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Title:
Avoiding premature mortality in Ethiopia 2015–30: a review of national mortality trends and policy recommendations

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Abstract

Ethiopia has made considerable progress in improving the health of its people over the last 20 years, following the guidance of a series of governmental documents on health reform, particularly for its essential health services package launched in 2005. With the Millennium Development Goals (MDG) having reached its end target in 2015, and the move toward an even more ambitious agenda with the Sustainable Development Goals (SDG), the Ethiopian government is aiming at increasing the scope of the health services and interventions to finance and include in the country's essential health benefits package. One important step in this process is to identify the interventions which would reduce the country disease burden in the most cost-effective manner, and the conditions where accelerated investments in both funding and human capital are required. One of the health targets for Ethiopia would be to reduce the country's premature mortality by 40% by 2030. This paper uses similar methods as were previously adopted by scholars, and synthesizes evidence to identify the age groups and conditions where extra efforts could be invested in to achieve the 40% mortality reduction goal in Ethiopia. The paper also suggests which interventions could be adopted in order to accelerate the reduction of Ethiopia's disease burden.

Keywords: Mortality trends; Sustainable Development Goals; universal health coverage; equity; essential healthcare package, cost-effectiveness.

1. Introduction

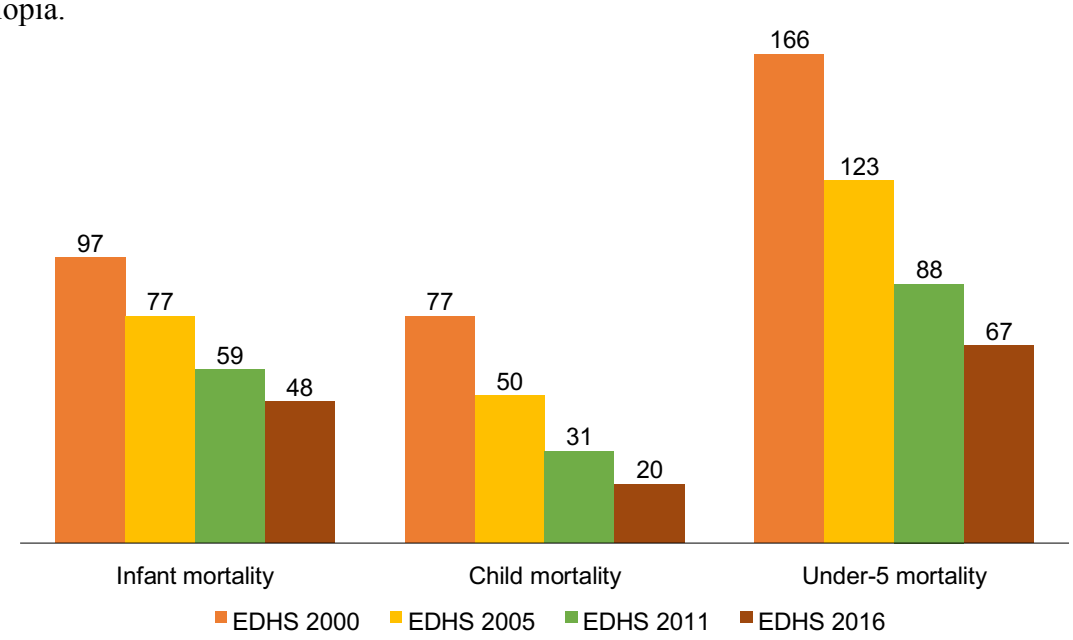
Ethiopia has fought hard the major killers of its population over the last two decades. Impressive health gains have been made as a result of reductions in maternal and child mortality, and prevention and control of major communicable diseases since the 1990s. As an illustration, the number of new HIV infections occurring in the country have declined by 90%, under-five mortality by 67%, tuberculosis (TB) and malaria mortality were halved since 1990; and life expectancy has now risen to 65 years (World Health Organization 2015). The mortality reductions were particularly large during the past decade (see Figures 1, 2).

1.1. Accomplishments

We explain below some of the major reasons why Ethiopia has successfully reduced mortality and improved the health of its population over the past decades.

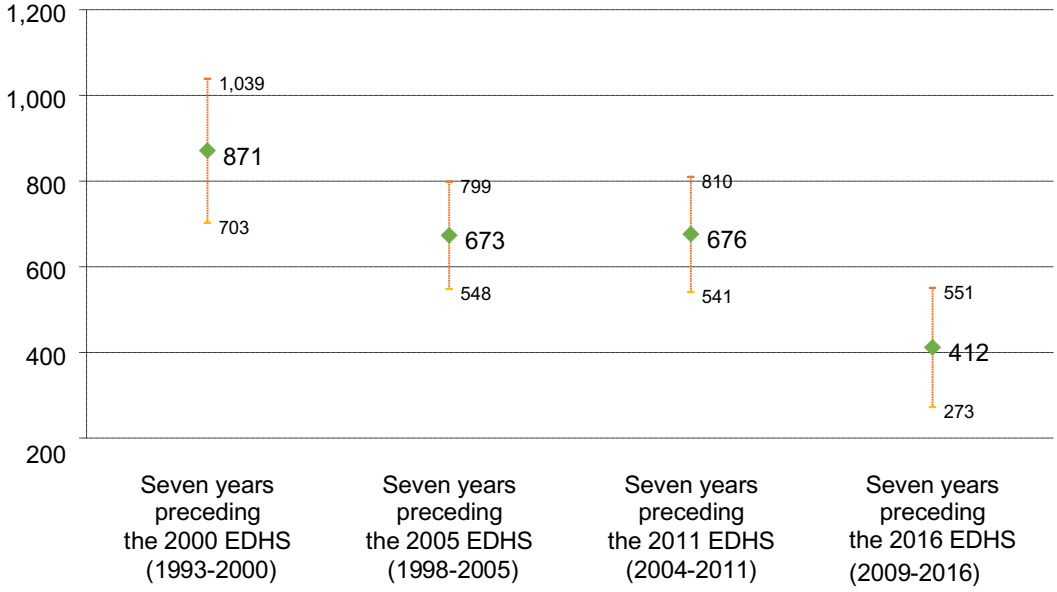
Timely policies, strategies and healthcare reforms. Health policy decisions in 1993 articulated the needed changes to reverse the deteriorating health situation by a series of effective treatment, health promotion and preventive interventions. A number of major healthcare reforms and strategies were put in place (Federal Ministry of Health Ethiopia 2015a, 2005, 2008, 2015b, 2016a, 2015c, d, 2012, 2010) and have helped the country's move toward improving health outcomes.

Figure 1. Trends in under-five (U5), infant and neonatal mortality rates (per 1,000 live births), Ethiopia.



Source: EDHS 2000, 2005 and 2011 & 2016.

Figure 2. Trends in estimates of the maternal mortality ratio (MMR, per 100,000 live births), Ethiopia.



Source: EDHS 2000, 2005 and 2011 & 2016.

Community empowerment and ownership with the flagship Health Extension Program and launch of a home-grown social mobilization strategy called the "Health Development Army".

In 2003, Ethiopia introduced the Health Extension Program (HEP) and subsequently implemented it at scale in all regions. The HEP is supported and relayed by 38,000 rural and urban government-salaried health extension workers (HEWs), trained and "equipped" to support the implementation of 16 "health promotive, disease preventive and basic curative health service packages" (Federal Ministry of Health of Ethiopia 2003) (Figure 3). The HEWs bring services to the doorsteps of each household, which makes it substantially different from conventional healthcare delivery, where people go to seek healthcare in dedicated health facilities. The HEWs live within the community, educate and provide the households with basic knowledge and skills to promote health and prevent the onset of diseases (Federal Ministry of Health Ethiopia and others 2015).

The HEP is one of the country's major strategies with the ambition of achieving universal coverage of primary health care to the country rural populations which constitute the large majority of the Ethiopian population (about 80% of the total population) (The World Bank 2016). The HEP is an innovative health delivery platform which has a set of 16 defined packages (Figure 3) provided to households.In 2016, the program added two packages; namely, First Aid and NCD (diabetes & hypertension prevention and promotion) taking the number of packages to 18 and heralding a new era of second generation health extension program (Federal Ministry of Health Ethiopia 2016b). By introducing innovative solutions to important considerations like task-shifting, the HEP has

initiated and enhanced healthcare access for the rural, marginalized, and hard-to-reach communities, ensuring equity of access to primary health care for all in Ethiopia.

Figure 3. The health services packages included in the Health Extension Program.

Source: Health Extension Program Profile, 2015, FMOH

With the philosophy of "if the right knowledge and skills are transferred to households, they can take up their responsibility for producing and maintaining their own health" (Federal Ministry of

Health of Ethiopia 2003), the HEP has empowered communities and has been leading the way towards full-fledged local and community ownership.

The Health Development Army strategy includes a network of women volunteers organized in one to five groups. One model household shares beneficial behaviors and practices with at least five other households among the neighborhoods at proximity. This has supplemented the HEP and further consolidated community empowerment and ownership in rural areas. The Health Development Army is mainly supported by the HEWs: HEWs give 96-hour trainings to households on the 18 HEP packages; and households then implement the packages with the assistance of the HEWs. The households that perform better on the implementation based on a number of application criteria are then "labelled" as model households, and these model households then take the responsibility of helping other households to become themselves "models". Indeed, the hallmark of the Health Development Army is the shaping of a generation of "model households": "model households" can shape "model communities", which can then shape "model districts" and "model regions" and ultimately the whole country (Federal Ministry of Health Ethiopia 2013, 2015b).

1.2. Sustained political commitment at all levels

As always, political commitment is critical to successfully introduce and implement any policy and reform. The Ethiopian health sector has enjoyed robust political support at all levels of government (from the district level to the regional and national levels) over the last decades. Such support helped championing the major health reform and implementation agenda, and increased financial resources to the health sector. In addition, the higher levels of government have been at

the forefront of securing replenishments of global financial resources and donor assistance in partnerships with international agencies like the Global Fund to Fight AIDS, TB and Malaria, and GAVI, the Vaccine Alliance in recent years, which resulted in raising the profile of donor funds to health sectors in developing countries. The government has also, with reference to the Paris declaration, promoted transparency and accountability in the efficient use of health funds in Ethiopia (Federal Ministry of Health of Ethiopia 2008).

1.3. Focus on building a resilient health system.

In trying to resist the tendency of "verticalism", Ethiopia has attempted to invest wisely in building a strong and resilient health system, with the intention to promote and deliver healthcare in an integrated manner to the population. Investing in health system development and strengthening is a way to ensure long-term sustainability. In this regard, vertical program funds (e.g. for HIV/AIDS) have also been partially used to strengthen the health system. In this way other programs can benefit from these existing platforms for healthcare delivery in a more efficient manner (e.g. integration of other services for chronic conditions and neglected tropical diseases). Acceleration in the expansion of health facilities (e.g. health posts and centers, and hospitals), human resources (e.g. nurses, midwives, laboratory and pharmacy professionals, and doctors), transformational changes in the pharmaceutical funding and supply system of the country with the development of the Pharmaceuticals Fund and Supply Agency (PFSA) (Pharmaceuticals Fund and Supply Agency), improvements in the health information systems and governance and leadership capabilities over the years have been central to the building of a resilient health system. For example, establishment of PFSA with capacity to do bulk pooled procurement resulted in economy of scale benefits, with profound improvement in availability of essential drugs. Health

policy reforms and health system development have also been greatly helped by contextual social changes including peace, avoidance of famines, economic growth, education, safe drinking water, and clean energy.

1.4. Ethiopia through 2030

As Ethiopia becomes a middle-middle income country by 2035 (Admasu, Tamire, and Tsegaye 2014), health improvements will hopefully follow the paths of the Sustainable Development Goals (SDG) and universal health coverage (UHC).

Ethiopia is now developing its economy with a high growth rate (e.g. 7.6% per annum) (The World Bank Group 2016) to become a middle-income country within a decade. The health sector will be a contributor to this economic growth by turning the vision of healthy, productive and prosperous Ethiopians into reality as well as the beneficiary from this sustained economic growth to avail adequate resources to provide essential high-quality services. Envisioning the future of Ethiopia's health has taken into account the assumption of Ethiopia becoming a lower-middle income country by 2025 and a middle-middle income country by 2035 and has led to the making of indicative targets with comparative benchmarking with other countries and subsequent strategic recommendations to meet those indicative targets (Table 1).

Table 1. Benchmarking of high impact indicators for 2035 for Ethiopia.

UMICs	MMR	NMR	IMR	U5MR	Age-standardized mortality rate per 100k			Cause-specific mortality rate per 100k			ALE
					CD	NCD	Injuries	Malaria	TB	HIV	
Brazil	56	10	14	16	97	534	76	0	3	No data	74
China	37	9	13	15	58	604	70	0	4	No data	76
Colombia	92	11	15	18	64	404	97	0	2	21	78
Cuba	73	3	5	6	47	468	48	0	0	1	78
Ecuador	110	10	20	23	105	400	81	0	5	13	76
Islamic Republic of Iran	21	14	21	25	82	599	90	0	3	11	73
Malaysia	29	3	6	7	185	526	51	0	6	21	74
Mexico	50	7	13	16	68	493	57	0	2	No data	75
Peru	67	9	14	18	173	387	52	0	7	10	77
Tunisia	56	9	14	16	134	465	36	0	3	1	76
Turkey	20	9	12	15	53	590	31	0	1	0	76
Average of selected UMICs (best case scenario for Ethiopia in 2035)	46	9	13	16	97	497	63	0	3	7	76
Average of all UMICs (base case scenario for Ethiopia in 2035)	53	10	16	20	125	600	81	1	6	22	74
Ethiopia-2011 status	350	31	52	77	721	903	139	4	18	No data	60

Acronyms used:		
	UMIC	Upper-Middle Income Countries
	MMR	Maternal Mortality Rate
	NMR	Neonatal Mortality Rate
	IMR	Infant Mortality Rate
	U5MR	Under 5 Mortality Rate
	ALE	Active Life Expectancy

Source: (Admasu, Tamire, and Tsegaye 2014).

The health sector strategic plans toward the end date of the SDGs are expected to cope with a changing landscape in the country in terms of socioeconomic changes, inequalities and demand

for high-quality health services. One approach is to develop UHC through ever improving primary health care and extend it to the higher levels of the healthcare system.

The 20-year vision toward the SDGs of the country could be summarized in being anchored on six strategic pillars (Admasu, Tamire, and Tsegaye 2014):

1. Empower the community to play a significant role in the health sector.
2. Strengthen primary health care units within the broader health sector context.
3. Ensure a robust human resources development that commensurates with the socio-economic development of the country in the decades ahead.
4. Engage the private sector and civil society organizations in support of the sector's vision.
5. Develop sustainable financing mechanisms necessary to achieve better health outcomes.
6. Develop institutional capacity at the Ministry of Health, Regional Health Bureaus, and related agencies to be responsive to the ever-changing economic, social, environmental, technical, and epidemiologic contexts of the country.

However, little is known about the concrete challenges facing the country in terms of demographic and epidemiologic change. In this paper, we examine past mortality rates in Ethiopia and estimate what these rates might be in the future (by 2030), taking into account those past mortality trends which the country has seen. We then reflect on what possible services, interventions, and packages

could be rolled out or strengthened in the years ahead in Ethiopia, given recently published evidence from the *Disease Control Priorities*, 3rd edition (Disease Control Priorities).

2. Methods

Two sets of data were used in this analysis: 1) United Nations Population Division (UNDP) World Population Prospects 2017 revision (United Nations 2017b) which provided population projections for 2030 based on medium fertility variant, death projections for 2030, and death estimates for the year 2010 and 2015, and 2) Institute of Health Metrics and Evaluation (IHME) Global Burden of Diseases Studies 2016 revision (Global Burden of Disease Study 2015 2016), which provided the mortality rates per 100,000 population, for the years 2010 and 2015. We selected the following age groups from IHME data: <5 years, 5-9, 10-14, 15-49, 50-69 and 70+. UNDP data provided more granular age division, and were regrouped to be consistent with the age groups used in IHME data. In addition, UNDP projected population and mortality in 5-year intervals, and the numbers for 2030 were calculated as the annual average of the 2025-2030 and the 2030-2035 projected numbers. All deaths below 70 were considered as premature, as suggested in SDG target 3.4 and by Norheim and colleagues (Norheim et al. 2014).

UNDP data did not allow by-condition analysis, so was used only to simulate different scenarios to see whether Ethiopia could achieve 40% reduction in premature deaths by 2030. IHME data were used to analyze condition breakdown for each age group and to identify which condition would constitute major concerns in 2030. We included all major health conditions and diseases, especially those mentioned by recently published strategies and policy documents from the Ministry of Health and the Ministry of Finance and Development of Ethiopia (Elias 2014; Federal

Ministry of Health Ethiopia 2015b, 2016a, 2015d, 2012, 2014a, b). Several reports were reviewed to identify diseases and health conditions of strong focus from the health policy agenda set out by the Ethiopian government (see Table 2 for the list of the conditions retained and examined in this paper). Table 3 illustrates the Global Burden of Disease (GBD) study codes of different conditions used in this analysis**.**

Table 2. List of the health conditions included in the analysis.

1	Infectious diseases
a.	Tuberculosis (TB)
b.	HIV
c.	Diarrhea, lower respiratory and other infectious diseases
d.	Neglected tropical diseases (NTDs), including malaria and others
2.	**Maternal disorders**
3.	**Neonatal mortality**
4.	**Nutritional deficiencies**
5.	**Other communicable diseases**
6.	**Non-communicable diseases (NCDs)**
a.	Neoplasms
b.	Cardiovascular diseases
c.	Mental and substance use disorders
d.	Diabetes, urogenital, blood and endocrine diseases
e.	Other NCDs
7.	**Injury**

Table 3. Health indicators selected and corresponding Global Burden of Disease study codes.

#	Name	Global Burden of Disease study codes	
1	**Infectious diseases**	A.1.1+A.1.2+A.2+A.3	
a.	Tuberculosis (TB)	A.1.1	297
b.	HIV	A.1.2	298
c.	Diarrhea, lower respiratory and other infectious diseases	A.2	301
d.	Neglected tropical diseases (NTDs), including malaria and others	A.3	344
2.	**Maternal disorders**	A.4	366
3.	**Neonatal disorders**	A.5	380
4.	**Nutritional deficiencies**	A.6	386
5.	**Other Communicable Diseases**	A.7	392
6.	**Non-communicable diseases (NCDs)**	B	409
a.	Neoplasms	B.1	410
b.	Cardiovascular diseases	B.2	491
c.	Mental and substance use disorders	B.7	558
d.	Diabetes, urogenital, blood and endocrine diseases	B.8	586
e.	Other NCDs	B.3+B.4+B.5+B.6+ B.9+B.10	
7.	**Injury**	C	687

In a first part, we analyzed and constructed four scenarios, using only UNDP data. For scenario 1 (baseline), we calculated deaths for each age group that would have occurred if the 2015 age-specific crude mortality rate were applied to the population projected in 2030. This baseline reflects population growth and aging, but does not account for any changes in mortality rates in the period 2015-2030 (Gonzalez-Pier and others 2016; Norheim 2015) (see Table 4 for the reported baseline death numbers for each age group for Scenario 1).

Scenario 2 presents deaths as projected by UNDP. Those projections are based on the development of treatment regimens, economic growth, epidemiological trends and major political events that might affect people's health in the years ahead (United Nations 2017a). Specific changes in future health policies and health services were not discussed in this estimation procedure; hence we consider Scenario 2 projections to be a situation of no major changes to health policies currently in place in Ethiopia. All age groups below age 70 were added up to capture all premature mortality.

In scenario 3, we simply calculated deaths and mortality rates under the assumption that the SDG 40x30 target would be achieved (a 40% reduction in premature mortality from the baseline level by 2030).

In Scenario 4, we projected the age-specific mortality rates in 2030 assuming they would drop at the same rates from the mortality rates of 2015, compared with the mortality changes observed in the period 2010 to 2015. The calculation formula used are described below:

$$m(t) = m(0) * e^{-rt} \quad , \qquad (1)$$

$$m(t') = m(t) * e^{-r*(t'-t)} \quad , \qquad (2)$$

$$r = -\ln(m(t')/m(t))/(t'-t) \, , \qquad (3)$$

where m(t) is the mortality rate per 100,000 in year t, r is the decline factor calculated from any given mortality of year t and year t' from (3).

It is worth noting that one could anticipate diminishing marginal returns of mortality reductions, in other words as mortality rates drop it would be increasingly difficult to continue to drop at the same rates. Such mortality reduction trends have been documented in other countries (Gonzalez-Pier and others 2016). Also note that for age group <5, instead of using mortality rate of per 100,000 population of that age group, we calculated mortality rate as per 1,000 live births, using data on live births from UNDP.

In a second part, we applied the same methods as used in scenario 4 to the mortality rate by condition and by age group from IHME data. We were thus able to project the distribution of mortality by age and condition by 2030 in Ethiopia.

3. Results

Table 4 displays the four scenarios of mortality projections by 2030 in Ethiopia. The population size of Ethiopia using medium fertility estimates in 2030 for age group <5, 5-9, 10-14, 15-49 and 50-69 are estimated to be at 17, 16, 15, 74 and 13 million, respectively.

For Scenario 1, using the same mortality rates as those from 2015, total deaths for the age group 0-69 would be about 745,000. Scenarios 2 and 3 are subsequently compared to Scenario 1, to determine whether either Scenario 2 or 3 has achieved 40% reduction in the number of deaths. In Scenario 2, using UNDP projections (business as usual), children under age 15 would achieve about 50% mortality by 2030. Overall, in this scenario, premature mortality would be reduced by

34%. Therefore, accelerations in mortality reductions would be needed to help achieve the goal of reaching overall 40% reduction in total premature deaths by 2030.

Table 4. Death projections by 2030 under different scenarios in Ethiopia.

Age group	Projected population (in 1,000s)	**Scenario 1: baseline**	**Scenario 2: United Nations' projections**			**Scenario 3: SDGs (reduction of 40%)**		**Scenario 4: Assuming constant rate of change from 2010-2015 to continue**		
			Deaths	Rate per 100,000	Change (%)	Deaths	Rate per 100,000	Deaths	Rate per 100,000	Change (%)
0-69 years	136,172	745,375	493,558	362	-34%	447,225	328	407,683	299	-45%
0-4 years	16,726	214,278	108,803	32*	-49%	128,567	769	98,499	29*	-54%
5-9 years	16,220	30,237	15,707	97	-48%	18,142	112	15,338	95	-49%
10-14 years	15,455	28,286	14,958	97	-47%	16,971	110	15,654	101	-45%
15-49 years	74,412	269,202	185,297	249	-31%	161,521	217	122,104	164	-55%
50-69 years	13,359	203,371	168,794	1 264	-17%	122,022	913	156,087	1 168	-23%
> 70 years	3,448	271,534	254,574	7 384	-6%	162,921	4 725	249,503	7 237	-8%
***For age group of 0-4, the mortality rate is per 1,000 live birth**										

In Scenario 3, assuming the 40% reduction target is hit by 2030, the age-specific mortality rate per 100,000 population would be 769 for 0-4 year-olds, 112 for 5-9 year-olds, 110 for 10-14 year-olds, 217 for 15-49 year-olds, and 913 for 50-69 year-olds. In Scenario 4, assuming constant mortality reductions from 2015 to 2030, i.e. at the same annual reduction rates as from 2010 to 2015, all age groups would achieve >40% reductions in mortality, except the age group of 50-69 year-olds (Table 4).

To identify the specific conditions where acceleration in policies or deployment of appropriate health services would be needed to achieve the "40 by 30" reduction goal, we examined further

(Tables 5-7, Figure 4-6) the condition breakdown by age group in the years 2010, 2015 and the projected condition breakdown in 2030 assuming constant annual reduction rates over 2010-2015.

As presented in Tables 5-7, condition-specific data and UNDP population projections rely on distinct sources of data and estimation methods. We thus only present the percentage of each condition among the total mortality of each age group in Figures 4-7. Infectious, maternal, neonatal and nutritional disorders are at the bottom of the graph in yellow, red, orange and light purple colors, respectively; while NCDs are stacked on top in green and blue, with injury on the top in purple (Figures 4-6).

Table 5. Mortality rate by condition and age group in Ethiopia, 2010.

	Mortality rate per 100,000 population					
Condition name	<5	5-9	10-14	15-49	50-69	70+
TB (A.1.1)	20	3	4	58	285	750
HIV (A.1.2)	24	12	20	76	63	17
Diarrhea, lower respiratory and other infectious diseases (A.2)	745	60	39	63	370	1777
Neglected Tropical Diseases (A.3)	14	5	4	5	15	35
Maternal disorders (A.4)	0	0	1	34	3	0
Neonatal mortality (A.5)	515	0	0	0	0	0
Nutritional Deficiencies (A.6)	133	7	3	5	36	213
Other Communicable Diseases (A.7)	64	5	1	4	14	41
Neoplasms (B.1)	5	6	6	33	340	883
Cardiovascular diseases (B.2)	6	2	3	31	569	3282
Mental and substance use disorders (B.7)	0	0	0	2	7	18
Diabetes, urogenital, blood and endocrine diseases (B.8)	15	2	2	11	124	526
Other NCDs (B.3+B.4+B.5+B.6+ B.9+B.10)	47	5	7	35	288	1459
Injury	52	21	25	54	157	524

NCDs = non-communicable diseases.

Figure 4. Disease breakdown by age group in Ethiopia, 2010.

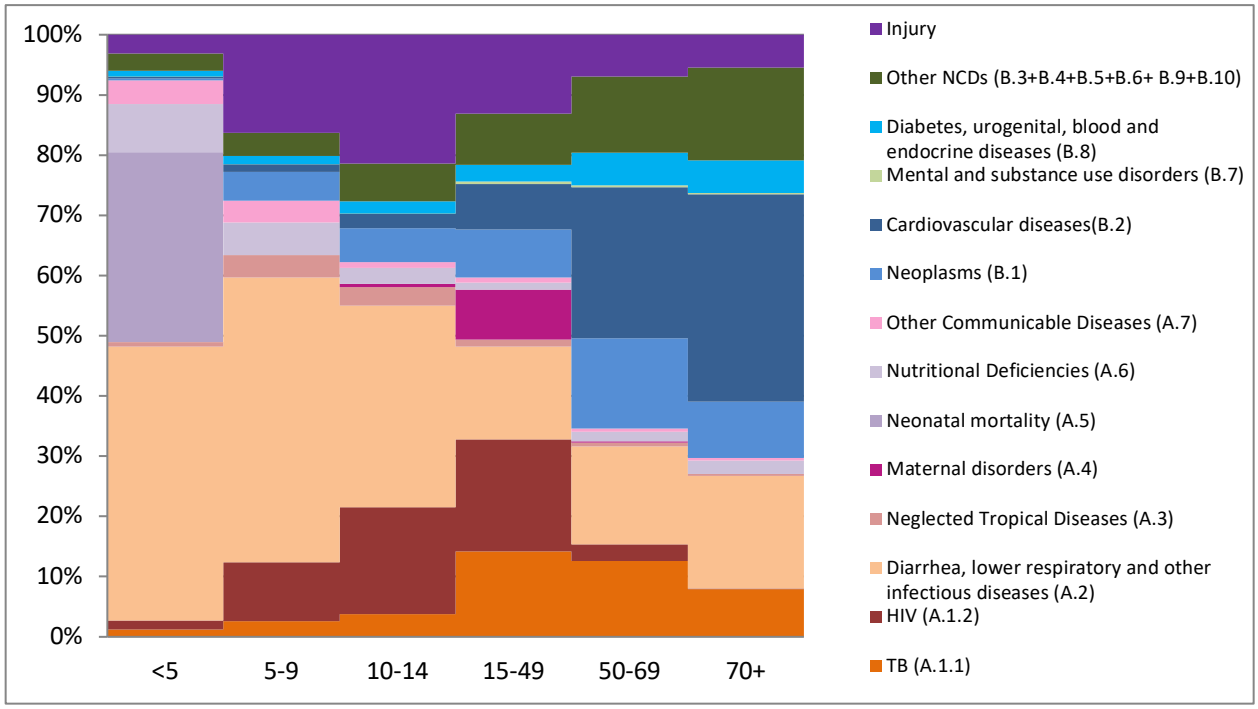


Figure 5. Disease breakdown by age group in Ethiopia, 2015.

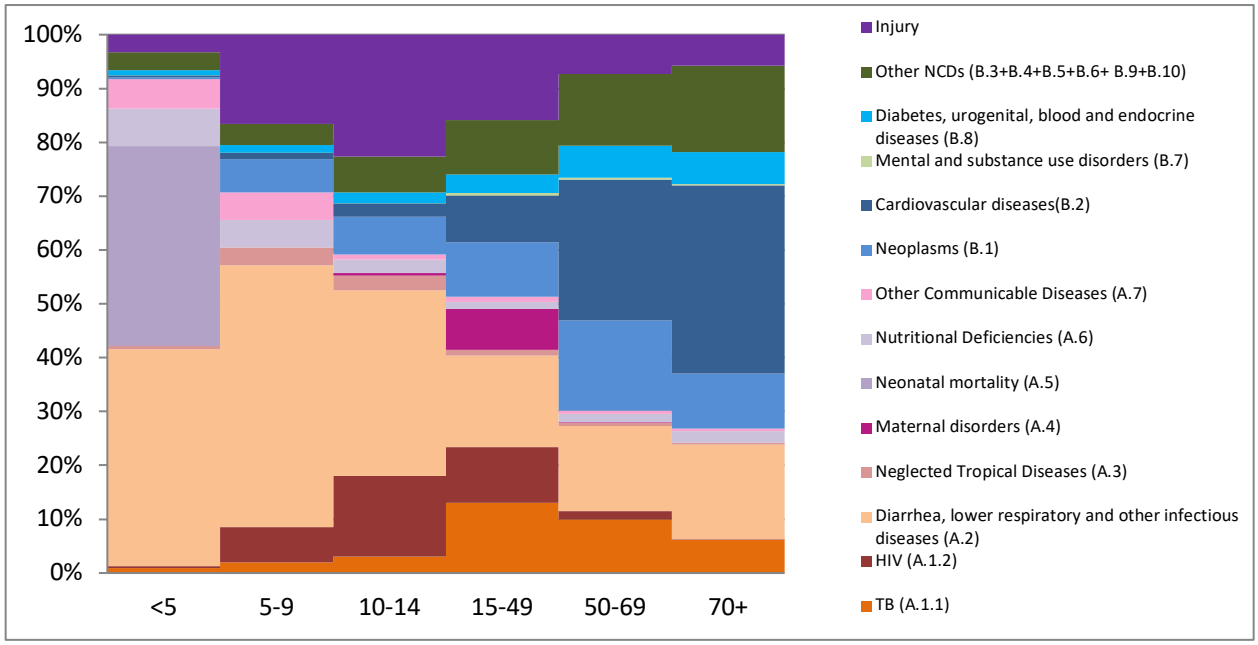


Figure 6. Disease breakdown by age group in Ethiopia, 2030.

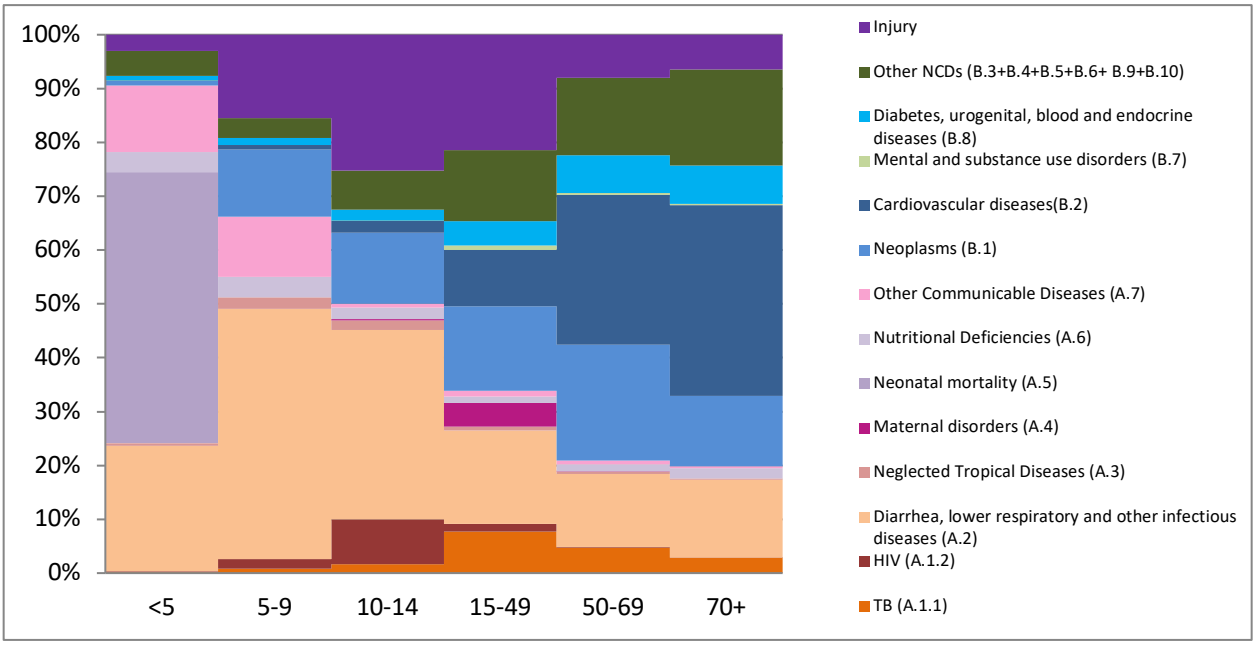


Table 6. Mortality rate by condition and age group in Ethiopia, 2015.

	Mortality rate per 100,000 population					
Condition name	<5	5-9	10-14	15-49	50-69	70+
TB (A.1.1)	9	2	3	43	203	549
HIV (A.1.2)	4	5	13	34	30	8
Diarrhea, lower respiratory and other infectious diseases (A.2)	410	40	29	56	322	1578
Neglected tropical diseases (A.3)	8	3	2	4	12	29
Maternal disorders (A.4)	0	0	0	25	2	0
Neonatal mortality (A.5)	376	0	0	0	0	0
Nutritional deficiencies (A.6)	71	4	2	4	31	194
Other communicable diseases (A.7)	55	4	1	3	12	38
Neoplasms (B.1)	4	5	6	33	340	910
Cardiovascular diseases (B.2)	3	1	2	28	533	3125
Mental and substance use disorders (B.7)	0	0	0	2	7	17
Diabetes, urogenital, blood and endocrine diseases (B.8)	10	1	2	11	120	530
Other NCDs (B.3+B.4+B.5+B.6+ B.9+B.10)	34	3	6	33	272	1431
Injury	33	14	19	52	148	516

Table 7. Projected mortality rate by condition and age group in Ethiopia, 2030

2030 projection	Mortality rate per 100,000 population					
Name	<5	5-9	10-14	15-49	50-69	70+
TB (A.1.1)	1	0	1	17	74	214
HIV (A.1.2)	0	0	3	3	3	1
Diarrhea, lower respiratory and other infectious diseases (A.2)	68	12	12	37	213	1103
Neglected tropical diseases (A.3)	1	1	1	2	6	16
Maternal disorders (A.4)	0	0	0	9	1	0
Neonatal mortality (A.5)	146	0	0	0	0	0
Nutritional deficiencies (A.6)	11	1	1	3	21	146
Other communicable diseases (A.7)	36	3	0	2	10	30
Neoplasms (B.1)	2	3	5	34	338	999
Cardiovascular diseases (B.2)	1	0	1	23	437	2699
Mental and substance use disorders (B.7)	0	0	0	2	6	17
Diabetes, urogenital, blood and endocrine diseases (B.8)	2	0	1	10	110	544
Other NCDs (B.3+B.4+B.5+B.6+ B.9+B.10)	14	1	3	28	227	1353
Injury	9	4	9	46	125	494

In summary, as in many low- and middle-income countries today, addressing the increasing burden of NCDs will be one of the biggest challenges of Ethiopia in the decades to come, which we will discuss in the section below.

4. Discussion

To reduce premature mortality (below age 70) in Ethiopia by 40% by 2030 (compared with baseline using the projected population in 2030 and the mortality rate in 2015), more actions have to be taken in terms of health policies, enhancing prevention, early detection and treatment provision of key interventions, especially in the adult age groups and in non-communicable

conditions and risk factors, where the reduction rate for the past 25 years was observed not to be sufficient to yield a 40% mortality reduction by 2030. Targeted health policies focusing on specific age groups and conditions will help Ethiopia in achieving substantial mortality reduction goals in the decades ahead.

So far, Ethiopia has achieved remarkable successes in reducing maternal, neonatal and under-five mortality rates over the past decades. In both scenario 2, where mortality rates per age group are assumed to drop continuously through improved public health awareness and treatment methods, and scenario 4, where a constant annual mortality reduction rate is assumed from 2010 to 2015, deaths from <15 age groups would be reduced by more than 40% by 2030. However, in spite of large progress, the under-five mortality rate in Ethiopia is still relatively high compared to some neighboring countries in sub-Saharan Africa such as Tanzania (World Health Organization 2015) and highly cost-effective interventions to reduce mortality for this age group have been identified (Black and others 2016; Black and others 2017). For example, as stated by Black and colleagues (Black and others 2016; Black and others 2017), progress could be accelerated by scaling up integrated packages of essential interventions across the continuum of care for reproductive, maternal, newborn, and child health; and individual interventions that would have the highest impact would be: provision of contraception, management of labor and delivery, care of preterm births, treatment of severe infectious diseases, including pneumonia, diarrhea, malaria, and neonatal sepsis, and management of severe acute malnutrition. In addition, Bundy and colleagues (Bundy and others 2017) proposed two cost-effective packages, to provide care and support to children during school and extending to later adolescence, to secure the gains of investment to neonatal and under age 5 phases, and to constitute a good foundation for physical, mental and social development across the life cycle.

Not surprisingly, infectious diseases still continue to take a big proportion of the total deaths in Ethiopia, especially in children below age 15, although the is declining substantially, from about 60% in 2010 to below 50% in 2030 (see Figures 4-6). The threat from infectious diseases, especially those which have the grave potential to travel across borders, needs to be tackled by a convergence of global actors, from both public and private sectors, and across different levels of the health system (Jamison and others 2013; MoH 2015). The Global Health 2035 Commission (Jamison and others 2013) pointed that a "grand convergence" in the mortality rates related to childhood and maternal conditions and infectious diseases would be possible with the scaling up of interventions including those targeting HIV, TB, and malaria, neglected tropical diseases and immunization. Research conducted for *The Lancet* Commission on Investing in Health revealed that the total overall costs, including for health systems, of covering highly cost-effective interventions for Reproductive, Maternal and Children's Health and for HIV/AIDs, TB and malaria in Ethiopia would be $22 per capita in 2015 (Jamison and others 2013).

On the other hand, the challenges ahead for mortality reductions in NCDs are substantial. Due to the slower reduction in mortality from NCDs, compared to that from infectious, maternal and nutritional causes, NCDs are going to take a much bigger proportion of deaths in 2030 than they do now. For example, in the age group 15-49 year-olds, the proportion of NCDs will raise from taking less than 30% of total mortality in 2010 to be about 45% in 2030 (Figures 4-6). A large burden from NCDs would come from neoplasms, cardiovascular diseases, and diabetes (Figure 6). In particular, a recent national burden of cancer study has shown the large burden incurred in the country in terms of breast and cervical cancers (Memirie and others 2017).

In this respect, health policy development for the coming 15 years would need to focus more on the reduction of the NCD burden, including cancers and cardiovascular diseases, in the adult population of those above age 15. Notably, various studies have identified cost-effective interventions for cancer control, from prevention to early detection and treatment, especially for low-and-middle income countries; among the most recommended interventions for cancer prevention are tobacco control with the implementation of all interventions recommended by WHO's Framework Convention on Tobacco Control (FCTC) for both prevention of smoking-related cancers as well as stroke and heart diseases, as well as selected vaccines such as HepB vaccine and Human papillomavirus vaccine (Gelband and others 2016). As for cardiovascular diseases, these diseases often directly lead to higher risks of developing other cardio-metabolic conditions that require complex and expensive interventions. In particular, a recent nation-wide STEPS survey in Ethiopic suggested that most of the population have at least 1 risk factor for NCDs (Ethiopian Public Health Institute 2016). Another earlier study found the prevalence of people with elevated blood pressure is as high as 30% in a subgroup of the Ethiopian population (Awoke and others 2012). Early adoption of health policies targeting NCDs could be quite cost-effective and prevent a large related mortality burden in the future. WHO has identified and costed a package of interventions targeting NCDs (World Health Organization 2011), which is echoed by *The Lancet* Commission on Investing in Health as cost-effective and thus recommended for all governments (Jamison and others 2013). Recently, Prabhakaran and colleagues (Prabhakaran and others 2017) costed an essential package of interventions to reduce risk of and management of NCDs including cardiovascular diseases, including tobacco taxation, bans on trans fats, reduction on salt consumption and so forth. They also recommended strengthening primary health service to ensure medicine supply and better quality of care. The

estimated costs of full implementation were estimated at US$21 per person in low-income countries and $24 in lower-middle-income countries. This could serve as a starting place and be expanded as demand goes up. Moreover, reducing the onset of NCDs can also prevent large impact on household finances by preventing treatment-related healthcare bills which could be quite substantial as reported recently by Tolla and colleagues (Tolla and others 2017).

With all competing priorities from infectious diseases, maternal and children's health, and non-communicable illness, local governments also need to take the system perspective, and focus on building a platform that can host all essential packages. The recent publications on Disease Control Priorities 3 provides such granular assessment and called for more investment, especially from government revenues (Jamison and others 2017).

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