Childhood and Maternal Health in the Middle East and North Africa

Ken Sagynbekov
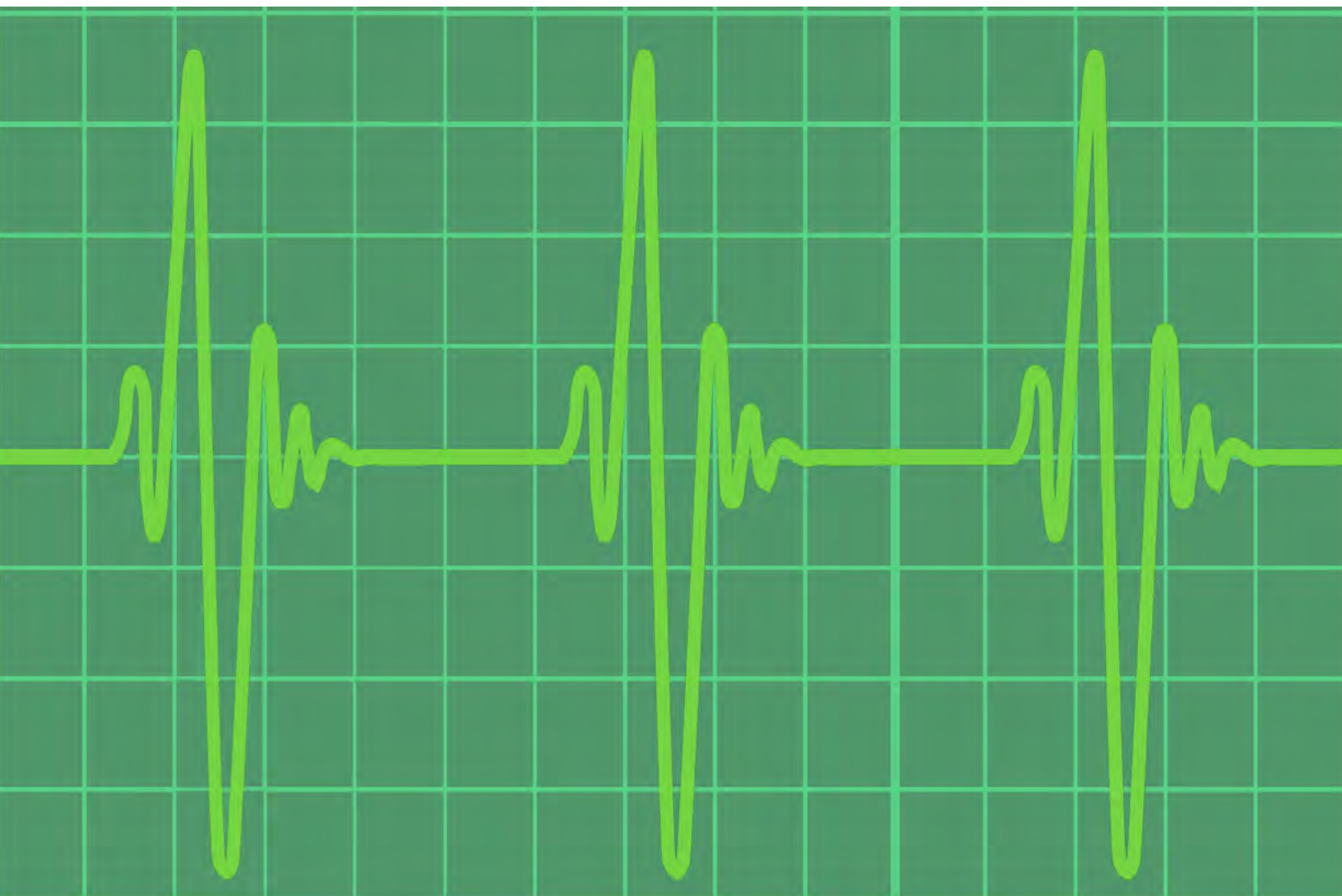
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ABOUT THE AUTHOR

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ACKNOWLEDGMENTS

EXECUTIVE SUMMARY

The importance of childhood and maternal health goes beyond human rights and morality. The health of women and children are also strong predictors of overall population health.[1] Although improvements in childhood and maternal health have been impressive, there is wide recognition of what an essential role sustainable progress in these indicators can play.[2]

This report focuses on the progress of childhood and maternal health in 18 Middle East and North Africa (MENA) countries. We provide plausible explanations for this dramatic fall in childhood and maternal mortality rates in the region and identify effective long-term policies to ensure sustainable improvements in population health for the region.

Our contribution to the literature is twofold. First, we estimate latent MENA region-specific trends for childhood and maternal mortality rates, identify trend changes, and identify potential causes of these changes. Then, we estimate the relative contribution of economic and socio-demographic forces to the improvement in childhood and maternal health in the region.

> The mortality data for the region shows that on average the childhood mortality fell by 63 percent and the maternal mortality fell by 56 percent over the period of 1990 to 2015.

- **Childhood mortality rates across MENA countries are best captured by a single regional trend, whereas maternal mortality rates are best captured by two distinct regional trends. These trends are very strong predictors of childhood and maternal mortality rates in every MENA country.**

- **The estimated regional trends for childhood and maternal mortality rates comprise of two distinct time segments, the first from 1990 to 2001 and the second from 2002 to 2015. The progress in the second period shows a significant slowdown, possibly reflecting the uneven impact of oil price shocks as some economies in the region are more dependent on oil and gas than others.**

- **Regional income growth and decline in birth rates are two major drivers behind the remarkable improvements in childhood and maternal health in the MENA region.**

- **Improving economic well-being appears to be the best long-term initiative for ensuring sustainable progress in health for all citizens in MENA countries.**

Although some of the findings reported are based on statistical associations and cannot be interpreted as causal, the report highlights several useful lessons. Perhaps the most important lesson for global leaders is the persistent correlation between economic prosperity and health and the understanding that it deserves at least as much attention, and hopefully more, as foreign aid in tackling the world's population health challenges.

INTRODUCTION

Child mortality and maternal mortality are considered to be good measures of population health and the effectiveness of the health care system in a nation.[3] It is not surprising that the United Nations General Assembly in 2000 included childhood and maternal health as part of the eight Millennium Development Goals (MDGs). Despite sizeable decline in child and maternal mortality rates around the world (the global childhood mortality rate fell by more than half and the maternal mortality rate dropped by almost half from 1990 to 2015), substantial regional disparities in mortality rates still persist. Roughly 70 percent of variation in maternal mortality across countries, for example, is driven by region-specific factors.[4] Therefore, it is more likely that we can identify causes and, subsequently, effective policies to improve childhood and maternal health by exploring the evolution of mortality rates in countries with similar institutional frameworks, cultural and linguistic origins, and demographic composition.

In this report, we adopt the logic of comparing similar countries and studying persistent patterns in childhood and maternal health in the Middle East and North Africa region, where countries have more commonalities than they do differences. Specifically, we estimate latent trends of childhood and maternal mortality rates common to all countries in the region and identify their likely drivers.

The results of this study suggest that most of the long-run decline in childhood and maternal mortality rates can be attributed to a dramatic improvement in the economic well-being of families as well as a substantial decline in the fertility rate of women in the region. Although foreign aid, an important policy tool to achieve the MDGs, does not appear to have played a major role in the reduction of childhood mortality, we show that it had a positive and non-negligible impact on the reduction of maternal deaths in the 2000s, which implies that the MDGs were partially effective.[5]

These findings are consistent with a large body of empirical studies showing an inverse relationship between childhood and maternal mortality and income.[6] For example, a recent study of 146 low- and middle-income countries from 1990 to 2010 estimates relative contributions of education, health service delivery, human resources in the medical sector, infrastructure, immunization, fertility, gender equality, GDP per capita, and urbanization to the decline in childhood and maternal mortality rates.[7] The authors report that over 50 percent of total decline in childhood mortality was associated with improvements in GDP per capita and reductions in fertility rates over the same period. These two variables accounted for 87 percent of total decline in maternal deaths. A significant decline in fertility rates across the globe, including the MENA region, appears to be a product of improved incomes. A comparison of biological, cultural, and economic causes of fertility decline shows a strong support for the economic

model as the most likely driver of observed reductions in birth rates.[8] An econometric study of fertility rates in 33 Muslim countries over the period 2000-2013 shows that economic factors have been the key driver of fertility decline.[9] The study also points to the important role of cultural norms as a mediating factor.

How can these findings help public policy makers improve childhood and maternal health and population health in general? The nature of our study does not allow us to make any prescriptive comments about short-term policies. However, the results indicate that decision makers attempting to ensure sustainable improvements in population health must recognize the integral role of economic prosperity as a necessary condition for better population health.

DATA AND METHODOLOGY

Health expenditure as a percentage of GDP shows no discernable association with mortality rates.

DATA

The dataset for 18 Middle East and North Africa countries is constructed using the publicly available data from the World Bank's World Development Indicators and the World Health Organization's Global Health Observatory Data Repository.[10]

TABLE 1. DATA SUMMARY: 2014-2015

Country	GDP Per Capita US Dollars	Health Expenditure, % of GDP	Rural Population, % of Total Population	Births Per 1,000 People	Childhood Mortality Per 1,000 Live Births	Maternal Mortality Per 100,000 People	Childhood Mortality, % Change 1990-2015	Maternal Mortality, % Change 1990-2015
ALGERIA	5,496	7	30	25	26	140	-46	-35
BAHRAIN	24,515	5	11	15	6	15	-73	-42
DJIBOUTI	1,812	11	23	24	65	229	-45	-56
EGYPT	3,366	6	57	28	24	33	-72	-69
IRAN	5,443	7	27	18	16	25	-73	-80
IRAQ	6,485	6	31	34	32	50	-41	-53
JORDAN	4,831	7	17	28	18	58	-51	-47
KUWAIT	43,332	3	2	17	9	4	-52	-43
LEBANON	8,149	6	12	15	8	15	-74	-80
LIBYA	4,578	5	22	21	13	9	-68	-77
MOROCCO	3,187	6	40	21	28	121	-66	-62
OMAN	19,130	4	23	20	12	17	-71	-43
QATAR	94,944	2	1	10	8	13	-62	-55
SAUDI ARABIA	24,406	5	17	20	15	12	-67	-74
SYRIA	1,821	3	43	23	13	68	-65	-45
TUNISIA	4,277	7	33	19	14	62	-75	-53
UAE	44,239	4	15	10	7	6	-59	-65
YEMEN	1,651	6	66	33	42	385	-67	-30

Source: World Bank, World Development Indicators, http://databank.worldbank.org. Note: Syria's GDP per capita value is for 2011, the latest available data.

Table 1 provides a snapshot of economic, social, and health conditions across MENA countries in 2014-2015. Childhood and maternal mortality rates exhibit substantial variation. Member countries with higher GDP per capita values, lower rural population, and lower birth rates appear to have lower childhood and maternal mortality rates. Despite differences in mortality rates, all MENA countries show a significant decline in childhood and maternal mortality over time (an average reduction of 63 percent for childhood mortality and 56 percent for maternal mortality). For the most part, childhood mortality rate trends over time are strikingly similar; rapid

decline in the 1990s followed by a deceleration in the 2000s (Figure 1). A visual inspection of childhood mortality time-series reveals that by 2015, there were four distinct groups:

1. Djibouti and Yemen with the highest mortality rates;
2. Iraq, Morocco, Algeria, and Egypt;
3. Iran, Jordan, Lebanon, Libya, Oman, Saudi Arabia, Syria, and Tunisia;
4. Bahrain, Qatar, Kuwait, and the UAE with the lowest mortality rates.

A similar exercise with the maternal mortality time-series reveals that Djibouti, Yemen, Algeria, and Morocco form a group with the highest rates. Although maternal mortality rates declined for all MENA countries, trajectories of decline are visibly less synchronized in comparison to childhood mortality time-series.

FIGURE 1. CHILDHOOD MORTALITY: MENA COUNTRIES, 1990-2015
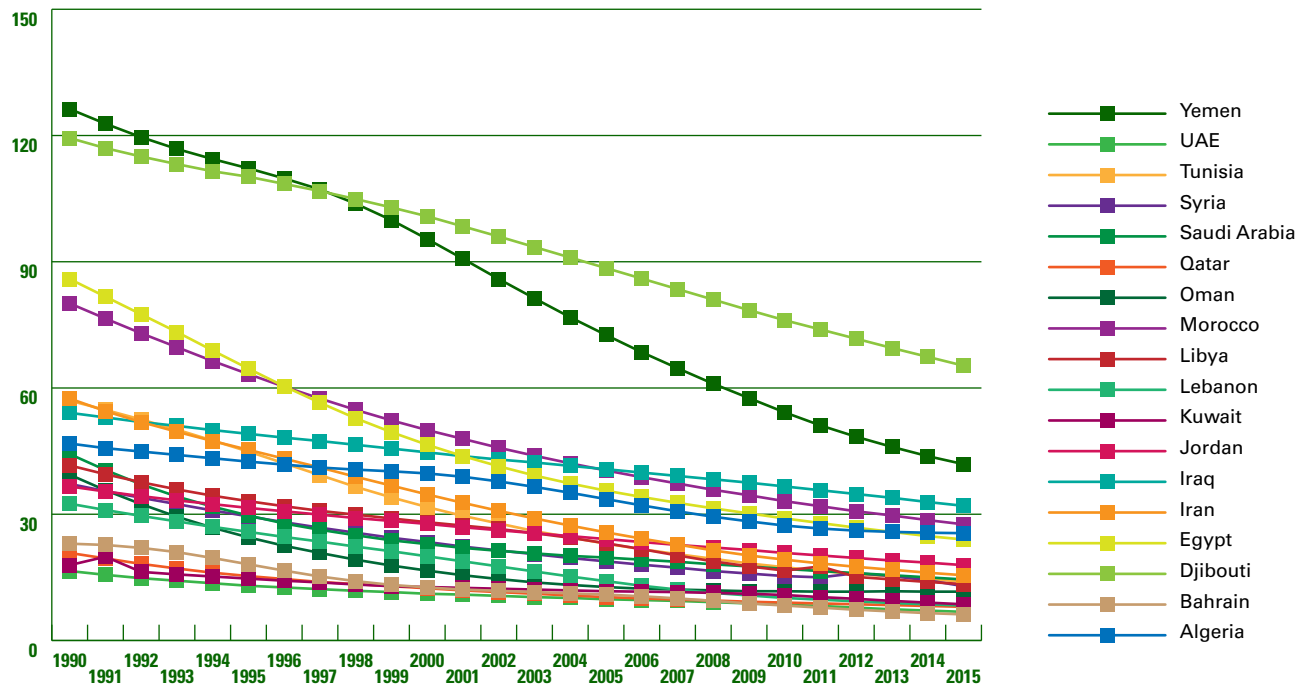
Source: Milken Institute.

FIGURE 2. MATERNAL MORTALITY RATE: MENA COUNTRIES, 1990-2015

Source: Milken Institute.
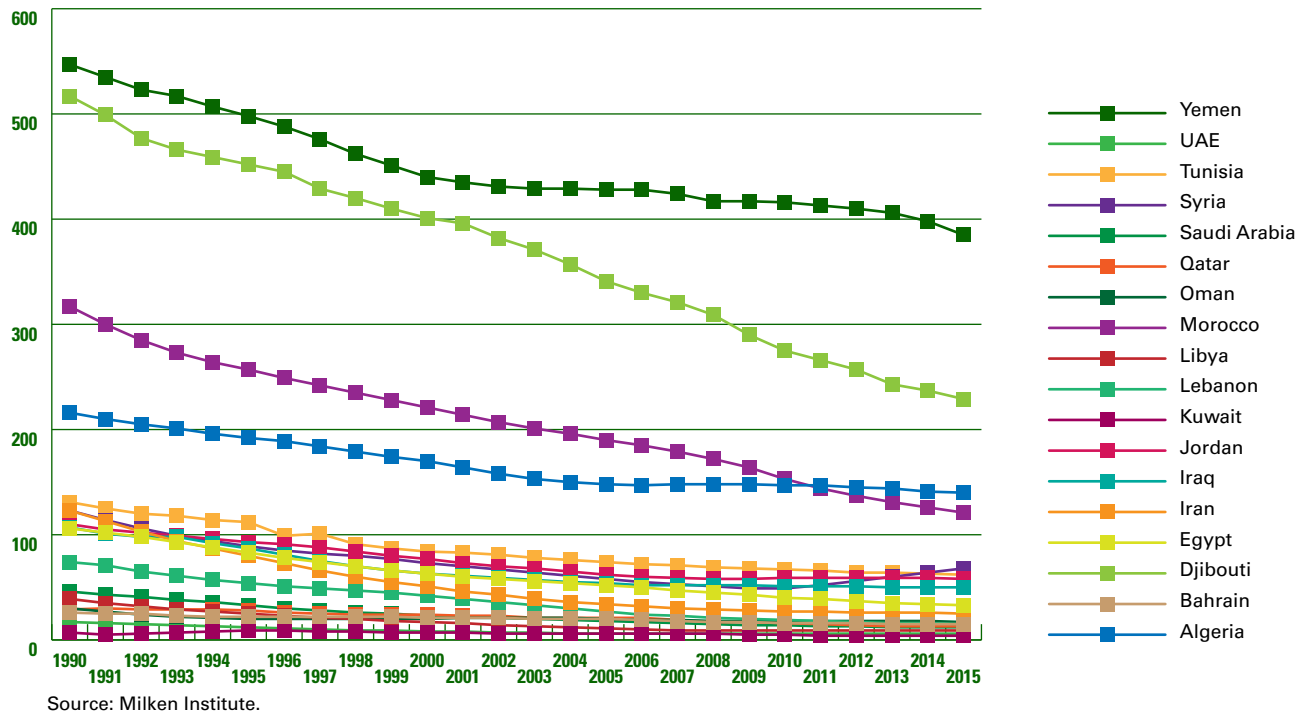
METHODOLOGY

We extract MENA region-specific trends using a multivariate time-series analysis technique called dynamic factor analysis (DFA). The general form of the estimation equation is as follows:

$$x_t = x_{t-1} + w_t$$
$$y_t = Zx_t + a + u_t$$
$$x_0 \sim MVN(\mu, \Delta)$$
$$w_t \sim MVN(0, Q)$$
$$u_t \sim MVN(0, R)$$

We follow Zuur et al.'s (2003) estimation procedure.[11] The y_t series denote childhood and maternal mortality rates in each MENA country. The latent common dynamic factors, x_t, are structured to follow random walk. In other words, a latent common trend at time t equals its previous value in time *t-1* plus the random shock, w_t. These latent common dynamic factors capture information shared by observed mortality rates for each country in the region. The analysis relied on MARSS package for R statistical software, which employs the EM algorithm to solve for latent common dynamic factors.[12]

Once common trends have been estimated, we can easily decompose total variance of each country's mortality series into two parts: a systematic variation due to latent common trends and a sum of country-specific trend and white noise. Since estimated latent common trends are orthogonal to each other, the fraction of variance due to a specific latent common trend is obtained as follows:

$$Var(Y_{it}) = \sum z_{ij}^2 Var(F_j) + Var(u_{it})$$

$$Variance\ Explained\ By\ Factor\ j = \frac{z_j^2 Var(F_j)}{Var(Y_{it})}$$

where Y_{it} is a mortality series for country i at time period t, z is a loading factor associated with country i and corresponding to factor j, F_j. We can carry out variance decomposition for particular parts of the entire sample period using the same procedure.

In order to identify structural breaks, a distinct change in the slope of trends, we follow the approach developed by Muggeo (2003).[13]

COMMON LATENT TRENDS

Our analysis indicates that the childhood mortality rate series for MENA countries are best described by one common trend and that the maternal mortality rate series are best captured by two latent common trends. Table 2 shows estimates of loading factors, which measure how well a particular country's mortality rate series is associated with that factor. The estimated values of latent common trends are given in Table 3. Figures 3 and 4 depict actual standardized mortality rates and predictions based on latent common trends for each country (filled circles are actual values and lines are predictions). These results together indicate the following:

- **The estimated latent common trend for the childhood mortality in the region is a very strong predictor of childhood mortality for every MENA country. This point is clearly illustrated by high values of loading factors for all countries and a remarkably close fit of prediction lines to the actual values (Figure 3).**

- **The estimated two latent common trends for the maternal mortality in the region have a weaker predictive power than the single trend for childhood mortality. Individual country trajectories for maternal mortality exhibit substantial dissimilarities, especially in the later periods of 2000s, which is shown by the departure of predicted line from the actual values.**

- **Thirteen out of 18 countries primarily associated with the first latent common trend for maternal mortality.[14] Kuwait, Qatar, Bahrain, Djibouti, and Morocco associated mostly with the second latent common trend (inverted U shape or a small hump in Figures 4).**

TABLE 2. ESTIMATED FACTOR LOADINGS

| Country	Childhood Mortality Loadings	Maternal Mortality Loadings 1	Maternal Mortality Loadings 2
ALGERIA	0.960	0.220	0.080
BAHRAIN	0.991	0.135	0.135
DJIBOUTI	0.967	0.141	0.135
EGYPT	0.995	0.198	0.099
IRAN	0.996	0.237	0.068
IRAQ	0.983	0.241	0.063
JORDAN	0.992	0.219	0.081
KUWAIT	0.967	0.002	0.156
LEBANON	0.994	0.194	0.102
LIBYA	0.987	0.236	0.068
MOROCCO	0.998	0.164	0.122
OMAN	0.958	0.195	0.065
QATAR	0.992	0.133	0.137
SAUDI ARABIA	0.978	0.218	0.084
SYRIA	0.996	0.248	0.050
TUNISIA	0.996	0.218	0.083
UAE	0.992	0.252	0.052
YEMEN	0.973	0.219	0.081

Source: Milken Institute.

TABLE 3. ESTIMATED LATENT COMMON TRENDS

| Year	Childhood Mortality Factor	Maternal Mortality Factor 1	Maternal Mortality Factor 2
1990	2.0	8.6	3.5
1991	1.8	7.3	3.5
1992	1.6	6.2	3.2
1993	1.4	4.9	3.3
1994	1.1	3.8	3.8
1995	1.0	2.6	4.3
1996	0.8	1.4	4.6
1997	0.6	0.5	4.6
1998	0.4	-0.4	4.7
1999	0.3	-0.9	4.4
2000	0.1	-1.6	4.3
2001	0.0	-2.1	4.1
2002	-0.1	-2.5	3.7
2003	-0.3	-2.8	2.9
2004	-0.4	-3.1	2.4
2005	-0.5	-3.1	1.3
2006	-0.6	-3.1	0.3
2007	-0.7	-3.0	-0.8
2008	-0.8	-2.8	-2.2
2009	-0.9	-2.4	-4.0
2010	-0.9	-2.0	-5.7
2011	-1.0	-1.7	-7.0
2012	-1.1	-1.4	-8.1
2013	-1.2	-1.1	-9.6
2014	-1.2	-0.8	-10.4
2015	-1.3	-0.8	-11.1

Source: Milken Institute.

FIGURE 3. STANDARDIZED CHILDHOOD MORTALITY RATES (FILLED CIRCLES) AND PREDICTION LINES BASED ON LATENT TRENDS
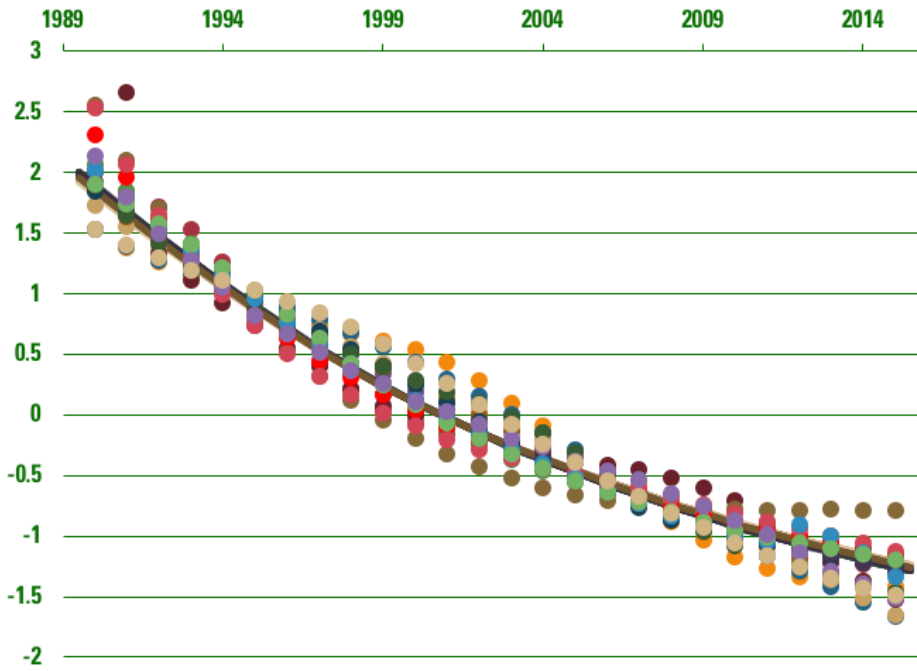
Source: Milken Institute.

FIGURE 4. STANDARDIZED MATERNAL MORTALITY RATES (FILLED CIRCLES) AND PREDICTION LINES BASED ON LATENT TRENDS
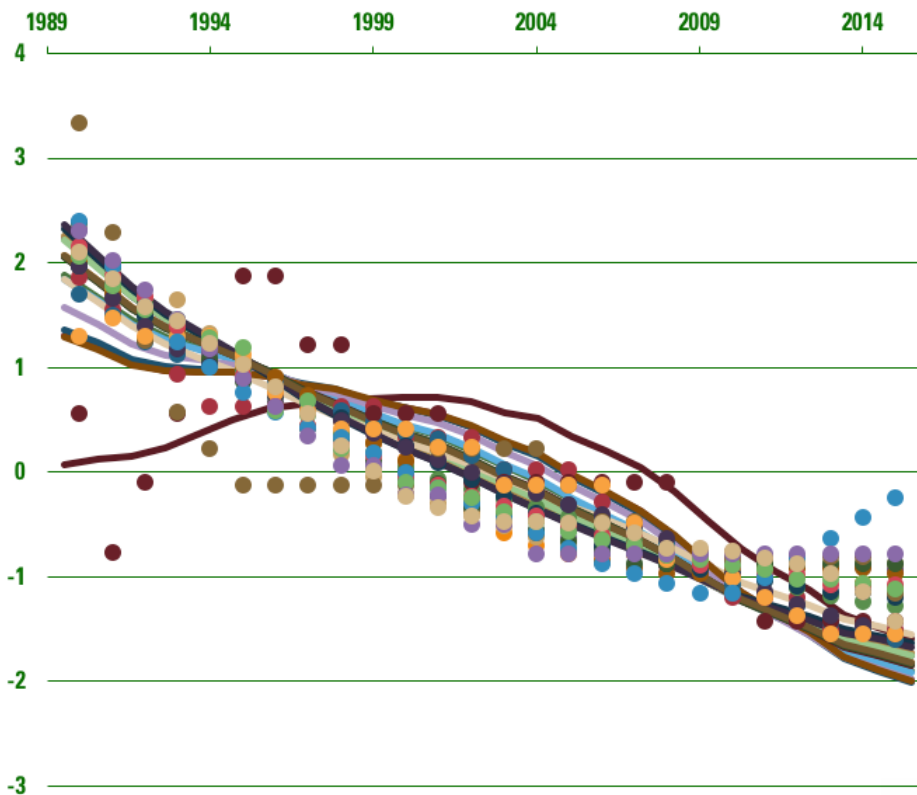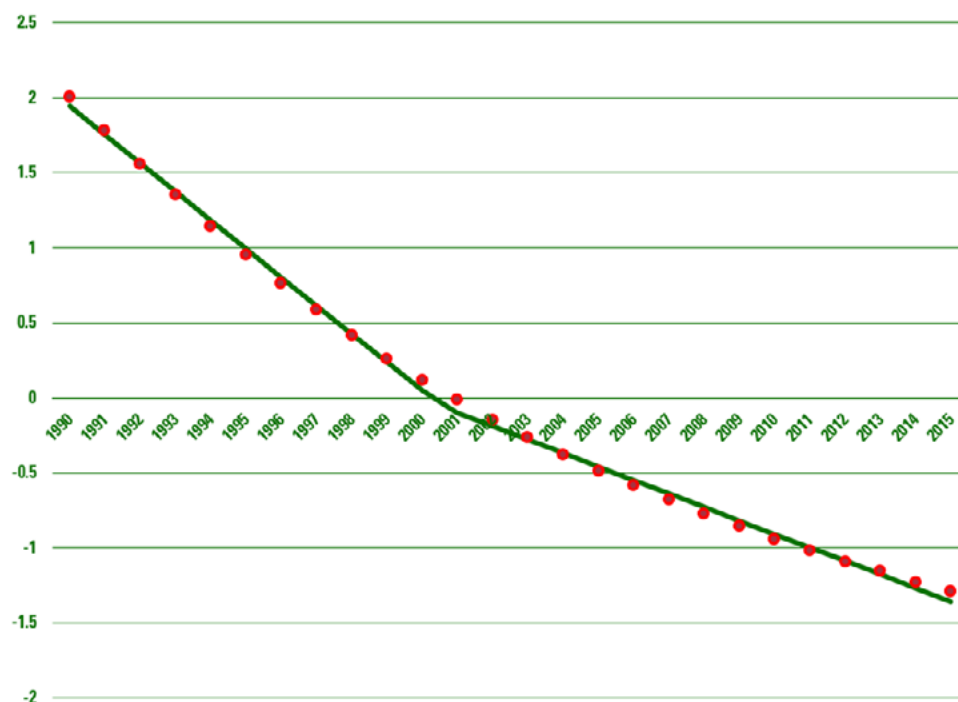

Source: Milken Institute.

STABILITY OF
REGIONAL LATENT TRENDS

The estimates shown in Table 3 indicate downward sloping latent common trends for childhood and maternal mortality. But Figures 3 and 4 also suggest that the predictions based on regional trends have been less accurate in the 2000s as seen by the departure of standardized mortality rates from prediction lines. To test if the rate of decline in mortality in the region has been similar throughout the entire sample period, we carried out several structural break tests. These tests use the data at hand to determine if the slope of trend lines remain unchanged. If the slope has not been constant, these tests can determine the date when the changes took place. Figures 5-7 depict the results of our structural break tests. Red circles denote values of latent common trends and segmented lines show the best fitting trend lines.
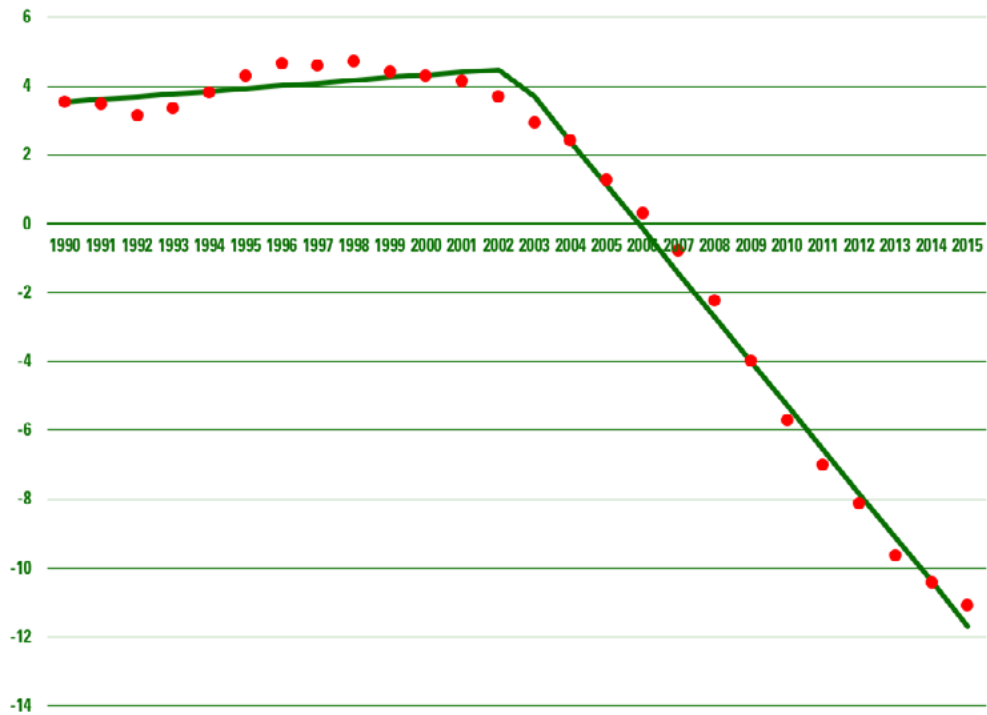
FIGURE 5. CHILDHOOD MORTALITY LATENT TREND

Source: Milken Institute.

FIGURE 6. MATERNAL MORTALITY LATENT TREND 1
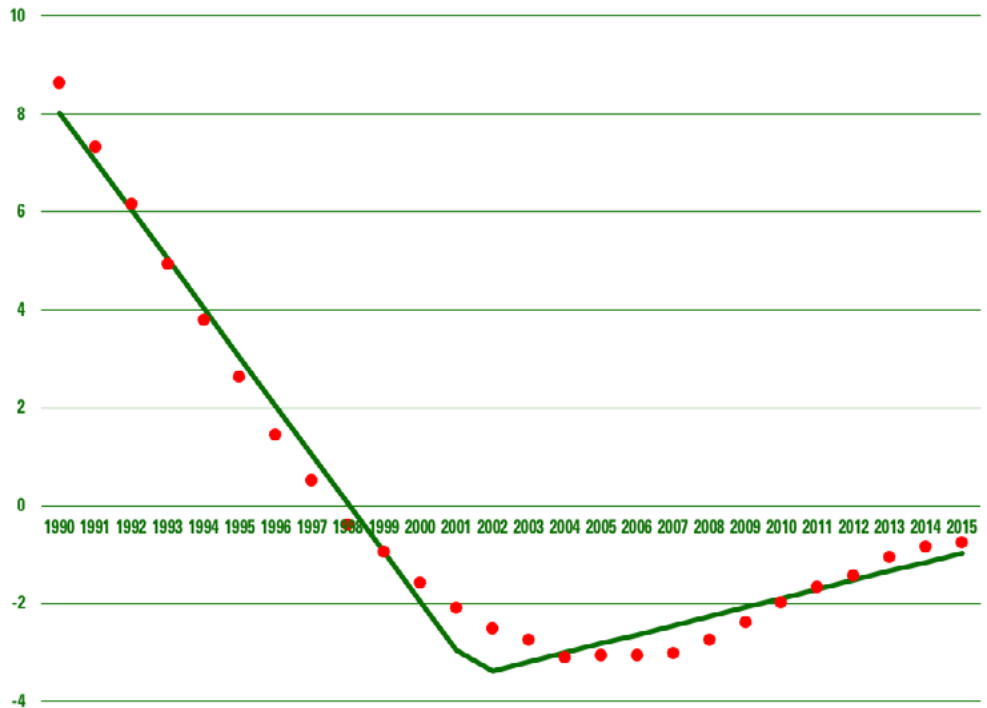
Source: Milken Institute.

**FIGURE 7. MATERNAL MORTALITY LATENT TREND 2**

Source: Milken Institute.

THE RESULTS OF STRUCTURAL TESTS REVEAL THE FOLLOWING:

- **The regional latent trend for childhood mortality comprises two distinct segments, first from 1990 to 2001 and the second from 2002 to 2015. The slope of the second segment is roughly twice as flat, which suggests that childhood mortality decline was significantly slower after 2001.**

- **The first latent trend for maternal mortality also has two segments, first from 1990 to 2001 and the second from 2002 to 2015. The rate of maternal mortality fell in the first segment and then rose sharply in the second segment.**

- **The second latent trend for maternal mortality shows a slow rise from 1990 to 2002, followed by a sharp decline from 2003 to 2015.**

In all three cases, it appears that there was a structural shift in the dynamics of both childhood and maternal mortality in the region after 2001. Since the region's economic activities are influenced by the price of crude oil, we carried out a similar structural break test on the oil price over the same period as in our analysis. Figure 8 shows that the price of crude oil began to rise in 1999, rising sharply after 2001. Although the timing of the oil price increase and the slowing in regional trends for childhood and maternal mortality should not be interpreted as a causal link, it is suggestive that economic forces in the region have a tremendous impact on public health outcomes.

FIGURE 8. CRUDE OIL PRICE IN U.S. DOLLARS
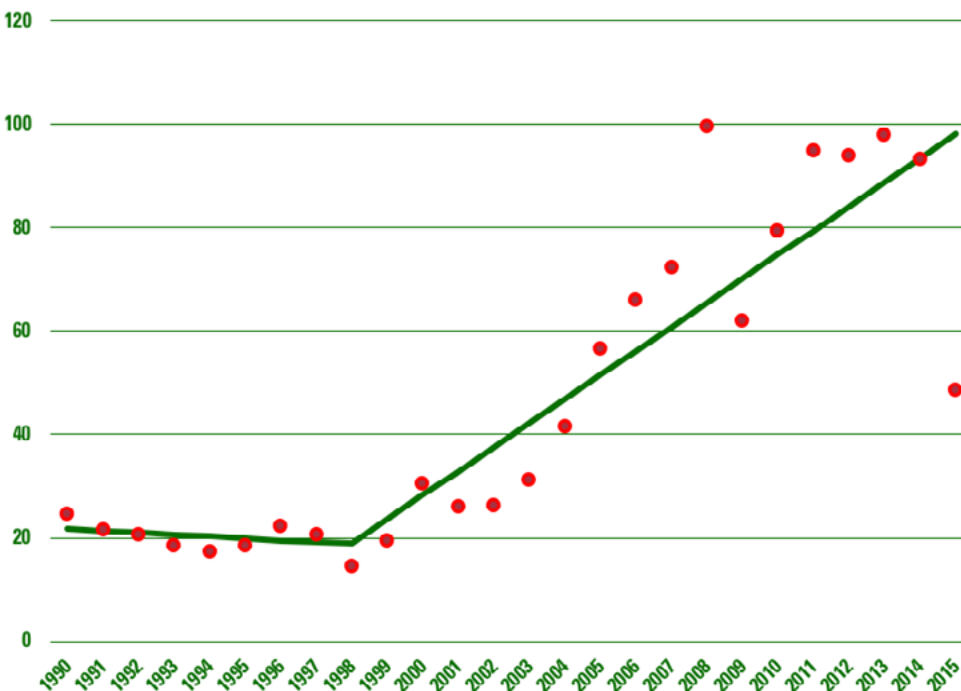
Source: Milken Institute.

VARIANCE DECOMPOSITION

How important are regional factors as drivers of childhood and maternal health in MENA countries? Tables 4 and 5 provide estimates of how much of each country's total variation in childhood and maternal mortality is explained by regional latent trends. On average, 97.2 percent of variation in each MENA country's childhood mortality over time can be explained by a common regional trend (Table 4, column 2). The first regional trend on average explains roughly 48 percent and the second trend explains 27 percent of total variation in maternal mortality over time (Table 5, columns 2 and 3).

The fall in the explanatory power of regional trends after 2001 points to a divergence of individual country trajectories from the regional trends, most likely driven by diverging economic progress across the region.

Did these common regional trends become more or less important after 2001, the year when all three regional trends and oil price series changed trajectories? The decomposition exercise suggests that the answer is the latter: common regional trends became less relevant. For example, the regional trend for childhood mortality between 1990 and 2001 on average explains 98.3 percent of total variation across MENA countries, whereas between 2002 and 2015 it explains 97 percent of total variation. The difference is more pronounced in the case of maternal mortality. The first and second common trends for maternal mortality explain roughly 54 percent of total variation between 1990 and 2001, whereas between 2002 and 2015 these trends explain only 29 percent of total variation.

TABLE 4. VARIANCE DECOMPOSITION, CHILDHOOD MORTALITY

Country	1990-2015	1990-2001	2002-2015
ALGERIA	92.3%	99.7%	97.4%
BAHRAIN	98.7%	98.0%	97.6%
DJIBOUTI	93.6%	98.6%	99.5%
EGYPT	99.4%	99.9%	99.9%
IRAN	99.7%	99.8%	99.4%
IRAQ	97.0%	99.7%	98.1%
JORDAN	98.7%	99.9%	99.6%
KUWAIT	93.6%	86.5%	88.5%
LEBANON	99.2%	99.8%	97.9%
LIBYA	97.7%	99.2%	98.6%
MOROCCO	100.0%	100.0%	100.0%
OMAN	91.9%	98.6%	80.7%
QATAR	98.7%	98.5%	99.7%
SAUDI ARABIA	96.0%	97.4%	99.1%
SYRIA	99.6%	100.0%	94.8%
TUNISIA	99.7%	99.2%	99.4%
UAE	98.9%	98.8%	96.5%
YEMEN	94.9%	96.4%	99.9%

Source: Milken Institute.

TABLE 5. VARIANCE DECOMPOSITION, MATERNAL MORTALITY

Country	Factor 1: 1990-2015	Factor 2: 1990-2015	Factor 1: 1990-2001	Factor 2: 1990-2001	Factor 1: 2002-2015	Factor 2: 2002-2015
ALGERIA	57.6%	18.7%	63.6%	0.2%	3.7%	17.7%
BAHRAIN	21.7%	52.7%	24.0%	0.6%	1.4%	49.9%
DJIBOUTI	23.6%	52.5%	26.1%	0.6%	1.5%	49.8%
EGYPT	46.9%	28.4%	51.9%	0.3%	3.0%	26.9%
IRAN	66.9%	13.2%	73.9%	0.1%	4.3%	12.5%
IRAQ	68.9%	11.4%	76.2%	0.1%	4.4%	10.8%
JORDAN	56.9%	19.1%	62.9%	0.2%	3.6%	18.1%
KUWAIT	0.0%	70.2%	0.0%	0.7%	0.0%	66.5%
LEBANON	44.8%	30.0%	49.6%	0.3%	2.9%	28.4%
LIBYA	66.4%	13.3%	73.4%	0.1%	4.2%	12.6%
MOROCCO	32.0%	42.8%	35.4%	0.5%	2.0%	40.6%
OMAN	45.5%	12.2%	50.3%	0.1%	2.9%	11.6%
QATAR	21.1%	54.3%	23.3%	0.6%	1.3%	51.4%
SAUDI ARABIA	56.5%	20.5%	62.4%	0.2%	3.6%	19.4%
SYRIA	73.0%	7.3%	80.7%	0.1%	4.7%	6.9%
TUNISIA	56.5%	20.1%	62.5%	0.2%	3.6%	19.0%
UAE	75.8%	7.7%	83.8%	0.1%	4.8%	7.3%
YEMEN	57.2%	18.9%	63.2%	0.2%	3.6%	17.9%

Source: Milken Institute.

FORCES DRIVING
REGIONAL TRENDS

In previous sections, we established that trajectories for childhood and maternal mortality rates in MENA countries are more alike than different. We also showed that the commonality had been weakened after 2001 as a result of exogenous economic forces that may have had a differential impact on MENA countries. To formally assess the relative importance of various regional economic and social factors as potential candidates for unobserved regional factors, we carried out a series of statistical estimations. Namely, we calculated the proportion of variation in our estimated regional trends that can be allotted to regional median values of per capita income, per capita development assistance, foreign direct investments, and fertility rate.

The results are shown in Table 6.[15] Income, measured with the GDP per capita in U.S. dollars, appears as a statistically and substantively important candidate for all three regional trends. It has especially strong explanatory power for the second maternal mortality trend. Fertility rates have the biggest explanatory power for the childhood mortality trend as well as for the first maternal mortality regional trend. The decline in birth rates is itself also influenced by economic progress such as expanded labor market opportunities. Fertility, however, does not appear to be associated with the second maternal mortality trend. Foreign direct investment had substantively no influence on all three trends. Foreign aid, however, appears to be an influential factor in the second maternal mortality trend, which suggests that the United Nation's Millennium Development Goals initiative has been successful in reducing maternal mortality in the region.

TABLE 6. RELATIVE IMPORTANCE OF REGIONAL INCOME, FOREIGN AID, FDI, AND FERTILITY TRENDS TABLE

	Linderman-Merenda-Gold*	Beta Squared	Pratt
CHILDHOOD MORTALITY, REGIONAL COMMON TREND			
INCOME	28.72%	17.04%	34.74%
AID	7.88%	0.07%	1.16%
FDI	17.57%	0.04%	1.45%
FERTILITY	44.12%	43.88%	60.97%
MATERNAL MORTALITY, REGIONAL COMMON TREND 1			
INCOME	15.35%	4.95%	11.28%
AID	9.42%	11.86%	1.34%
FDI	11.23%	0.41%	3.42%
FERTILITY	59.71%	69.48%	79.68%
MATERNAL MORTALITY, REGIONAL COMMON TREND 2			
INCOME	35.45%	24.28%	45.44%
AID	32.15%	22.98%	40.98%
FDI	15.47%	-0.24%	3.38%
FERTILITY	8.87%	3.15%	8.92%

*Linderman-Merenda-Gold, Beta Squared, and Pratt are criteria to allocate the proportion of variation to each explanatory variable.

Source: Milken Institute.

CONCLUSION

Dramatic socio-demographic transformations and economic progress have been key drivers of the unprecedented decline in childhood and maternal mortality.

The findings in this report indicate that the improvements in childhood and maternal health in MENA countries were driven by common regional factors. Specifically, dramatic socio-demographic transformations and economic progress have been key drivers of the unprecedented decline in childhood and maternal mortality. Our analysis also reveals a shift in the mortality trajectories after 2001. Namely, we find that following a sharp increase in the price of crude oil and social unrest in some countries within the region, the decline in regional childhood and maternal mortality trends were slower compared to the 1990-2001 period. Taken together, these results point to a growing divergence in childhood and maternal health across MENA countries in recent years, reflecting uneven economic progress.

ENDNOTES

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