,099	1,237
Namibia	1992	2006	1,333	331		1,037	412	
Nepal	1996	2006	31,787	1,750		24,721	3,484	
Nicaragua	1998	2001	1,480	622	290	1,434	719	336
Niger	1992	2006	12,389	959	406	18,730	1,179	833
Nigeria	1990	2008	103,909	34,054	10,076	160,874	57,865	19,340
Pakistan	1990	2006	137,413	19,915	20,983	175,038	38,389	33,522
Peru	1991	2000	10,542	4,751	1,115	5,449	4,075	1,819
Rwanda	2000	2010	9,994	434		8,237	1,744	
Senegal	1992	2010	7,168	1,513	1,195	8,414	1,847	1,925
Tanzania	1991	2010	27,489	7,168	2,618	28,448	5,623	4,623
Turkey	1993	2003	12,674	11,968	7,046	10,085	9,492	4,554
Uganda	1995	2011	21,222	1,074	548	31,166	2,319	879
Zambia	1992	2007	9,270	2,873	1,173	11,231	3,228	1,716
Zimbabwe	1995	2010	6,529	2,244	171	7,664	2,051	2,005
Total			2,016,248	317,903	157,857	1,840,218	384,204	185,048
Share of deaths			80.9%	12.8%	6.3%	76.4%	15.9%	7.7%
Total excluding India			975,909	191,726	92,905	928,424	258,256	123,387
Share of deaths excl. India			77.4%	15.2%	7.4%	70.9%	19.7%	9.4%

No Evidence for Convergence

Figure 2 shows ratios of under-5 mortality rates for rural and large urban residences in the 1990s and 2000s. As the Figure illustrates, no convergence in (relative) mortality across residential areas was observed over the time period; the average rural:large-urban under-5 mortality ratio increased from 1.61 in the 1990s and 1.68 in the 2000s.

Figure 2: Ratio of rural vs. large urban mortality ratios 1990s and 2000s

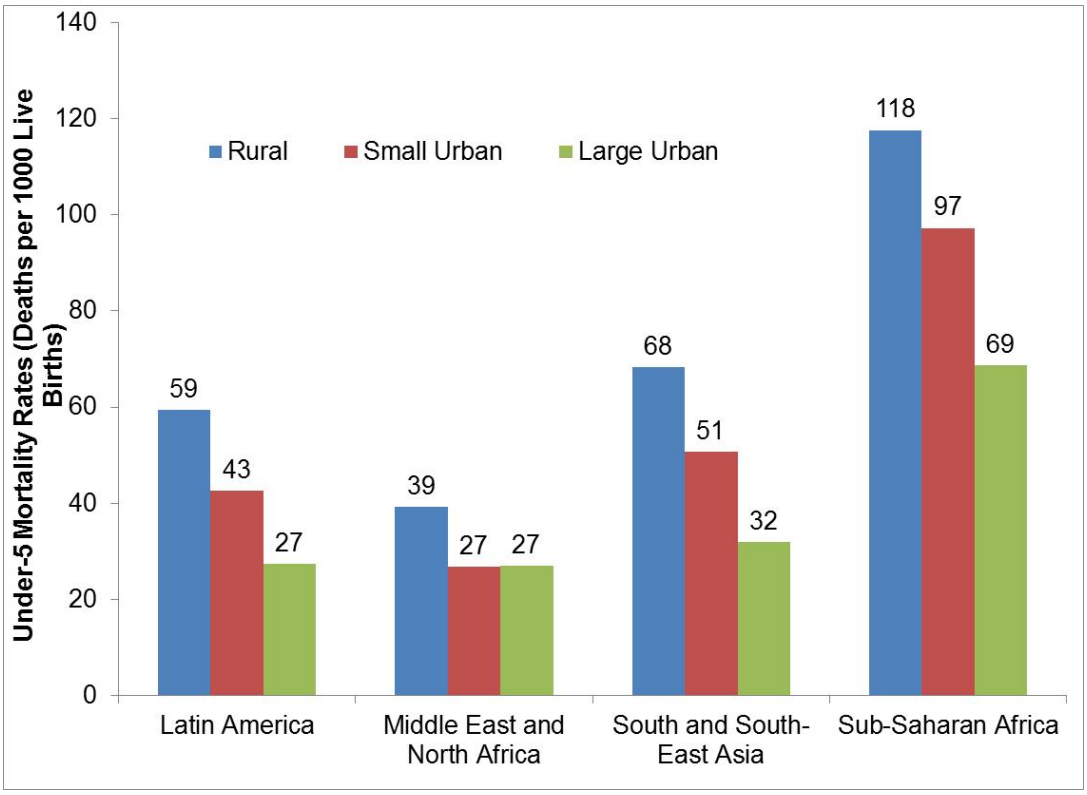


Regional Differences

Figure 3a shows estimated mortality rates by World Bank region for the 2001-2010 period. Average mortality rates were highest for sub-Saharan Africa, and lowest for the Middle East and North Africa (MENA) regions. In terms of relative mortality levels, the gaps were largest for Latin America and South & South East Asia, with relative mortality ratios (rural over large urban) of 2.17 and 2.14, respectively, and lowest for the MENA region (1.44). The overall mortality ordering appears to be rather stable; the only region where large and small urban areas

experienced similar mortality rates was MENA, which is the area which has achieved the lowest mortality rates overall.

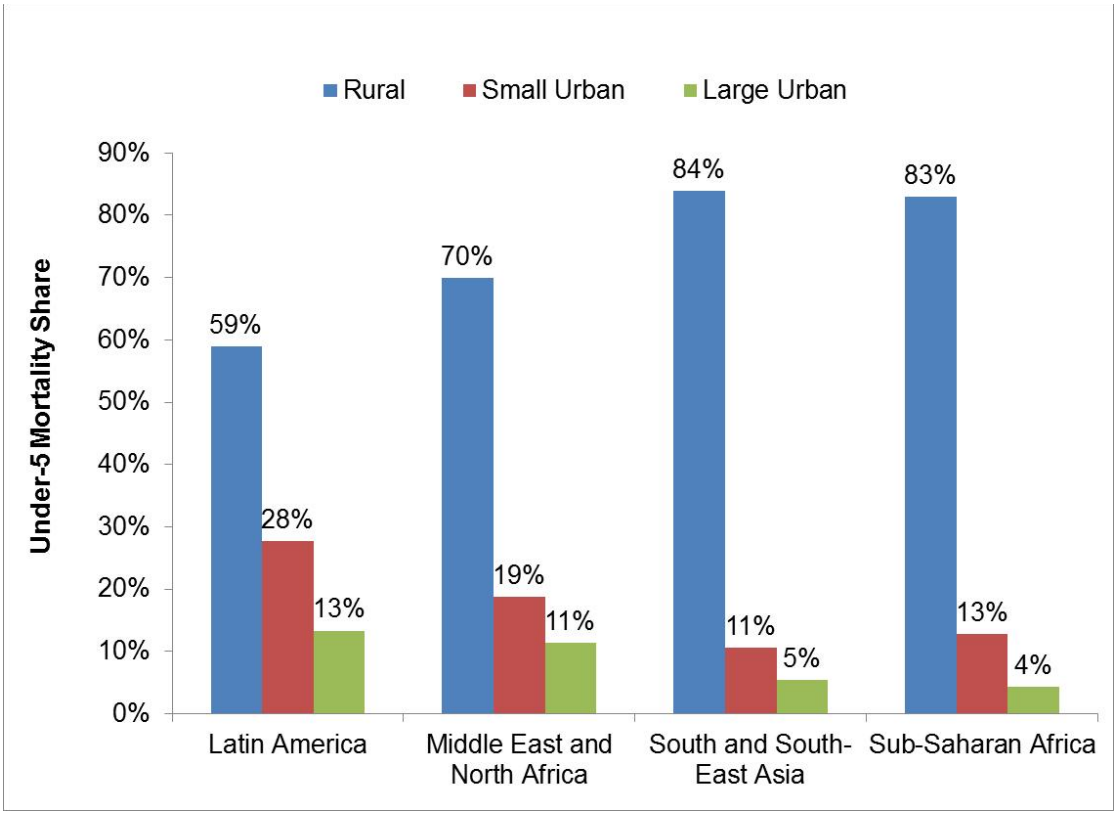
Figure 3a: Under-5 Mortality Rates by Region, 2000-2010



Note: Rates are Country Averages (which means only 4 countries in the case of MENA)

Figure 3b shows the residential distribution of the absolute number of under-5 deaths per region. Rural children accounted for the overwhelming majority of all deaths across all regions, with total under-5 mortality shares ranging between 59% (Latin American) and 84% (South & Southeast Asia). Urban mortality shares are largest in Latin American and the MENA region, the regions with the highest urban population shares.

Figure 3b: Shares of Under-5 Deaths by Type of Place of Residence and Region



Note: Shares are percentages of total death, i.e. deaths rather than country weighted.

Discussion

The results presented in this paper have yielded four main results: first, the improvements in child mortality achieved over the past two decades are sizeable, with average country-level reductions in neonatal mortality rates of about 20%, and average reductions of more than 30% in under-5 mortality rates. As a result of these improvements and increased urbanization, the total number of children dying annually has decreased substantially, a trend which has also been supported by lower absolute number of births due to declining fertility rates in many middle income countries.

Second, children in urban areas continue to fare substantially better in terms of child mortality than children in rural areas. With the exception of a few HIV-affected countries in the Southeastern part of sub-Saharan Africa, under-5 mortality rates are consistently lower in urban than in rural areas. The absolute gap between rural and urban areas has narrowed over the past 20 years; however, the relative improvements across all residential areas were rather similar, so that the rural-urban mortality ratios have roughly stayed the same over the period.

Third, despite the many challenges faced by modern metropolitan areas in developing countries, children in large cities fare substantially better than children growing up in smaller urban areas.

On average, the mortality gap between large and small urban areas was about the same as the gap between small urban areas and rural areas. Given the major health risks posed by the increased levels of environmental degradation, air pollution, traffic and violence observed in large cities in general, and poor (slum) neighborhoods in particular, the positive effect of large cities is somewhat surprising. Better access to health infrastructure, generally higher levels of education and increased domestic as well as international investment in large cities frequently corresponding to countries' capitals are likely to contribute to the this phenomenon; further research will be needed to better understand the causal factors underlying the rather wide mortality gaps observed across residential areas.

Last, despite the large improvements in child mortality observed, the overwhelming majority of child deaths continue to occur in rural areas. In rural India alone, an estimated 1.5 million children died each year in the 2001-2010 period; globally, more than three quarters of all child deaths in developing countries occur in rural areas. Even though increased rural development and continued urban migration will help to reduce this burden over time, major health efforts targeting rural populations will be critical for reducing the under-5 mortality burden over the next decades.

The study presented has several important limitations. First, even though major efforts were made to keep the study periods consistent, estimation periods depended on available survey data. As a result, the reported changes from the 1991-2000 (pre-) period to the 2001—2010 (post-) period do not necessarily correspond to 10 year changes, but rather to the changes observed between the first survey covering the 1991-2000 period and the last available survey covering the 2001-2010 period. Second, the study was restricted by the focus on the 37 countries covered by the DHS in both decades. Even though these countries account for a majority of the low-income, and for a large share of the middle-income country population, countries not covered by DHS may differ with respect to their mortality levels and trends, and the results presented here thus will not be fully representative of average trends in these country groups. Last, the study's explicit focus on measuring mortality trends implies that the study contains no information regarding the causal determinants of the declines observed beyond the shifts in countries' residential composition, which appear relatively minor over the sample period studied. Further research will be needed to better understand the contributions of various socioeconomic and health system changes to the overall improvements achieved.

Conclusions

Despite the major improvements in child mortality achieved over the past two decades, large mortality gaps persist between rural and urban areas in general, and between rural and major urban areas in particular. While increasing urban population shares will likely contribute to a lower child mortality burden over time, major health efforts will be needed to reduce the overwhelming majority of deaths occurring in rural areas.

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Appendix 1: List of 139 Low- and Middle-Income Countries

	Low-income economies ($1,025 or less)		Lower-middle-income economies ($1,026 to $4,035)		Upper-middle-income economies ($4,036 to $12,475)
1	Afghanistan	1	Albania	1	Algeria
2	Bangladesh	2	Armenia	2	American Samoa
3	Benin	3	Belize	3	Angola
4	Burkina Faso	4	Bhutan	4	Antigua and Barbuda
5	Burundi	5	Bolivia	5	Argentina
6	Cambodia	6	Cameroon	6	Azerbaijan
7	Central African Republic	7	Cape Verde	7	Belarus
8	Chad	8	Congo, Rep.	8	Bosnia and Herzegovina
9	Comoros	9	Cote d'Ivoire	9	Botswana
10	Congo, Dem. Rep.	10	Djibouti	10	Brazil
11	Eritrea	11	Egypt, Arab Rep.	11	Bulgaria
12	Ethiopia	12	El Salvador	12	Chile
13	Gambia, The	13	Fiji	13	China
14	Guinea	14	Georgia	14	Colombia
15	Guinea-Bissau	15	Ghana	15	Costa Rica
16	Haiti	16	Guatemala	16	Cuba
17	Kenya	17	Guyana	17	Dominica
18	Korea, Dem. Rep.	18	Honduras	18	Dominican Republic
19	Kyrgyz Republic	19	India	19	Ecuador
20	Liberia	20	Indonesia	20	Gabon
21	Madagascar	21	Kiribati	21	Grenada
22	Malawi	22	Lao PDR	22	Iran, Islamic Rep.
23	Mali	23	Lesotho	23	Jamaica
24	Mauritania	24	Marshall Islands	24	Jordan
25	Mozambique	25	Micronesia, Fed. Sts.	25	Kazakhstan
26	Myanmar	26	Moldova	26	Latvia
27	Nepal	27	Mongolia	27	Lebanon
28	Niger	28	Morocco	28	Libya
29	Rwanda	29	Nicaragua	29	Lithuania
30	Sierra Leone	30	Nigeria	30	Macedonia, FYR
31	Somalia	31	Pakistan	31	Malaysia
32	Tajikistan	32	Papua New Guinea	32	Maldives
33	Tanzania	33	Paraguay	33	Mauritius
34	Togo	34	Philippines	34	Mexico
35	Uganda	35	Samoa	35	Namibia
36	Zimbabwe	36	Sao Tome and Principe	36	Palau
		37	Senegal	37	Panama
		38	Solomon Islands	38	Peru
		39	Sri Lanka	39	Romania
		40	Sudan	40	Russian Federation
		41	Swaziland	41	Serbia
		42	Syrian Arab Republic	42	Seychelles
		43	Timor-Leste	43	South Africa
		44	Tonga	44	St. Lucia
		45	Ukraine	45	Vincent and the Grenadines

46	Uzbekistan	46	Suriname
47	Vanuatu	47	Thailand
48	Vietnam	48	Tunisia
49	West Bank and Gaza	49	Turkey
50	Yemen, Rep.	50	Turkmenistan
51	Zambia	51	Uruguay
		52	Venezuela, RB

Appendix Table A2: Sample Countries

	Name	Population (Millions)	World Bank Income Classification
1	Bangladesh	148.7	Low-income economies ($1,025 or less)
2	Benin	8.9	Low-income economies ($1,025 or less)
3	Bolivia	9.9	Lower-middle-income economies ($1,026 to $4,035)
4	Burkina Faso	16.5	Low-income economies ($1,025 or less)
5	Cambodia	14.1	Low-income economies ($1,025 or less)
6	Cameroon	19.6	Lower-middle-income economies ($1,026 to $4,035)
7	Chad	11.2	Low-income economies ($1,025 or less)
8	Colombia	46.3	Upper-middle-income economies ($4,036 to $12,475)
9	Dominican Rep.	9.9	Upper-middle-income economies ($4,036 to $12,475)
10	Egypt, Arab Rep.	81.1	Lower-middle-income economies ($1,026 to $4,035)
11	Ethiopia	83.0	Low-income economies ($1,025 or less)
12	Ghana	24.4	Lower-middle-income economies ($1,026 to $4,035)
13	Guinea	10.0	Low-income economies ($1,025 or less)
14	Haiti	10.0	Low-income economies ($1,025 or less)
15	India	1224.6	Lower-middle-income economies ($1,026 to $4,035)
16	Indonesia	239.9	Lower-middle-income economies ($1,026 to $4,035)
17	Jordan	6.0	Upper-middle-income economies ($4,036 to $12,475)
18	Kenya	40.5	Low-income economies ($1,025 or less)
19	Madagascar	20.7	Low-income economies ($1,025 or less)
20	Malawi	14.9	Low-income economies ($1,025 or less)
21	Mali	15.4	Low-income economies ($1,025 or less)
22	Morocco	32.0	Lower-middle-income economies ($1,026 to $4,035)
23	Mozambique	23.4	Low-income economies ($1,025 or less)
24	Namibia	2.3	Upper-middle-income economies ($4,036 to $12,475)
25	Nepal	30.0	Low-income economies ($1,025 or less)
26	Nicaragua	5.8	Lower-middle-income economies ($1,026 to $4,035)
27	Niger	15.5	Low-income economies ($1,025 or less)
28	Nigeria	158.4	Lower-middle-income economies ($1,026 to $4,035)
29	Pakistan	173.6	Lower-middle-income economies ($1,026 to $4,035)
30	Peru	29.1	Upper-middle-income economies ($4,036 to $12,475)
31	Rwanda	10.6	Low-income economies ($1,025 or less)
32	Senegal	12.4	Lower-middle-income economies ($1,026 to $4,035)
33	Tanzania	44.8	Low-income economies ($1,025 or less)
34	Turkey	72.8	Upper-middle-income economies ($4,036 to $12,475)
35	Uganda	33.4	Low-income economies ($1,025 or less)
36	Zambia	12.9	Lower-middle-income economies ($1,026 to $4,035)
37	Zimbabwe	12.6	Low-income economies ($1,025 or less)