Maternal Cumulative Prevalence Measures of Child Mortality: New Perspectives on the Mortality Burden in Sub-Saharan Africa

Emily Smith-Greenaway[1]
Department of Sociology
University of Southern California
851 Downey Way
Los Angeles, CA 90089
smithgre@usc.edu
213. 740.8869

Jenny Trinitapoli
Department of Sociology
University of Chicago
1126 E. 59th St.
Chicago, IL 60637

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[1] Corresponding author

Significance (120 word max)
Over the past half-century, infant and under-five mortality rates have fallen worldwide, reaching all-time-low levels. Even so, in many low-income settings, the death of a child remains a common parental experience. To quantify the burden of mortality from a new perspective, we generate population-level mortality indicators that estimate the prevalence of mothers who have ever experienced an infant, under-five-year-old, or any-age child die. The maternal cumulative prevalence of infant mortality (mIM), under-five mortality (mU5M), and offspring mortality (mOM) show that in many contemporary African settings a majority of mothers have experienced the death of at least one child. These indicators enhance our understanding of the levels and distributions of the mortality burden.

Abstract (250 word max)
We advance a new set of population-level indicators that quantify the prevalence of mothers who have ever experienced an infant, under-five-year-old, or any-age child die. The maternal cumulative prevalence of infant mortality (mIM), under-five mortality (mU5M), and offspring mortality (mOM) have both theoretical and practical value for a variety of disciplines. Here, we calculate and display maternal cumulative prevalence measures of mortality for multiple age-groups of mothers in 20 sub-Saharan African countries with Demographic and Health Survey data spanning more than two decades. The exercise demonstrates the persistently high prevalence of African mothers that have ever experienced a child die. In some African countries, more than one-half of 45- to 49-year-old mothers have experienced the death of a child under age five, and nearly two-thirds have experienced the death of any child, irrespective of age. Fewer young mothers have experienced a child die, yet in many countries, up to one-third have. Our results further show that the mIM and mU5M can follow distinct trajectories from the IMR and U5MR, offering an experiential view of mortality decline that annualized measures conceal. These measures can be adapted to quantify the prevalence of recurrent offspring mortality (mROM) and calculated for subgroups to identify within-country inequality in the mortality burden. These indicators offer a new perspective on global inequality and can be used to improve current understandings of mortality change, bereavement as a public health threat, and population dynamics.

Dramatic reductions in the infant and under-five mortality rate (IMR and U5MR) over the past half century are among the global health community's most notable achievements [1]. The trends are clear, and the message is positive: the world today is healthier and safer for young people than ever before.

Sub-Saharan African countries have experienced some of the swiftest reductions in the IMR and U5MR [2]. However, the all-time-low IMRs and U5MRs conceal the pervasiveness with which contemporary populations experience children die. The IMR and U5MR provide annualized snapshots of a population's mortality regime; these measures are, by design, amnesiac to any legacy of higher mortality. Yet, many African mothers today had children under higher mortality conditions, and these conditions persist in surviving mothers' lives. Moreover, because each live birth exposes mothers to the risk of a child dying, high fertility multiplicatively increases African mothers' lifetime likelihood of experiencing a child's death. The clustering of deaths among siblings in high-mortality countries is well-documented [3], yet we lack population-level measures that summarize the mortality burden from the perspective of parents.

We present new population-level mortality measures that estimate the proportion of mothers in a population who have experienced the loss of a child. Specifically, we calculate the cumulative prevalence of mothers who have ever experienced an infant death, the death of a child under age five, or the death of a child of any age (i.e., offspring mortality) for distinct age-groups of mothers in 20 sub-Saharan African countries over two decades. We express these estimates per 1,000 mothers and term them as follows: the maternal cumulative prevalence of infant mortality (mIM), under-five mortality (mU5M), and offspring mortality (mOM). By comparing the mIM and mU5M to their orthodox counterparts, the IMR and U5MR, we demonstrate that the mIM and mU5M can follow trajectories that deviate from the annualized IMR and U5MR. The mOM summarizes high levels of mortality among older children and adolescents. Each indicator can be expanded to estimate recurrent offspring mortality (mROM) or tailored to particular sub-populations and used to evince within-country inequality in the mortality burden. Maternal cumulative prevalence indicators offer an experiential view of how annualized mortality rates are manifest in the lives of ordinary mothers.

Quantifying mothers' experiences of child death is valuable for at least three reasons. First, these estimates offer new evidence of global inequality. Recent scholarship from high-income settings identifies death in one's family as an underappreciated source of social inequality [4, 5]. The death of a child, in particular, is a major life stressor with long-term consequences [6]. In the West, bereaved parents are at elevated risk of serious and persistent psychological problems [7-9], physical health deterioration [7, 10, 11], and relationship strain [7]. The generalizability of these results to African contexts is unknown, but select studies similarly conclude that bereaved mothers in sub-Saharan Africa are vulnerable in myriad ways. Even where mothers are accustomed to, and skilled at, navigating uncertain environments [12], a child's death can lead to guilt and blame, stigma, stress, and relationship strain [13-17].

Second, clarifying the burden of child death among mothers has theoretical significance for understanding population change [18-20]. Demographic transition theory links declining death rates, driven primarily by reductions in the IMR and U5MR, to subsequent declines in birth rates [21-24]. A presumed bridge between these processes is mothers' experience of child mortality—both personal experience and what women witness among the mothers around them [25-28]. Even as micro-level studies show that women's observations of mortality in their networks and communities inform their child mortality perceptions, their fertility desires, and related behaviors [27-32], the link between the IMR and fertility is weak at the macro-level [33, 34]. Mother-centered measures of child mortality may better operationalize an average woman's mortality perceptions and, thus, more

accurately estimate the relationships between a population's mortality conditions and women's fertility behaviors.

Third, mother-centered measures facilitate a shift from the global community's intensive focus on under-five mortality and consider child deaths more comprehensively. The prioritization of infant and child survival in sub-Saharan Africa is warranted. Yet, childhood, adolescent, and young-adult mortality rates are also high across the region [35]. The region's mortality conditions are so harsh that there is a unique pattern of positive health-selection into adulthood—unlike other world regions, only the healthiest survive in Africa [36]. Mortality conditions at age six and beyond suggest that a sizeable proportion of mothers will experience older children or adolescents die.

Material and Methods

To construct the maternal cumulative prevalence indicators, we use Demographic and Health Surveys data from 20 sub-Saharan African countries.[2] See **S1** for a list of countries, survey years, and analytic sample sizes.

Our calculations are based on women who have ever had a child, beginning with the mIM: the prevalence of mothers who have experienced the death of at least one infant. We sum the number of mothers who had a child die before age one, among those who ever had a live birth, and express this per 1,000 mothers. We calculate these indicators separately for women of reproductive age (20 to 44 years old) and those completing their reproductive years (45 to 49 years old). Note that we exclude mothers younger than 20 years old from our primary analyses, but report estimates of the mIM among 15- to 19-year-olds in **S2**[3].

In supplementary analyses, we disaggregate mothers into five-year age-groups (20-24, 25-29, 30-34, 35-39, 40-44) to explore differences by age and cohort (see **S3** and **S4**).

Next, to estimate the mU5M we do the same for mothers who have ever had a child die before reaching age five. Comparisons to the IMR and U5MR rely on published DHS estimates [37]. Finally, we estimate mothers' experience of offspring mortality (mOM), that is, the prevalence of mothers who have experienced a child death, regardless of the child's age at the time of death. We calculate the mOM for 45- to 49-year-old mothers and extend the measure to estimate the cumulative prevalence of recurrent offspring mortality (mROM) among this same age-group.

Maternal cumulative prevalence indicators are susceptible to three measurement concerns. First, estimates are based on self-reports, which tend to undercount deaths. Our estimates are thus conservative, especially for older mothers who tend to provide incomplete data [38]. Because we use the same data source to generate IMRs and U5MRs, this bias applies equally to these measures.

Second, some of the world's highest maternal mortality rates are in sub-Saharan Africa [39], and our estimates omit deceased mothers, who may have experienced higher levels of offspring mortality than surviving mothers. Survivor bias will also lead to conservative estimates. Moreover, because HIV/AIDS causes joint maternal-child deaths, our estimates may be especially conservative in countries with severe HIV epidemics.

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[2] Because of our interest in trends, we present only the analyses for countries in which DHS data have been collected since the late 1980s/early 1990s through 2000s. Estimates from all other countries with DHS data available since 2010 are in **S1**.

[3] In no country-years have one-half of this age-group even had a child; in recent years fewer than 15% have. Because the populations of 15-19-year-old mothers are small and comprised of highly selected mothers, we exclude them. As shown in **S2**, these estimates are nearly identical to the IMR: young mothers have had only one child, and they did so recently, under current mortality conditions. Nonetheless, that more than 50 teenage mothers per 1,000 have had an infant die in multiple countries raises questions about vulnerabilities associated with bereavement at such a young maternal age.

Third, the maternal cumulative prevalence indicators are subject to multiple sources of censoring and are sensitive to the fertility conditions (e.g., age at first birth, fertility rate, birth spacing) that characterize each country-year. To address the biases introduced by one type of censoring, in supplementary analyses we adopted a probability-based approach, wherein we adjust for variation in the duration of motherhood (i.e., exposure) using the inverse of the Kaplan-Meier survivor function to estimate the probability of a mother experiencing an infant, under-five-year-old, or any-age child die by a specific age. Mothers begin the hazard at the year of first birth and fail when they experience an infant, under-five-year-old, or any-age child die. This approach produces slightly higher estimates for mothers age 20 to 44[4] and almost identical estimates for mothers age 45 to 49 (results available upon request), confirming that the simple proportions provide accurate but conservative estimates of the cumulative burden of child death on mothers.

Results

Fig. 1 depicts trends in the mIM among reproductive-age mothers (20 to 44 years old) and mothers age 45 to 49, relative to the IMR over three decades for 20 African countries. The magnitude of the shift from a live-birth-oriented perspective on mortality conditions to a mother-focused one is stark.

During the late 1980s and early 1990s, approximately one-third of surviving mothers age 20 to 44 in almost all countries had experienced the death of at least one infant. For example, in Niger and Malawi, the IMR stood at roughly 100 deaths per 1,000 live births during the early 1990s, which corresponds to roughly 400 mothers having lost an infant per 1,000 reproductive-age mothers. The mIM for mothers age 45 to 49 is far higher. In Benin, Burkina Faso, Liberia, Malawi, Mali, and Niger, having had at least one infant die was a more common experience than having had all of one's children survive infancy. Only in Namibia is the mIM lower than 100 among reproductive-age mothers (90 per 1,000 in 2013). In no country has the mIM fallen below 100 per 1,000 for mothers age 45 to 49, and only in Benin, Kenya, Namibia, and Zimbabwe has it fallen below 200.

Fig. 2 depicts comparable trends in the mU5M and the U5MR. Throughout the 1980s and 1990s, about one-fifth of live births in sub-Saharan Africa ended in death before age five. In the vast majority of countries, however, the mU5M for mothers age 45 to 49 exceeded 500—more than one-half of mothers. The mU5M was as high as 750 per 1,000 mothers age 45 to 49 in Benin, Burkina Faso, Malawi, Mali, Niger, and Senegal.

U5MRs have dropped precipitously in recent years; mU5M levels, however, remain astonishingly high. As recently as 2010, the mU5M was above 500 per 1,000 mothers age 45 to 49 in Burkina Faso, Liberia, Malawi, Niger, Nigeria, Rwanda, Tanzania, and Uganda. In all countries save five (Benin, Ghana, Kenya, Namibia, Zimbabwe), more than 200 per 1,000 mothers age 20 to 44 had lost a child under age five.

Figs. 1 and **2** also depict the complex correspondence between standard, live-birth-oriented mortality measures and these cumulative, mother-centered indicators. Generally speaking, where the reduction in the IMR has been steep, the mIM tends to follow a similar trajectory. Yet the two measures diverge in some countries. In Uganda, for example, the mIM remained stable even as the IMR fell (see **Fig. 1**). A similar pattern is evident in Niger where, for a select period, stable mortality rates were accompanied by distributional shifts that show even higher prevalence of child death among surviving mothers (see **Fig. 2**). The opposite pattern characterizes Kenya, Rwanda, and

[4] The projected probabilities are based on older mothers' past mortality experiences; against the backdrop of dramatic mortality, and in some cases fertility, decline, this is problematic. Due to reductions in mortality and fertility, current 20-year-olds are unlikely to experience the same level of child loss as older mothers. This concern motivated us to adopt a parsimonious estimation strategy that requires fewer assumptions.

Zimbabwe: as the IMR increased, the mIM declined. These divergences could be driven by a complex set of adjacent population changes, including changing causes of death manifesting in shifts in the number of mothers affected; fertility change, which can alter both a mother's exposure and her children's risk of mortality [40]; reductions in joint maternal-neonatal deaths; changing patterns of sibling death clustering [3]; or a combination.

Because the 20 to 44 age-range is wide, it conceals considerable variation in factors like duration of motherhood, number of children, and age profile of children. We calculate the mIM and mU5M for five-year age-groups (see **S3** and **S4**), which allows us to index the experiences of specific age-groups. Compared to older mothers, few young mothers have experienced child loss. Even so, the mIM and mU5M often exceed the IMR and U5MR. For instance, as recently as 2010, the mU5M stood at 200 per 1,000 young mothers (age 25 to 29) in eight countries (Burkina Faso, Cameroon, Cote d'Ivoire, Liberia, Mali, Niger, Nigeria, and Uganda) and exceeded 300 per 1,000 mothers in two (Burkina Faso and Niger). Even if the U5MR could be reduced immediately (i.e., aligned with European levels), decades from now large shares of mothers in these populations will have experienced the death of at least one small child. **S3** and **S4** show that mortality improvements are dissimilar across distinct age-groups of mothers, revealing heterogeneity our conventional mortality metrics do not capture.

Beyond Infancy and Early Childhood: mOM and mROM

Fig. 3 depicts the prevalence of surviving mothers (age 45 to 49) who ever experienced a child die, regardless of the child's age at death. To offer a sense of scale, we simultaneously plot the corresponding mIM and mU5M. The mOM show that deaths of older children and adolescents are prevalent and essential to fully capturing the magnitude of child loss in sub-Saharan Africa. As recently as 2010, in 12 countries (Burkina Faso, Cameroon, Cote D'Ivoire, Liberia, Malawi, Niger, Nigeria, Rwanda, Senegal, Tanzania, Uganda, and Zambia) more than one-half of mothers age 45 to 49 had lost at least one child. In some countries, relatively few mothers (10%) who see all their children survive to age five experience an older child die; in other settings (e.g., Kenya, Namibia, and Zimbabwe, which have relatively low U5MRs), however, about 20% of mothers who experience offspring mortality by age 45 to 49 never experienced an under-five death.

The indicators presented thus far capture the prevalence of mothers who experienced at least one child die; we now adapt this approach to estimate the prevalence of recurrent offspring mortality. **Fig. 4** depicts the mROM as a share of the mOM for 45- to 49-year-old mothers. In the 1980s and 1990s, more than 500 mothers per 1,000 in Benin, Burkina Faso, Liberia, Malawi, Mali, Niger, Rwanda, and Senegal had experienced two or more children die. As recently as 2010, the figure stood at around or above 200 per 1,000 mothers in every country but Kenya, Namibia, and Zimbabwe. Viewed alongside the mOM, we see that changes in the prevalence of child loss do not always track neatly with shifts in the prevalence of mothers experiencing recurrent losses.

Calculating Maternal Cumulative Prevalence Indicators for Additional Populations

Our analyses focused on a subsample of 20 sub-Saharan African countries in which the DHS program has collected data from the early 1990s through 2010, allowing for an analysis of change over time. **S1** includes estimates for 16 additional African countries that fielded a DHS survey in the past decade. Population-health researchers can easily calculate the mIM, mU5M, and mOM annually and publish them alongside standard measures like the IMR and U5MR to offer a new, distinct view of mortality conditions. Because they draw on routinely collected data, their addition adds little burden to measurement systems in low-income countries.

Where nationally representative data on mothers' age and child loss is unavailable, researchers can estimate mother-centered mortality measures indirectly by adapting the equation used for estimating the lifetime risk of maternal mortality [41].[5] Supplementary analyses demonstrate that the indirect method estimates the mU5M within approximately 10% of the mU5M values shown in **S1**, although this approach generates estimates that are less accurate for the mIM. Nonetheless, this approach generates rough estimates in settings where the minimally requisite reproductive histories are unavailable.

Conversely, where micro-data are available, these measures can be calculated at smaller aggregates, allowing researchers to study the more immediate subnational or community contexts within which mothers live. To illustrate, **S5** displays the mOM for each of the 20 focal countries, by subnational region, revealing stark subnational differences in the prevalence of mothers who have experienced a child die. Mother-centered indicators further illuminate inequality in the mortality burden across social groups, for example, by wealth quintile (see **S6**)**.** As depicted in **S6**, mortality change has benefited mothers in certain social strata more than others: in many countries, only mothers in the wealthiest households are meaningfully insulated from child loss.

Discussion

Focusing on sub-Saharan Africa, we show that even in the wake of notable improvements in mortality conditions, the death of a child remains an extraordinarily common experience: between one-quarter and one-half of mothers in contemporary African populations have experienced the death of at least one child. These findings have implications for public health and population theory.

Given the prevalence of offspring mortality in contemporary Africa, the limited empirical work on its consequences is problematic. A rich literature details the far-reaching and long-lasting consequences of child death for parents in high-income countries [6], yet research on African settings primarily concerns itself with whether child mortality affects women's subsequent fertility—with the exception of a few studies [13-17], the subsequent disadvantages for African mothers remain under-studied. Bereavement should be prioritized as a scholarly issue on a global scale, and it should be engaged in policy circles as a true threat to public health in sub-Saharan Africa.

By summarizing a mortality regime from the perspective of mothers, these indicators can inform theories of population change, especially to the extent that they approximate the mortality burden women perceive. Mortality perceptions are notoriously complex; they are strongly informed by the experiences of similar others [32] and tend to be over-assessed in comparison to true mortality levels due to cognitive biases [42]. For example, cognitive research on negativity bias suggests child survival in one's network is a forgettable, null event, whereas a child's death registers as memorable and influential. Cognitive research on the primacy effect suggests time is also a factor: women's mortality perceptions may be anchored in their own childhood conditions, giving more weight to earlier experiences and less weight to contemporary patterns and events. Insights from this study suggest yet another possible explanation: elevated mortality perceptions among women could be driven by their treatment of the denominator when assessing risk. Psychologists frequently point to "denominator neglect" in puzzles of risk assessment [43], but we posit that cognitive egocentrism may mean that women perceive child death as a fundamentally maternal phenomenon—placing themselves and other mothers in the denominator. From this perspective, it follows that mothers' mortality perceptions are calibrated to the prevalence of mothers that have experienced children die, rather than the number of live births that have ended in death.

[5] The equations are $mIM=1-((1-IMR)^{TFR})$; $mU5M=1-((1-U5MR)^{TFR})$.

To explore this idea, we turned to a population-based study in Malawi. Tsogolo La Thanzi [44] measured young women's perceptions of infant mortality using an interactive elicitation method [45] in which interviewers gave respondents 10 beans and asked the women to shift from one plate to another the number of beans representing the likelihood that a child born today would die within the year. In 2009, the mean response was two beans, which we interpret as women perceiving that, on average, 20% of infants would die—a major overassessment because at this time the IMR stood at 58.4 deaths per 1,000 births [46]. The mIM for mothers age 20 to 44 in Malawi, however, was 237 in 2010. This close correspondence between perceived survival probability and the mIM suggests that, when contemplating the risks infants face, women may be thinking of the mothers around them, not about live births.

By quantifying the burden of child death on African mothers, mother-centered indicators of mortality add a new dimension to contemporary and historical portraits of mortality decline. These new measures quantify the extent to which a legacy of high mortality lives on in surviving mothers: even though mortality rates have declined, the number of African mothers who have lost a child remains very high. If these measures truly approximate the mortality perceptions held by surviving adults in a population, they may possess more predictive power vis-à-vis fertility behaviors than the IMR. These measures could thus be leveraged to shed new light on fertility decline and the unique patterns of family change that characterize sub-Saharan Africa [47-49]. The simultaneous deployment of these maternal cumulative prevalence measures alongside standard annualized measures will be valuable descriptively for scholars of global health and analytically relevant for research on inequality, mortality trends, child bereavement, and population dynamics.

Data availability

All data used in this study are publicly available. Demographic and Health Survey data are available at https://dhsprogram.com/ & http://statcompiler.com/en/. Tsogolo la Thanzi data are available at https://www.icpsr.umich.edu/icpsrweb/DSDR/studies/36863. Replication files will be posted at: [www.redacted_for_blind_review.com].

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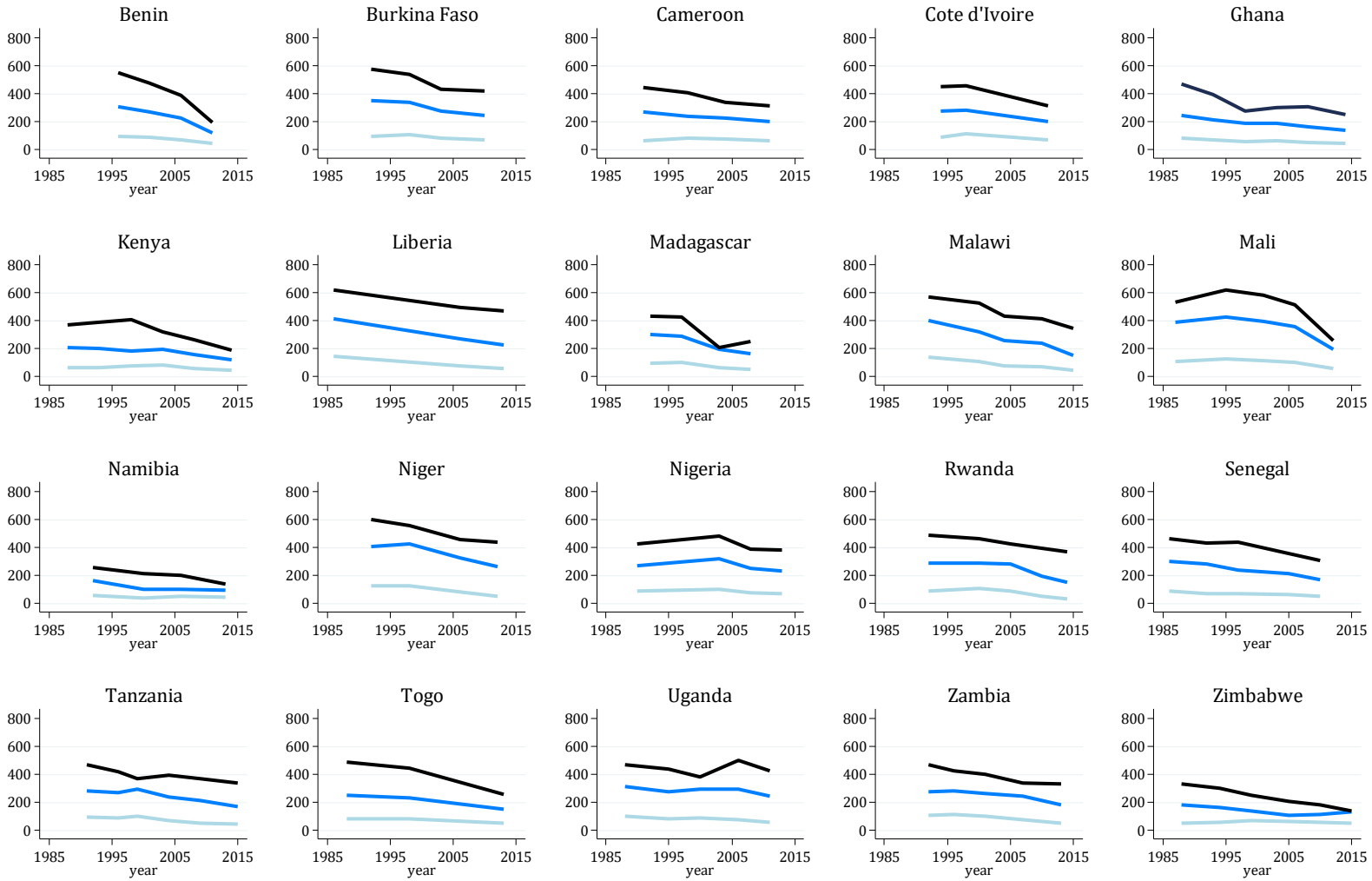
Figure Legends

Fig. 1 Infant mortality rate (IMR) & maternal cumulative prevalence of infant mortality (mIM) for mothers age 20 to 44 and age 45 to 49 in 20 sub-Saharan African countries between c. 1990s and c. 2010. Expressed per 1,000 live births (IMR) & 1,000 mothers (mIM).

Fig. 2 Under-five mortality rate (U5MR) & maternal cumulative prevalence of under-five mortality (mU5M) for mothers age 20 to 44 and age 45 to 49 in 20 sub-Saharan African countries between c. 1990 and c. 2010. Expressed per 1,000 live births (IMR) & 1,000 mothers (mU5M).

Fig. 3 Maternal cumulative prevalence of infant mortality (mIM), under-five mortality (mU5M), & offspring mortality (mOM) among mothers age 45 to 49 in 20 sub-Saharan African countries between c. 1990 & c. 2010. Expressed per 1,000 mothers.

Fig. 4 Maternal cumulative prevalence of offspring mortality (mOM) & recurrent offspring mortality (mROM) among mothers age 45 to 49 in 20 sub-Saharan African countries between c. 1990 & c. 2010. Expressed per 1,000 mothers.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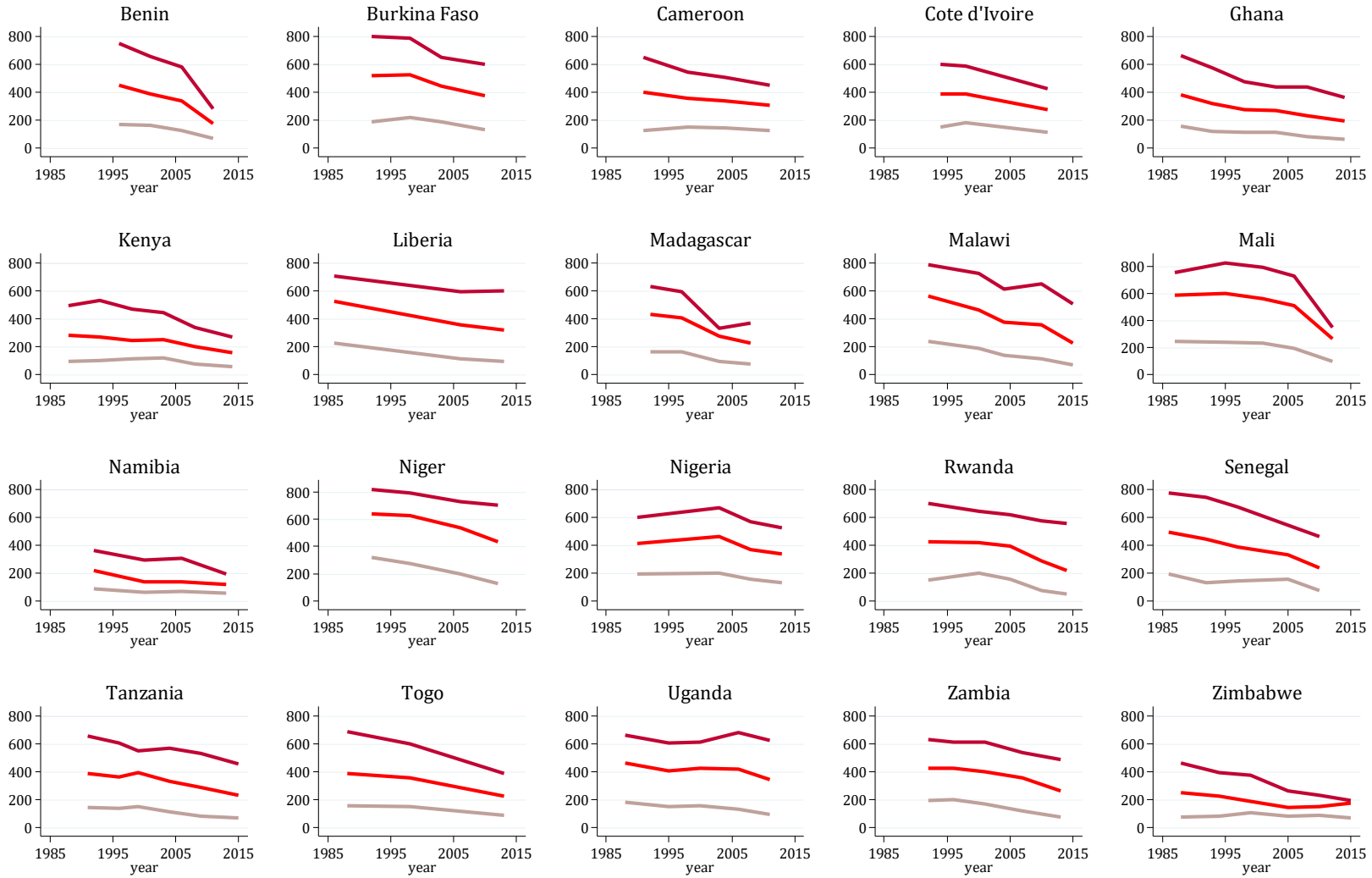
mIM (20-44 yr olds)
mIM (45-49 yr olds)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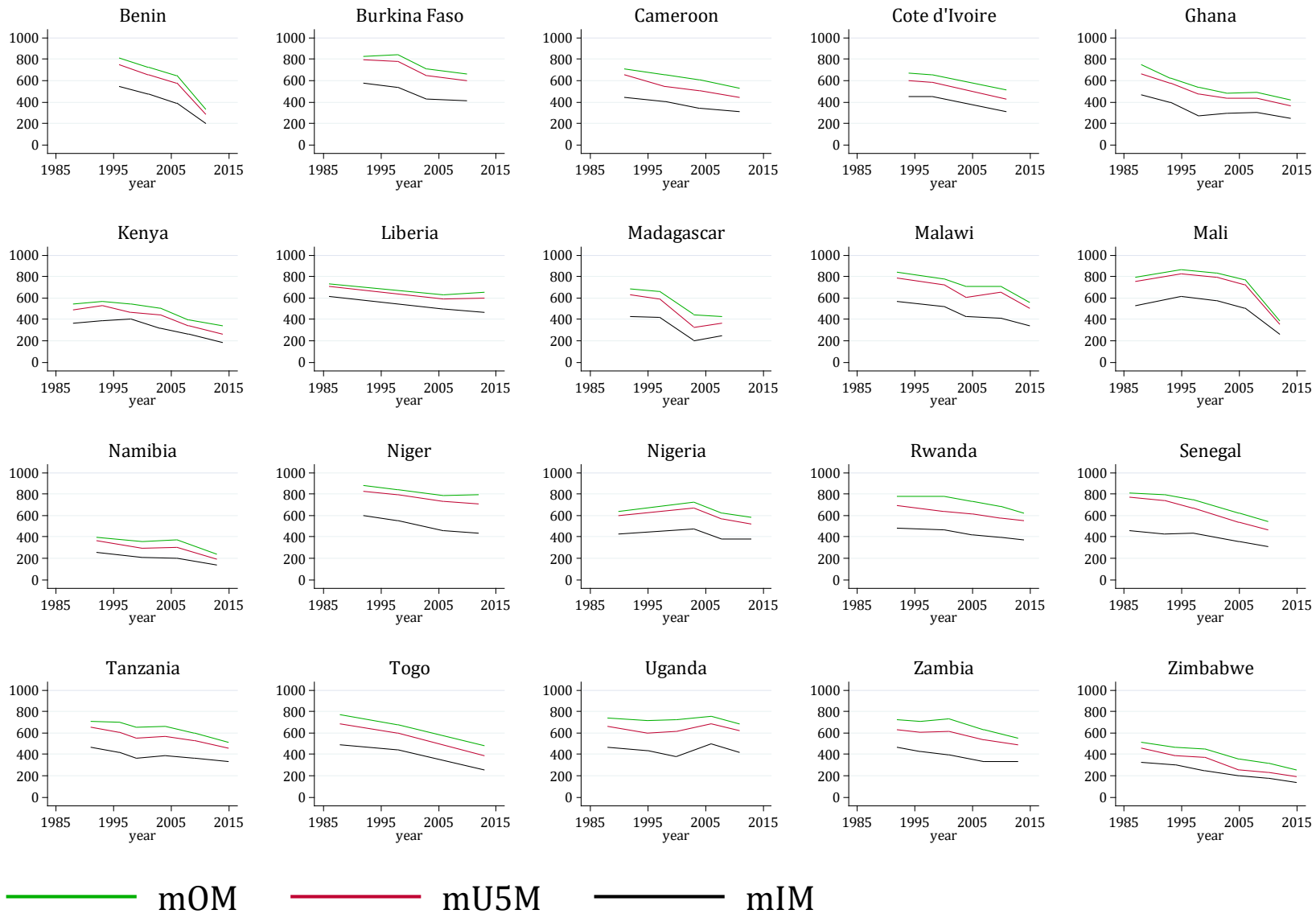
mU5M (45-49 yr olds)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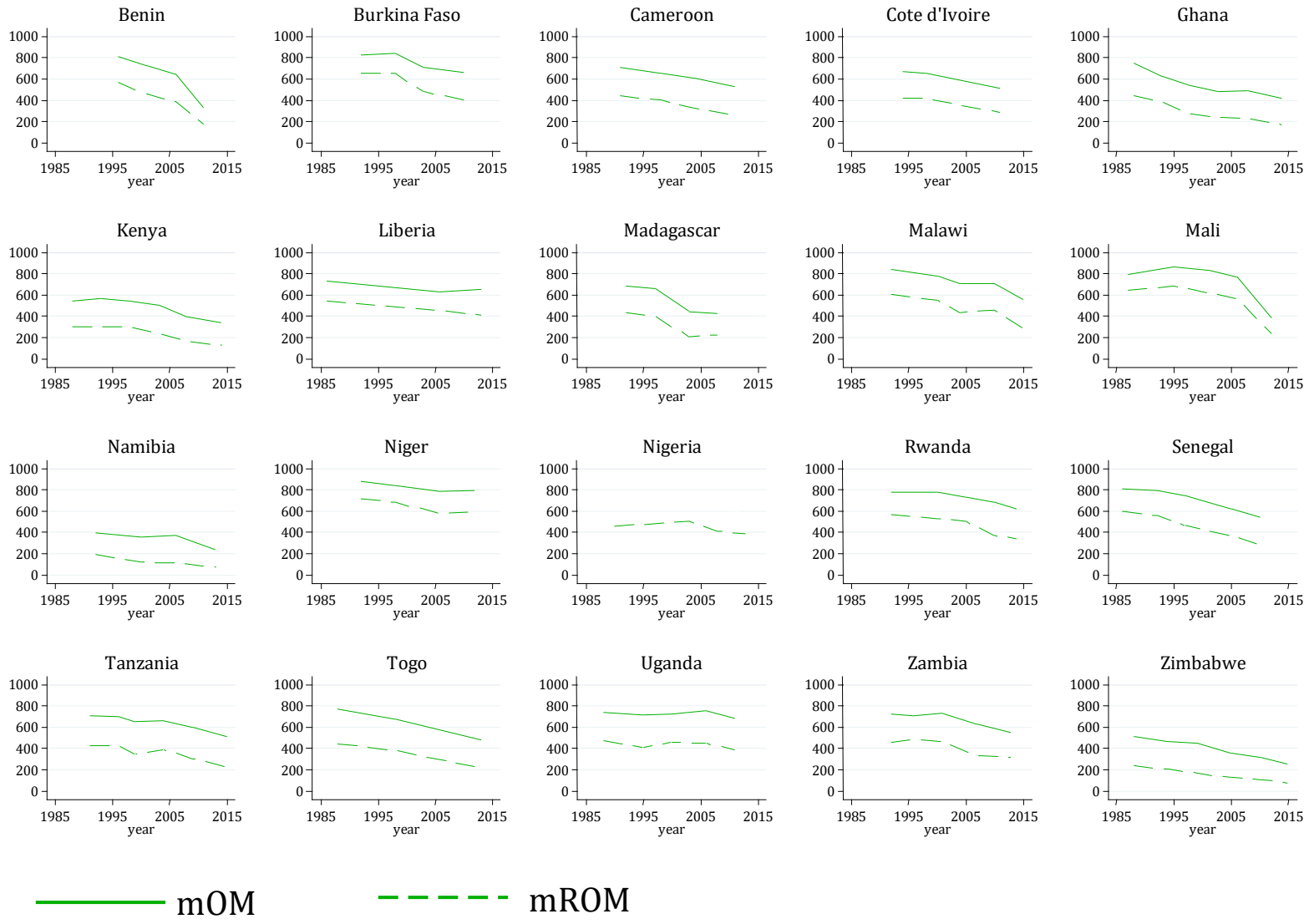
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S1. Maternal Cumulative Prevalence Estimates of Mortality, by country and year, for sub-Saharan Africa

		mIM maternal cumulative prevalence of infant mortality			**mU5M** maternal cumulative prevalence of under-five mortality			**mOM** maternal cumulative prevalence of offspring mortality	**mROM** maternal cumulative prevalence of recurrent offspring mortality	**N** analytic sample size, 20-49 year-old mothers
Country[a]	**Year**	**20-44**	**45-49**	**IMR**[b]	**20-44**	**45-49**	**U5MR**[b]	**45-49**	**45-49**	
Angola	2015-16	168	310	44	225	442	68	484	343	10054
Benin	1996	308	548	94	450	751	166	808	568	4045
	2001	268	473	89	386	652	160	728	456	4421
	2006	223	388	67	334	579	125	649	385	13291
	2011-12	118	191	42	174	277	70	326	169	12117
Burkina Faso	1992	346	574	94	520	799	187	829	653	4461
	1998-99	337	538	105	521	784	219	845	654	4636
	2003	275	430	81	440	648	184	706	480	9002
	2010	243	415	65	372	599	129	666	402	12654
Burundi	2016-17	188	349	47	258	530	78	608	316	10845
Cameroon	1991	265	441	64	396	652	125	710	440	2578
	1998	233	402	77	353	544	151	658	401	3552
	2004	225	339	74	338	507	144	611	326	6941
	2011	198	312	62	306	446	122	530	263	10225
Chad	2014-15	274	383	72	403	564	133	633	441	13012
Comoros	2012	111	203	36	136	254	50	298	120	2807
Congo	2011-12	132	221	39	198	351	68	429	146	8058
Congo Demogratic Republic	2013/14	209	340	58	294	484	104	558	342	13258
Cote d'Ivoire	1994	276	448	89	388	600	150	674	420	5552
	1998-99	278	455	112	385	586	181	655	417	1886
	2011-12	199	314	68	272	424	108	516	284	7050
Eswatini	2006-07	153	269	85	202	346	120	452	186	9915
Ethiopia	2016[c]	214	385	48	264	520	67	594	333	3250
Gabon	2012	110	201	43	150	292	65	384	156	5851
Gambia	2013	128	246	34	183	374	54	421	222	6471
Ghana	1988	242	467	77	380	664	155	747	444	3289
	1993	209	394	66	317	575	119	624	385	3356
	1998	183	271	57	274	473	108	536	269	3399
	2003	184	297	64	267	438	111	480	238	3869
	2008	159	304	50	231	438	80	488	230	3193
	2014	135	251	41	189	364	60	419	174	6327

NOTE: All maternal cumulative prevalence estimates are stated per 1000 mothers in the specified age-group and calculated from full birth histories collected by the DHS. Estimates are weighted as per DHS recommendations, unless otherwise specified (*).

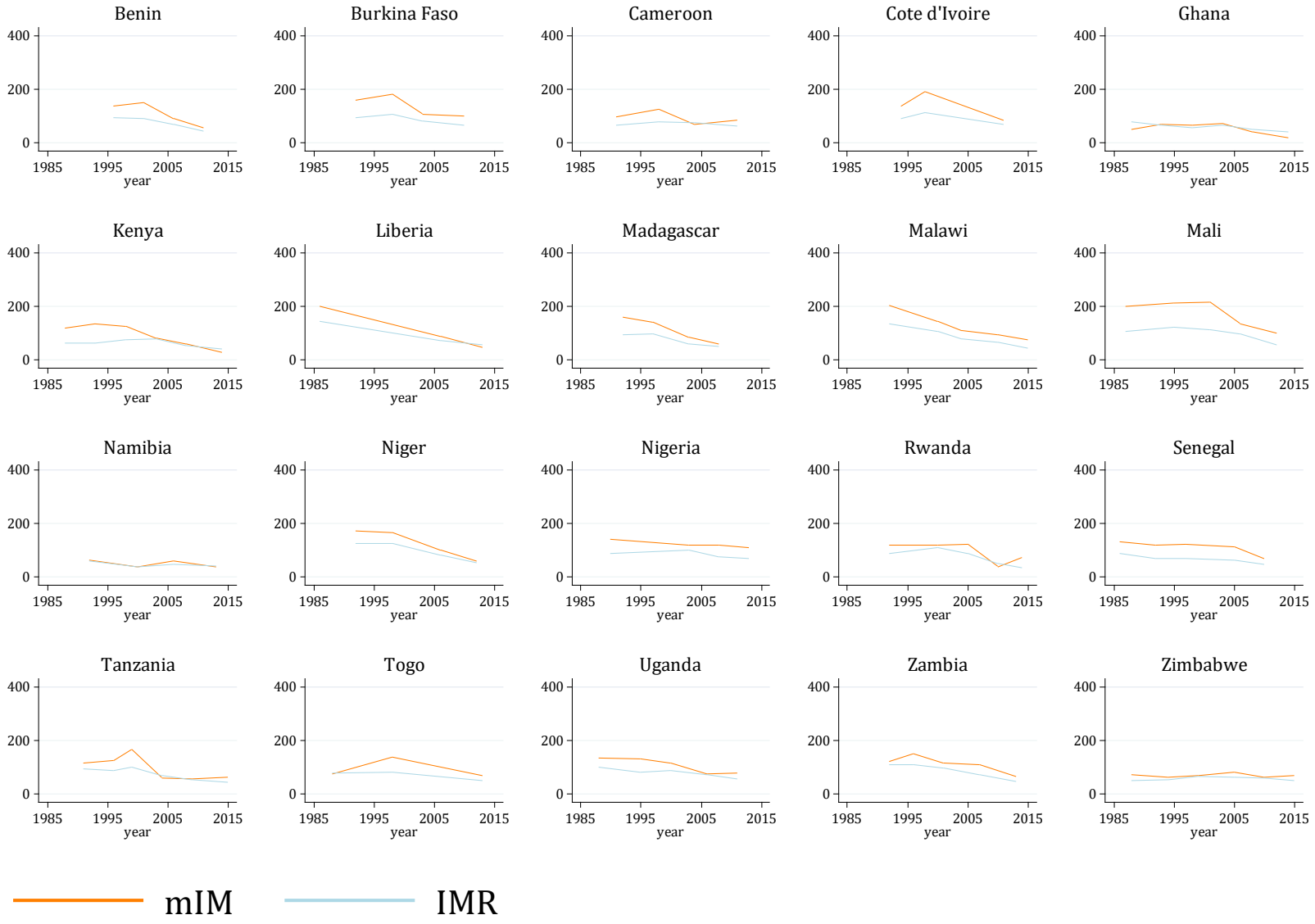
[a]Shaded countries excluded from trend figures; [b]Estimates published by the DHS: https://dhsprogram.com/; [c]Gregorian Calendar

S1. Maternal Cumulative Prevalence Estimates of Mortality, by country and year, for sub-Saharan Africa, cont.

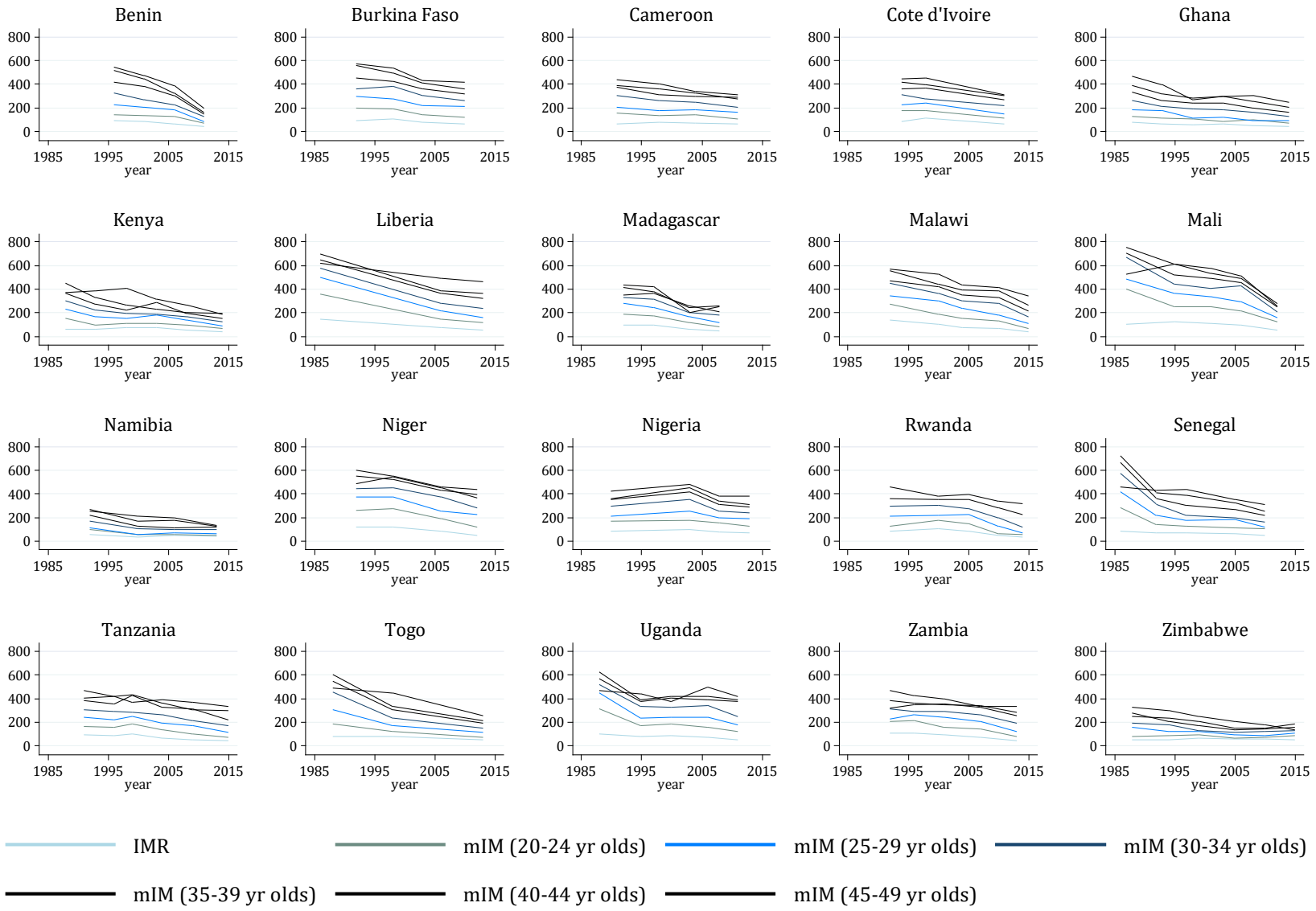
		mIM			mU5M			mOM	mROM	N
Country	**Year**	**20-44**	**45-49**	**IMR**	**20-44**	**45-49**	**U5MR**	**45-49**	**45-49**	
Guinea	2012	237	380	67	336	540	123	612	391	6394
Kenya	*1988-89	203	369	61	278	493	90	544	301	5172
	1993	200	388	62	270	530	96	566	300	5119
	1998	180	404	74	241	470	111	545	302	5386
	2003	191	318	77	247	439	115	509	243	5523
	2008-09	152	263	52	201	339	74	396	169	5801
	2014	119	189	39	156	265	52	338	128	22347
Lesotho	2014	135	219	59	168	271	85	368	103	4312
Liberia	*1986	413	618	144	526	708	222	734	548	3759
	2006-07	265	494	71	355	591	110	631	456	5339
	2013	224	465	54	318	597	94	654	414	6966
Madagascar	1992	300	431	93	432	630	163	689	436	4053
	1997	283	422	96	402	590	159	666	404	4760
	2003-04	193	202	58	272	329	94	440	209	5510
	2008-09	164	248	48	226	369	72	430	226	11915
Malawi	1992	401	569	135	561	786	234	838	609	3442
	2000	316	524	104	458	723	189	780	550	9581
	2004	256	431	76	370	609	133	709	438	8681
	2010	237	410	66	355	651	112	711	456	17001
	2015-16	151	341	42	223	502	64	564	290	17834
Mali	*1987	386	528	105	584	755	247	795	646	2454
	1995-96	421	614	122	599	827	238	866	688	7277
	2001	390	578	113	561	795	229	831	621	9544
	2006	357	510	96	511	727	191	769	570	10629
	2012-13	191	253	56	263	348	95	377	233	7858
Mozambique	2011	228	339	64	295	476	97	551	334	9745
Namibia	1992	163	255	57	218	362	84	394	195	3471
	2000	96	209	38	136	293	62	357	121	4547
	2006-07	98	198	46	134	303	69	369	111	6329
	2013	90	137	39	118	191	54	243	77	6167
Niger	1992	402	598	123	641	823	318	882	720	4664
	1998	420	552	123	632	795	274	839	682	5337
	2006	326	455	81	539	730	198	785	582	6708
	2012	260	435	51	437	706	127	793	590	8656
Nigeria	1990	267	424	87	412	600	193	636	459	6116
	2003	316	477	100	458	668	201	724	507	4797
	2008	245	383	75	369	564	157	619	412	22496
	2013	227	379	69	334	525	128	580	385	26174

S1. Maternal Cumulative Prevalence Estimates of Mortality, by country and year, for sub-Saharan Africa, cont.

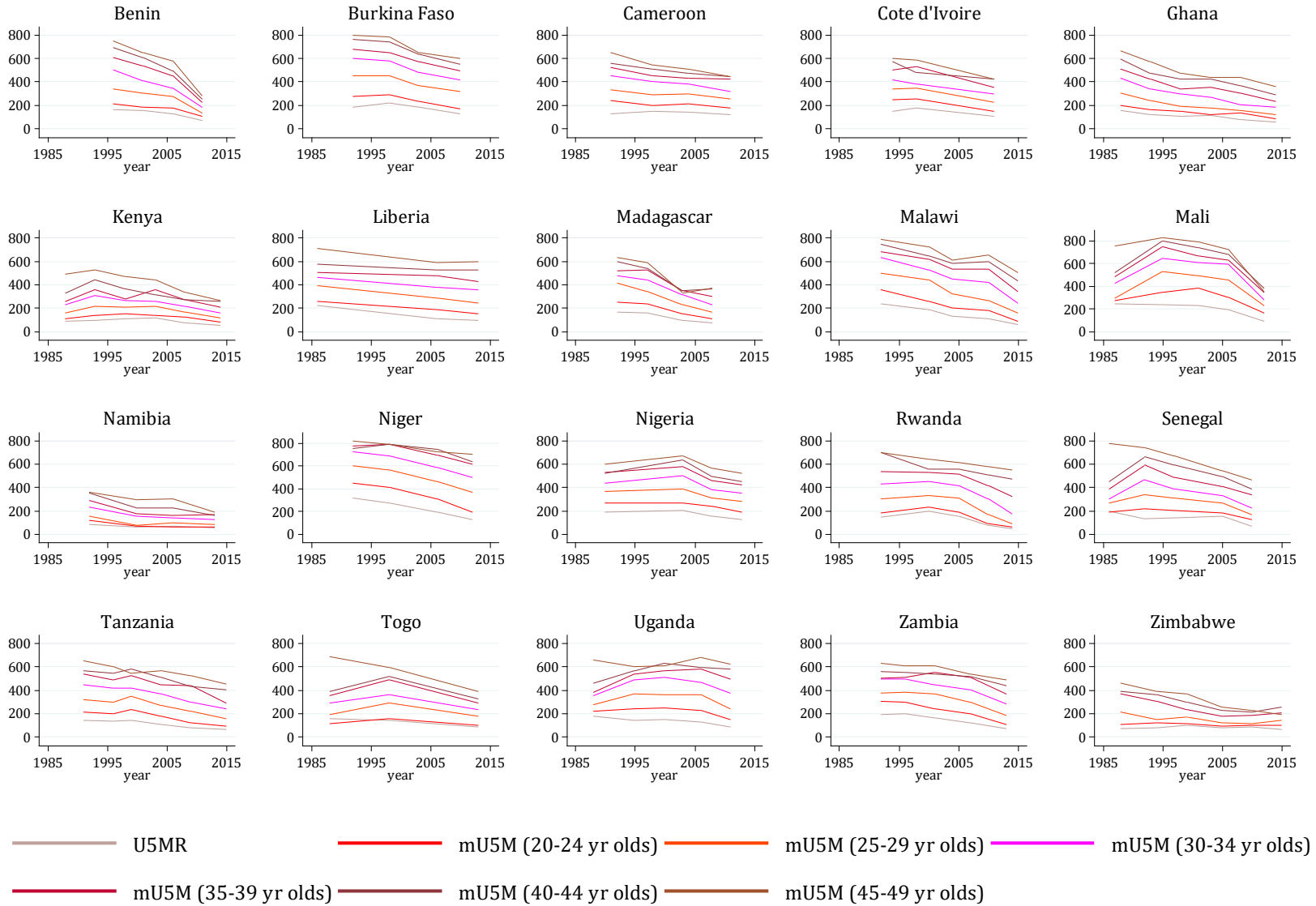
		mIM			mU5M			mOM	mROM	N
Country	**Year**	**20-44**	**45-49**	**IMR**	**20-44**	**45-49**	**U5MR**	**45-49**	**45-49**	
Rwanda	1992	288	483	85	423	695	151	778	565	4171
	2000	285	463	107	419	641	196	782	533	6412
	2005	277	423	86	395	617	152	733	503	6956
	2010	195	394	50	285	576	76	687	373	8367
	2014-15	151	370	32	215	553	50	623	339	8587
Sao Tome Principe	2008-09	132	297	38	191	393	63	470	192	1901
Senegal	*1986	296	460	88	493	775	195	812	596	3047
	1992-93	278	431	68	440	740	132	793	558	4247
	1997	234	434	68	386	673	139	747	470	5706
	2005	210	355	61	328	541	152	621	368	9027
	2010	164	307	47	239	464	72	544	291	10011
Sierra Leone	2013	303	461	92	399	614	156	670	445	11468
South Africa	2016	74	99	35	87	132	42	172	47	5919
Tanzania	1991-92	280	467	92	387	653	141	712	429	6385
	1996	268	417	87	363	604	136	699	426	5723
	1999	291	367	99	389	549	147	658	348	2763
	2004-05	236	390	68	329	567	112	661	391	7176
	2010	211	367	51	287	527	81	601	304	7008
	2015-16	168	334	43	227	455	67	509	228	9168
Togo	*1988	249	486	77	388	685	155	775	446	2381
	1998	226	445	80	356	596	146	674	381	6014
	2013-14	151	253	49	225	387	88	484	218	6702
Uganda	*1988-98	313	468	98	461	662	177	738	471	3214
	1995	275	437	81	407	603	147	716	412	4959
	2000	291	378	88	425	612	151	728	456	5093
	2006	290	497	71	418	682	128	753	451	6050
	2011	243	422	54	339	621	90	683	387	6017
Zambia	1992	272	465	107	422	631	191	725	461	4650
	1996	279	423	109	422	608	197	707	484	5514
	2001-02	260	395	95	399	611	168	733	466	5354
	2007	239	335	70	357	537	119	630	330	5046
	2013-14	178	331	45	259	487	75	555	319	11562
Zimbabwe	1988	180	329	49	250	461	71	511	239	2839
	1994	157	300	53	221	391	77	466	205	4152
	1999	136	247	65	185	371	102	449	169	3952
	2005-06	106	204	60	143	258	82	357	127	5950
	2010-11	110	177	57	146	229	84	319	109	6371
	2015	130	136	50	170	193	69	259	78	6893



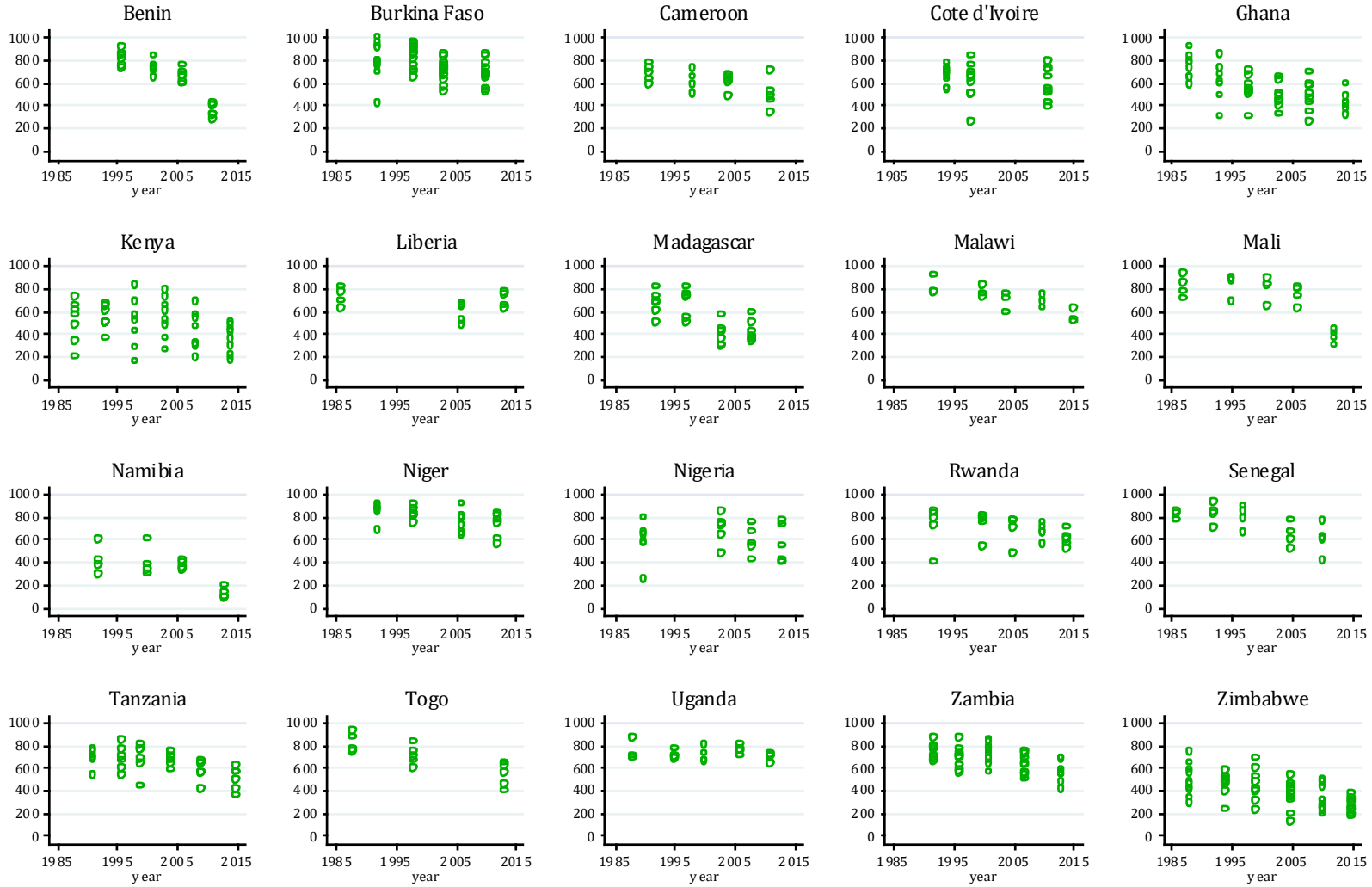
S2. Infant mortality rate (IMR) & maternal cumulative prevalence of infant mortality (mIM) among 15- to 19-year-old mothers in 20 sub-Saharan African countries between c. 1990s and c. 2010. Expressed per 1,000 live births (IMR) and 1,000 mothers (mIM).



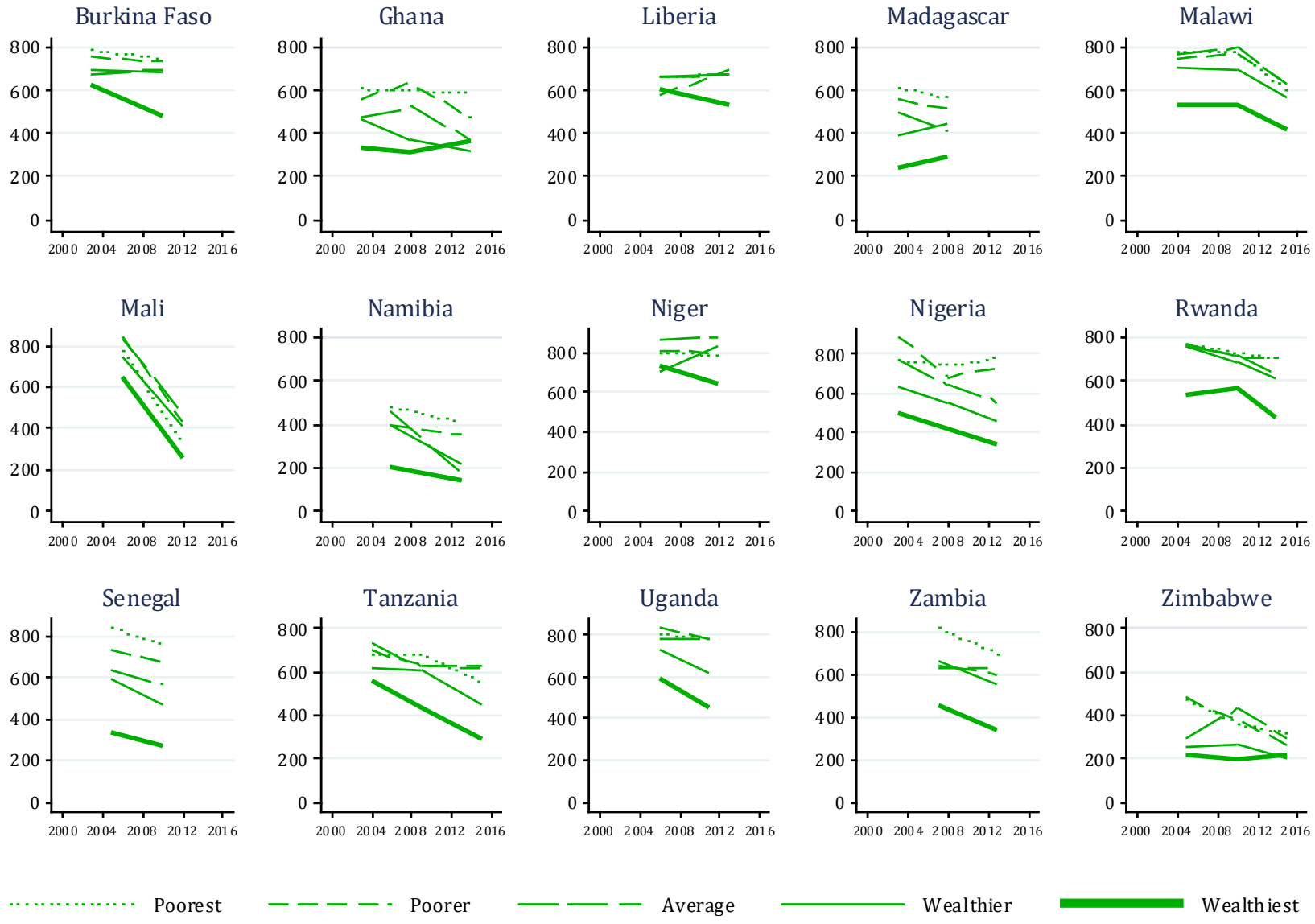
S3. Infant mortality rate (IMR) & maternal cumulative prevalence of infant mortality (mIM), disaggregated by five-year birth cohorts in 20 sub-Saharan African countries between c. 1990s & c. 2010. Expressed per 1,000 live births (IMR) and 1,000 mothers (mIM).



S4. Under-five mortality rate (U5MR) & maternal cumulative prevalence of under-five mortality (mU5M), disaggregated by five-year birth cohorts in 20 sub-Saharan African countries between c. 1990s & c. 2010. Expressed per 1,000 live births (U5MR) & 1,000 mothers (mU5M).



S5. Subnational region-level maternal cumulative prevalence of offspring mortality (mOM) for 45- to 49-year-old mothers in 20 sub-Saharan African countries between the c. 1990s & c. 2010. Expressed per 1,000 mothers. To facilitate comparison over time, we harmonized regions across time, even if the DHS-specified subnational boundaries changed between survey rounds We maintained the largest numbers of regions possible. For each country, the number of regions are as follows: Benin 6; Burkina Faso 13; Cameroon 5; Ghana 8; Ivory Coast 10; Kenya 8; Liberia 5; Madagascar 6; Malawi 3; Mali 4; Namibia 4; Niger 6; Nigeria 6; Rwanda 5; Senegal 4; Tanzania 6; Togo 5; Uganda 4; Zambia 9; Zimbabwe 10).



S6. Maternal cumulative prevalence of offspring mortality (mOM) for 45- to 49-year-old mothers, by household wealth, in 15 sub-Saharan African countries between the c. 2000s & c. 2015. Expressed per 1,000 mothers.