Analysis of the Levels and Trends in Infant and Under-Five Mortality in Ethiopia

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Abstract: **Childhood mortality is a core indicator for child health and well-being, and useful for the calculation of overall mortality, as the highest risk of death and proportion of deaths occurs during childhood. It is also, an important demographic, health and development issue for a number of reasons. As well infant and child mortality rates are basic indicators of a country's socioeconomic situation and quality of life. This research has the overall objectives of describing the levels and trends of under-five mortality between 1990 and 2016, and to assess the progress of MDG4 looking back 15 years at the trends and positive forces during the MDG era in Ethiopia, mainly based on data from the 2000, 2005, 2011 and 2016 Ethiopian Demographic and Health Surveys. The results from the level and trend analysis indicated that all the five childhood mortality indicators (under-five, child, infant, neonatal and postnatal mortality) have been steadily declining over the last two decades. For instance, under-five mortality has shown a continuous reduction over time; from 198 deaths per 1000 in 1990 had declined to 67 deaths per 1000 in 2016. As a result, Ethiopia had 67 percent reduction of deaths in under five-children with an average annual rate of decline of 5.0 percent between 1990 and 2015. This exceeded the 4.3 percent annual rate of decline needed to reach Millennium Development Goal-4 (MDG4). Therefore, the progress decline rate indicated that Ethiopia had been achieved MDG4 to gains in improving child survival. However, the contribution of neonatal mortality to infant mortality at national level has increased over time. In order to continue to accelerate progress and to achieve Sustainable Development Goals SDGs (target 3.2), it is critical to ensure that every pregnant woman and every newborn has access to and receives good quality care and life-saving interventions.**

Keywords: **Ethiopia, Under-Five Mortality, Trends, Childhood Mortality.**

1. INTRODUCTION

Childhood mortality is a core indicator for child health and well-being, and an important demographic, health and development issue for a number of reasons. Also, Infant and child mortality rates are basic indicators of a country's socioeconomic situation and quality of life [1].

Nowadays health becomes one of the major global concerns to improve the quality of life in both developed and developing countries. Although mortality remains the global challenge with million deaths occurring due to health related problem, there is a remarkable regional variation in its distribution [2]. Regarding this World Health Organization (WHO) set strategies to reduce child and maternal mortality in developing countries; however, it remains unacceptably high particularly in sub-Sahara African countries [3, 4].

Globally, in 2000, world leaders agreed on the Millennium Development Goals (MDGs) with eight pillars of goals. So the United Nation (UN) General Assembly adopted the Millennium Declaration, establishing a global partnership of countries and development partners committed to eight voluntary development goals, to be achieved by 2015. One of the targets of the MDGs called for reducing the under-five mortality rate (U5MR) by two thirds (67 percent) between 1990 and 2015 known as the MDG 4 target [5]. For instance, others two of the eight MDGs are focused on health which improve maternal health (MDG 5 target) and combat HIV/AIDS, malaria and other diseases (MDG 6 target), while health is also a component of several other MDGs (nutrition, water and sanitation) [6].

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There has been extraordinary mobilization of resources around MDG-related activities across a wide spectrum of worldwide and national initiatives and the development community has convened on a regular basis to evaluate progress [7]. Among the major global events related to the MDGs include: the 2008 high-level event at the UN, which there was a call to speed up progress in the direction of the MDGs [8]; in recent years, the UN launched the Global Strategy for Women's and Children's Health and the movement of Every Woman Every Child boosted global momentum in improving newborn and child survival as well as maternal health; in 2012, world leaders renewed their commitment during the global launch of committing to child survival with aiming for a continued post-2015 focus to end preventable child deaths; and the 2013 UN special event to follow up on MDG-related efforts [9]. Many regional and country events have also been held to review progress and make new commitments especially sub-Saharan countries [7].

During the MDG era looking back 15 years, many global progress records were set and. Progress towards the MDGs, on the whole, has been remarkable, including child mortality and maternal mortality decreased greatly since 1990. Despite substantial progress on child mortality, the MDG 4 target will not be met. The global U5MR fell by 53 percent between 1990 and 2015, short of the targeted two thirds (67 percent) reduction. It is estimated that 5.9 million children under five will die in 2015. The African Region and South-East Asia Region account for a disproportionate share of newborn and child deaths [7, 9].

Globally, looking back 15 years at the trends and positive forces during the MDG era and assessing the main challenges for the coming 15 years. Therefore, at the end of the MDG era, the international community is a promise renewed agreeing on a new framework including focus to end preventable child deaths. Consequently, the UN General Assembly adopted the new development agenda "*Transforming our world: the 2030 agenda for sustainable development*" [10].

The new agenda of Sustainable Development Goals (SDGs) integrated with 17 goals and 169 targets, including one specific goal for health with 13 targets, have many linkages and cross-cutting elements, reflecting the integrated approach that underpins the SDGs. One of the targets of the SDGs (target 3.2) by 2030 is end preventable deaths of newborns and children under five years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1000 live births and under-five mortality to at least as low as 25 per 1000 live births [10]. The new SDGs agenda is of unprecedented scope and ambition, applicable to all countries, and which nevertheless provided an important framework for combating poverty and promoting development in low and middle income countries during the past 15 years [7].

Therefore, Ethiopia is one of the parts of this new post-2015 framework. With more than 85.9 million inhabitants, Ethiopia is the most populous nation in Eastern Africa and second to Nigeria in Africa. Agriculture is the source of livelihood for majority of the Ethiopian population (80 percent) and is the basis for the national economy, where small-scale and subsistence mode of farming is predominant [11]. The population grows at a rate of 2.6 percent per annum and the majority of people (84 percent) reside in rural areas, with agriculture being the major source of livelihood [12]. High mortality, high fertility and low life expectancy characterize the demography, as in most sub-Saharan African countries. In the past two decades, however, the country witnessed an unprecedented decline in under-five mortality from 198 per 1000 in 1990 to 67 per 1000 live births in 2015 [9], an average decline of 66 percent. Approximately 60 percent of the under-five mortality in Ethiopia is attributable to neonatal deaths [9].

The levels and trends of under-five mortality are not well documented in Ethiopia since 1990, but previous studies report the trends of under-five mortality between 2000 and 2011. Therefore, the study aimed to contribute the understanding of levels and trends of under-five mortality between 1990 and 2016, and to assess the progress of MDG4 looking back 15 years at the trends and positive forces during the MDG era in Ethiopia.

2. DATA AND METHODS

The data sources of the study were the Central Statistical Authority (CSA), Ethiopian Demographic and Health Survey (EDHS, 2000, 2005, 2011, and 2016), World Bank Group (WB), World Population Data Sheet (WPDS), WHO, UN, and United Nations Children's Fund (UNICEF) data.

The main variables collected were include: under-five mortality rate (U5MR) (death between birth and the fifth birthday), child mortality rate (CMR) (death between first birthday and the fifth birthday or children from 12 months to 47 months old), infant mortality rate (IMR) (death before the first birthday), neonatal mortality rate (NMR) (death before 28 days), and post- neonatal mortality rate (PNMR) (death between 28 days and the first birthday).

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This study employed the level and trend analysis of under-five, infant, child, neonatal, and post neonatal mortality rate using percentage analysis and compared with MDGs standards.

3. RESULTS

1. Levels and Trends of Under-Five, Infant and Neonatal Mortality Rate

Fig 1 presents the trend data for the U5MR, IMR and NMR for the period 1990–2016. In Ethiopia, demographic and health surveys data and UNICEF report indicates that U5MR was decline from 198 deaths per 1,000 live births in 1990 to 166 death per 1000 live birth in 2000, and decline 166 to 67 deaths per 1000 live births from 2000 to 2016. The U5MR trend shows 16.2 percent decline from 1990 to 2000 and 59.6 percent decline from 2000 to 2016.

Infant mortality rate also consequently decline from 118 to 97 deaths per 1000 live births from 1990 to 2000, 97 to 77 deaths per 1000 live birth from 2000 to 2005, 77 to 59 deaths per 1000 live births from 2005 to 2011, and 59 to 48 deaths per 1000 live birth from 2011 to 2016. These were equivalent to 17.8 percent reduction from 1990 to 2000 and 50.5 percent decline from 2000 to 2016. The overall reduction was indicate that 59.3 percent from 1990 to 2016. The neonatal mortality rate was 11.0 percent reduction from 1990 to 2000 and 40.8 percent reduction from 2000 to 2016, which was declined by 1.9 percent per annum from 1995 to 2010 and the early NMR declined by 0.9 percent per annum [Fig 1].

2. Levels and Trends of Child and Post-Neonatal Mortality Rate

Data from the 2005 EDHS show that CMR has declined by 35 percent over the five year period preceding the survey from 77 deaths per 1000 live births to 50 deaths. The report of EDHS 2016 shows that CMR has declined by 74 percent over the 16 year period preceding the survey from 77 to 20 deaths per 1000 live births. Similarly, PNMR decline 60.4 percent from 2000 to 2016. Across 2000 to 2011, post neonatal death rates decreased by 26 deaths per 1000 live births (54 %). Those from 2001 to the early 2011, post neonatal mortality overhand a significant decline of 5.4 per 1000 live birth per year [Fig 2].

3. The Overall Levels and Trends of Childhood Mortality Rates in Ethiopia

Fig 3 presents trends in childhood mortality in Ethiopia since the 2000 EDHS survey. Data show that there has been a steady decline in infant, child, and under-5 mortality over the last 16 years. The figures pertain to the average mortality in the five-year period preceding the survey, not to the situation in the survey year itself.

The data indicates that all the five childhood mortality indicators have been steadily declining over the last decades. The magnitude of decline varies among the component rates that combine to form the U5MR. The highest mortality decline is observed in the CMR which declined from 77 deaths per 1000 live births in 2000 to 20 deaths per 1000 live births in 2016. This is equivalent to a 74.0 percent decline between the two surveys.

Neonatal mortality rates have the lowest mortality decline which is observed declined from 49 deaths per 1000 live births in 2000 to 29 deaths per 1000 live births in 2016. This is equivalent to a 40.8 percent decline between the two surveys. In addition to this, NMRs have not decreased to the same degree; the decline was just over 20 percent [Fig.3].
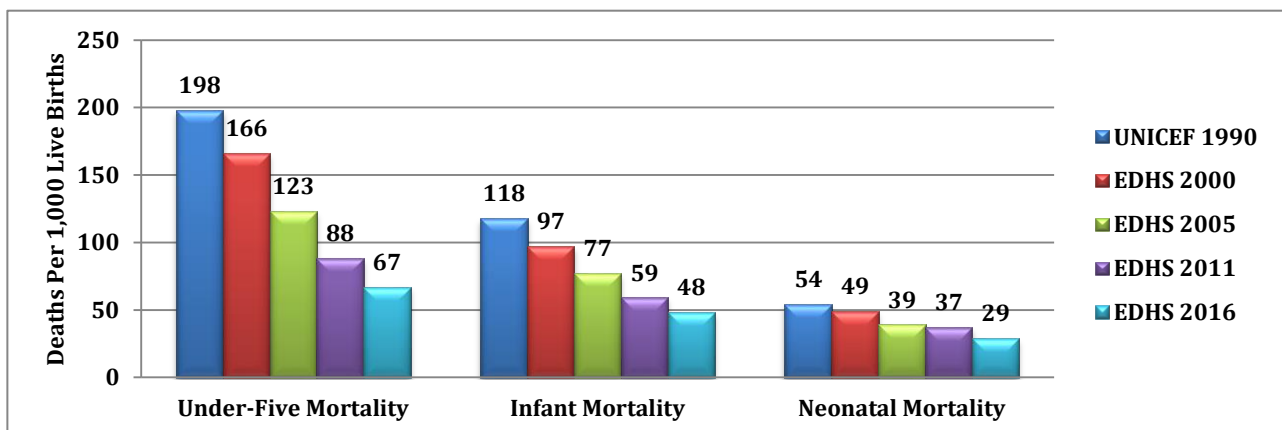

Fig. 1. Trends in under-5, infant and neonatal mortality rate in Ethiopia, 1990-2016 (Source: EDHS (2000, 2005, 2011, and 2016) and UNICEF (1990))
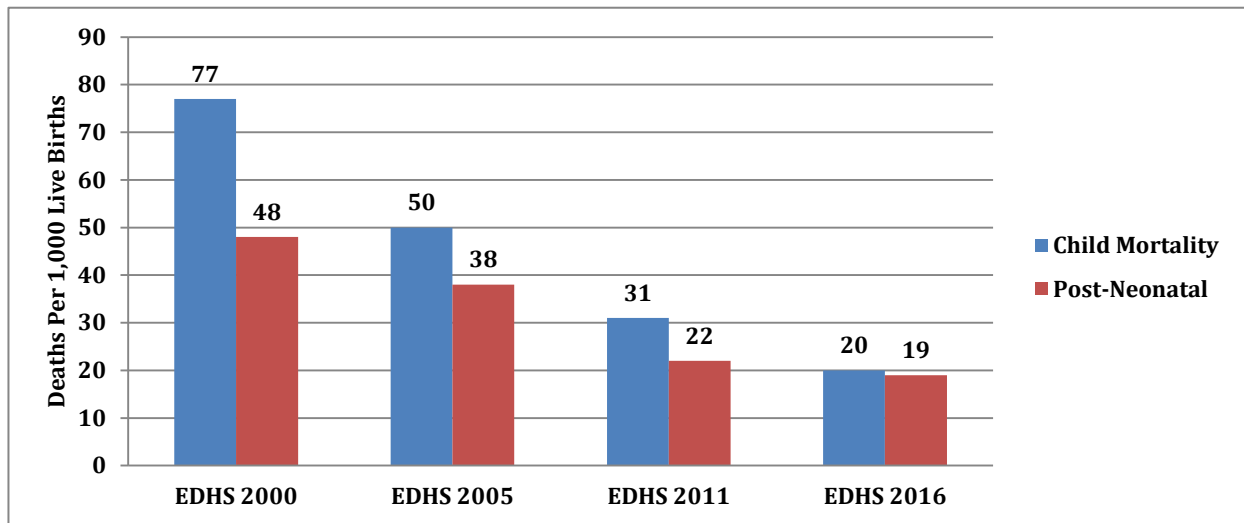
Fig. 2. Trends in child and post-neonatal mortality rate in Ethiopia, 2000-2016 (Source: EDHS (2000, 2005, 2011, and 2016))

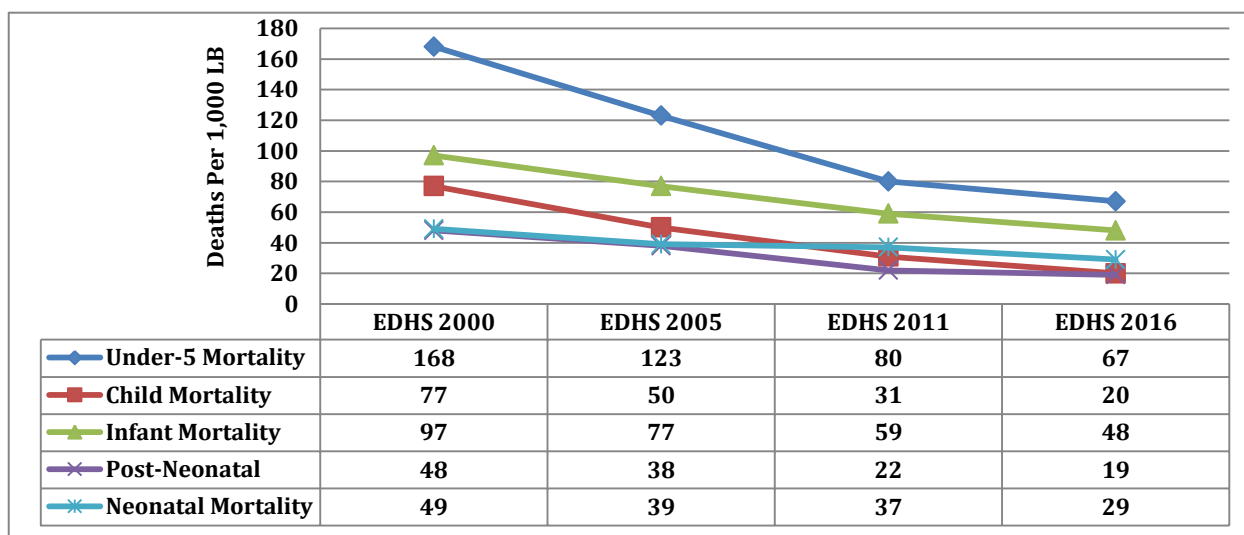|	EDHS 2000	EDHS 2005	EDHS 2011	EDHS 2016
Under-5 Mortality	168	123	80	67
Child Mortality	77	50	31	20
Infant Mortality	97	77	59	48
Post-Neonatal	48	38	22	19
Neonatal Mortality	49	39	37	29

Fig. 3. Trends in childhood mortality rates in Ethiopia, 2000-2016 (Source: EDHS (2000, 2005, 2011, and 2016))

4. Levels and Trends in the U5MR, by Millennium Development Goal Region, 1990-2015

Table 1 present at the MDG regional level, the developed, developing and sub-Sahara Africa regions have more than halved the U5MR decline from 1990 to 2015. Northern Africa has reduced the U5MR by two thirds or more since 1990. Similarly at the country level, Ethiopia reduced their U5MR by two third with annual rate of reduction (ARR) 5.0 percent. Fig 4 shows that levels and trends in the U5MR by MDG region from 1990 to 2015 with the regions MDG target for 2015.

Globally, the number of under-five death decline from 12,749 thousands in 1990 to 5,945 thousands in 2015 with 53 percent decline within the last 25 years. In sub-Saharan Africa countries, the number of under-five death decline 3,871 thousands in 1900 to 2,947 in 2015 with 24 percent decline, among this Ethiopia shared decline the number of death from 446 thousands in 1900 to 184 thousands in 2015 with 67 percent reduced [Table 2].

Sub-Saharan Africa, the neonatal mortality rate fell from 46 deaths per 1,000 live births in 1990 to 29 in 2015, and the numbers of 994 and 1027 thousands of neonatal deaths in 1990 and 2015, respectively. In Ethiopia, the number of neonatal death decline from 135 thousands in 1900 to 87 thousands in 2015 [Table 3], with the decline NMR from 54 per

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1,000 live birth in 1900 to 29 per 1,000 live birth in 2015 [Fig 5]; the figure shows that levels and trends of the NMR categorized by Millennium Development Goal region, 1990 and 2015.

Table 1: Levels and trends in the U5MR, by millennium development goal region, 1990-2015

Regions	U5MR (deaths per 1,000 live births)							Decline (%)		ARR (%)	
	1990	1995	2000	2005	2010	2015	MDG target for 2015	1990-2015	1990-2000	1990-2015	2000-2015
World	91	85	76	63	52	43	**30**	53	1.8	3.0	3.9
Developed Region	15	11	10	8	7	6	**5**	60	3.8	3.7	3.5
Developing Region	100	94	83	69	57	47	**33**	54	1.8	3.1	3.9
Northern Africa	73	57	44	35	28	24	**24**	67	5.0	4.4	4.1
Sub-Saharan Africa	180	172	154	127	101	83	**60**	54	1.6	3.1	4.1
Ethiopia	198	185	166	123	88	67	**68**	66		5.0	

Source: EDHS, UNICEF, WHO, UN, and WB (1990-2015)
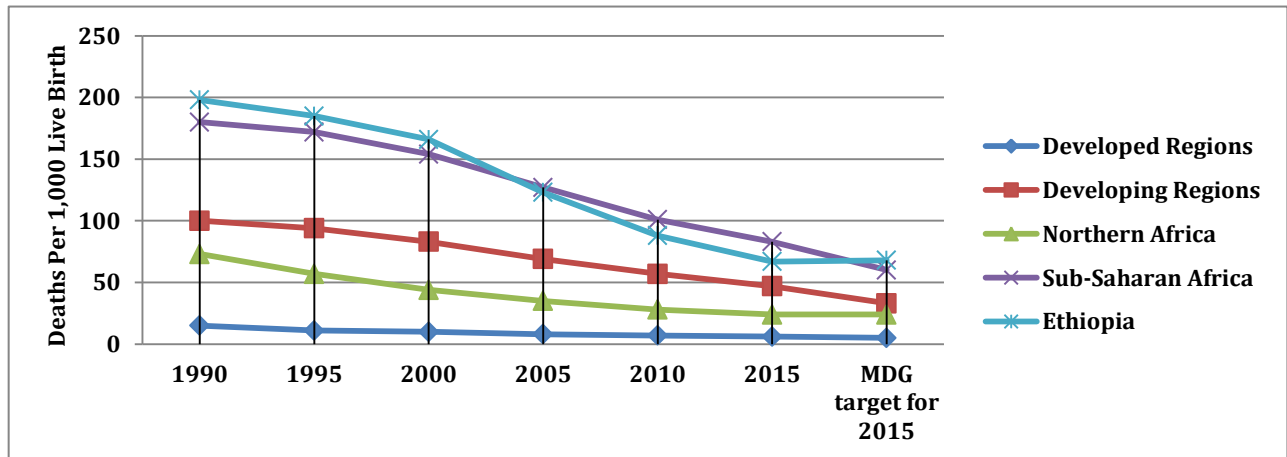
Fig. 4. Levels and trends in the U5MR, by MDG region, 1990-2015 (Source: EDHS, UNICEF, WHO, UN, and WB (1990-2015))

Table 2: Levels and trends in the number of deaths of children under age five, by Millennium Development Goal region, 1990-2015

Regions	Number of under-five deaths (thousands)						Decline (%)	Share of global under-five deaths (%)	
	1990	1995	2000	2005	2010	2015	1990–2015	1990	2015
World	12,749	10,994	9,783	8,299	7,013	5,945	53	100.0	100.0
Developed regions	223	154	129	111	96	80	64	1.7	1.3

Developing regions	12,526	10,840	9,654	8,189	6,917	5,865	53	98.3	98.7
Northern Africa	280	194	142	121	111	114	59	2.2	1.9
Sub-Saharan Africa	3,871	4,079	4,114	3,748	3,292	2,947	24	30.4	49.6

Source: UNICEF, WHO, UN, and WB (1990-2015)

Table 3: Neonatal mortality rate, number of neonatal deaths and neonatal deaths as a share of under-five deaths, by Millennium Development Goal region, 1990 and 2015

Regions	Neonatal mortality rate (deaths per 1,000 live births)			Number of neonatal deaths (thousands)		Neonatal deaths as a share of under-five deaths (%)		
	1990	**2015**	**Decline (%) 1990–2015**	**1990**	**2015**	**1990**	**2015**	**Relative increase (%) 1990–2015**
World	36	19	47	5,106	2,682	40	45	13
Developed regions	8	3	58	116	44	52	55	5
Developing regions	40	21	47	4990	2639	40	45	13
Northern Africa	31	14	56	117	66	42	58	38
Sub-Saharan Africa	46	29	38	994	1027	26	35	36
Ethiopia	54	29	46	135	87	35	60	63

Source: EDHS, UNICEF, WHO, UN, and WB (1990-2015)
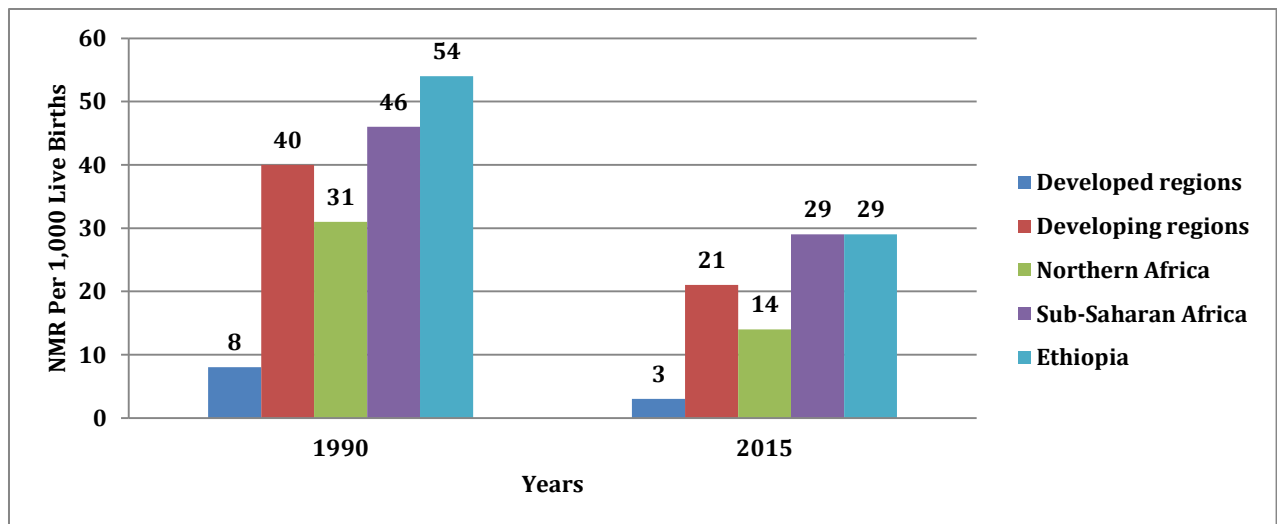
Fig. 5. Neonatal mortality rate, by Millennium Development Goal region, 1990 and 2015 (Source: EDHS, UNICEF, WHO, UN, and WB (1990-2015))

4.   DISCUSSION

The mortality rates of under-five children's in Ethiopia have been steadily declining over the past two decades. The under-five mortality rates have declined with 16, 26, 28, and 47 percents from the years 1900 to 2000, 2001 to 2005, 2006 to 2011, respectively [Fig 2]. These figures show the faster reduction of mortality rates on childhoods in Ethiopia, and

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also indicates that the country having the chance of to achieve the MDG4 by reducing U5MR by two-third (67 percent) at the end of 2015 from a base line in 1990.

Results from the 2011 EDHS are timely in evaluating the impact on the achievement of this MDG goal of some major national policies, such as the National Population Policy (NPP), the National Policy on Ethiopian Women (NPEW), and the National Health Policy (NHP). Thus, results from the 2011 EDHS data show a remarkable decline in all levels of childhood mortality. Infant mortality declined by 39 percent over the 10-year period preceding from 2011 EDHS, under-five mortality declined by 47 percent over the same period. The neonatal mortality rate was 37 deaths per 1,000 live births, the post-neonatal mortality rate was 22 deaths per 1,000 live births, and the prenatal mortality rate was 46 per 1,000 pregnancies. Childhood mortality is higher in rural areas than in urban areas. These rates were highest in Benishangul-Gumuz and lowest in Addis Ababa [13, 14, 15].

As per MDG4, Ethiopia should be decrease the U5MR from 1990 to 2011 by 5 percent of ARR to achieve the goal at 2015. From the result of 2011 EDHS, the U5MR from 1990 to 2011 has decreased by 5.2 percent of ARR. Therefore, the 2011 EDHS report was the signed Ethiopia is on the track to achieve MDG4 in 2015 [7, 9, 15].

As known, the target of MDG4 is to reduce the U5MR by 67 percent between 1990 and 2015 in globally. However, the 2015 WHO report of global and WHO regional status of the health-related MDGs based on WHO region indicated that the reduction of U5MR throughout the world at the end of 2015 have reduced 53 percent in globally, 78 percent in Western Pacific region (WPR), 65 percent in European region (EUR) and region of the Americas (AMR), 64 percent in South-East Asia region (SEAR), 54 percent in African region (AFR), and 48 percent in Eastern Mediterranean region (EMR), respectively [7]. This report also shows that having a half way to achieves MDG4 at global level, however at WHO regional level only WPR met or on track to achieve the MDG4, whereas the countries of AFR has half way to met this goal [7].

The result of 2016 EDHS indicated that, during the 5 years immediately preceding the survey, the IMR was 48 deaths per 1,000 live births. The CMR was 20 deaths per 1,000 children surviving to age 12 months, while the overall U5MR was 67 deaths per 1,000 live births with the decline percent of 16 from 2011. The NMR was 29 deaths per 1,000 live births, and the post-NMR was 19 deaths per 1,000 live births. The 2016 EDHS findings further indicate that all childhood mortality rates have declined over time. From this, the U5MR has declined from 80 to 67 and 198 to 67 deaths per 1,000 live births prior to the survey (2012-2016) and (1990-2016), respectively [9, 15, 16].

Similarly, NMR has decline from 54 to 29 deaths per 1,000 live births from 1900 to 2016, and the number of neonatal deaths decline from 135 thousand to 87 thousand; and only 22 percent reduced between 2012 and 2016 [9,16]. The share of neonatal mortality to under-five mortality by MDG region has increased over time. For instance Ethiopia has the contribution of neonatal mortality to under-five by 60 percent in 2015 [Table 3]. However, the decline in neonatal mortality over 1990-2015 has been slower than that of post-neonatal under-five mortality (1-59 months).

This is not surprising since neonatal mortality is mainly due to prematurity, asphyxia, and sepsis. These three areas that require antenatal care (ANC) from a skilled provider is important to monitor pregnancy and reduce morbidity and mortality risks for the mother and child during pregnancy, delivery, and the postnatal period (within 42 days after delivery). The percentage of women receiving antenatal care from a skilled provider has increased from 27 percent in 2000 to 62 percent in 2016 [12, 16].

Trends in childhood mortality in Ethiopia since 1990 and the 2016 EDHS survey show that there has been a steady decline in under-five mortality over the last 26 years. The overall reduction of U5MR was 66 percent since 1990. This percent was almost consistent with one of the targets of the MDGs, which is to reduce the U5MR by two-third (67 percent) between 1990 and 2015 [5]. Similarly, according to MDG classified regions, this decline percent was higher as compared with sub-Saharan Africa and developing regions have 24 and 53 percents, respectively.

Encouragingly, in the 2000-2015 periods the progress of improving child survival has been accelerated as compared with the 1990-2000 periods. Globally, the annual rate of reduction in U5MR has increased from 1.8 percent in 1990-2000 to 3.9 percent in 2000-2015. In particular promising, according to MDG region of sub-Saharan Africa has the highest U5MR in the world, the region also registered acceleration in reducing under-five mortality [9]. Its annual rate of reduction increased from 1.6 percent in the 1990-2000 to 4.1 percent in 2000-2015 [Table 1]. Among the forty nine sub-Saharan

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African countries, Ethiopia had accelerated the ARR in 2000-2015 compared to ARR in 1990-2000 with reduction rate of almost doubling or less than two times. However, the ARR was lower as compared with others 21 sub-Saharan African countries. Of the 21 countries, Kenya and South Africa have at least tripled their annual rates of reduction from the 1990s or reversed an increasing mortality trend in 2000-2015 compared with the 1990s [9].

The significantly improvements in child survival since 2000 have saved the lives of 48 million children under age five-children who survived as the U5MR has fallen from 2000 in a continuing forward direction. These children would have died had mortality remained at the same level as in 2000 in each country. Globally, the accelerated progress since 2000 has saved the lives of about 18 million children, accounting for nearly 40 percent of the 48 million children saved. In other words, 18 million children would not have survived to see their fifth birthday had the U5MR declined at the same pace it did in the 1990s [17].

Ethiopia had been 67 percent reduced the deaths in under five-children between 1990 and 2015 with an average annual rate of decline of 5.0 percent. This percent indicate that the progress had been achieved MDG4 to gains in improving child survival. This level was exceeded the 4.3 percent annual rate of decline needed to reach MDG4 and was significantly higher than the decline rates observed in many sub-Saharan African countries and even other low and middle-income countries [9, 18]. In addition, 53 and 24 percents decline in number of under-five deaths in globally and sub-Saharan Africa were far from the two-third (67 percent) reduction required to meet the MDG4 target respectively [Table 2]. If current trends continue, throughout the world would reach the MDG4 target in 2026 more than 10 years behind schedule. The number of under-five deaths spread over a period of time which the past two. Two hundred and thirty six million more children died before their fifth birthdays from 1990 to 2015 in worldwide, this number is more than today's population of Brazil, the world's fifth-most populous country. Had the necessary steady progress been made since 2000 to achieve MDG4, 14 million more children would have survived to age five since 2000 [5, 9].

Globally, 16,000 children still die every single day-equivalent to 11 deaths occurring every minute. Without any further acceleration to the current pace of reduction in under-five mortality, a projected 69 million children will die before they reach their fifth birthday until 2030 [9]. Similarly, In Ethiopia, one in every 17 children dies before the first birthday, and one in every 11 children dies before the fifth birthday [15], but these levels of death have decreased since 2011. However, these numbers are still unacceptably high so a concerted effort is needed to further accelerate the pace of progress, and countries and the international community must invest further to end preventable child deaths.

Beside this, the share of neonatal deaths in worldwide is projected to increase from 45 percent of under-five deaths in 2015 to 52 percent in 2030, in the same way, in Ethiopia the sharing of neonatal deaths to under-five deaths estimated to increase from 60 percent in 2015 to above 75 percent in 2030. The proposed SDG target for child mortality represents a renewed commitment to the world's children. Therefore, Ethiopia needs to accelerate progress to reach the SDG (target 3.2) of a neonatal mortality rate of 12 deaths per 1,000 live births by 2030 [10].

5. CONCLUSION

Generally, in Ethiopia the levels and trends of under-five mortality shows that the declined percent of mortality rate was meet with MDG4 target, which was reduced the U5MR by two-third between 1990 and 2015. However, the neonatal mortality rate is contributes high amount to the infant mortality rate. Therefore, in order to continue to accelerate progress and to achieve SDGs, it is critical to ensure that every pregnant woman and every newborn has access to and receives good quality care and life-saving interventions. The vast majority of maternal and newborn deaths can be prevented by relatively straightforward effective interventions. Quality of care in delivering these interventions along the continuum of care during pre-pregnancy, antenatal, intra-partum, childbirth and post-natal periods is paramount to ensure progress. Besides, extended efforts are needed to provide the necessary services and interventions given the expected growing number of births and child populations.

Strategies to address neonatal survival require a multifaceted approach that encompasses health-related and other measures. Addressing short birth interval and preventing early pregnancy must be considered as interventions. Programs must improve the coverage of TTI and the prevention of hypothermia for winter births should be given greater emphasis. Moreover, a good education is an important factor helping to improve the use of available facilities, change behaviour and improve life-saving interventions.

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