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Under-Five Mortality Causes and Prevention

Mehmet Tekin

Abstract

The under-five mortality rate (U5MR) represents children who die before reaching the age of 5 per 1000 live births. It is directly related to the development and economic income levels of countries. For this reason, high rates are observed in low- and middle-income countries (LMICs). The neonatal period deserves more attention as the decline in mortality rates has recently stalled. The most common causes of death under 5 years old are acute respiratory infections, diarrhea, malaria, and birth complications. Although neonatal disorders and birth complications have recently come to the fore, among these reasons, deaths due to infections are still high in LMICs. The crucial topics in prevention are perinatal care and vaccination. Apart from these, access to medicine, food, and clean water is essential in preventing deaths under 5. For preventive services to achieve their goal, these services must reach everyone. Ending preventable child deaths is only possible by improving access to well-equipped healthcare professionals during pregnancy and childbirth, life-saving interventions such as vaccinations, breastfeeding and the provision of low-cost medicines, and access to water and sanitation, which are now lacking in low-income countries.

Keywords: under-five mortality, neonatal mortality, low and middle-income countries, infections, perinatal mortality

1. Introduction

The under-five mortality rate (U5MR) represents children who die before reaching the age of 5 per 1000 live births [1]. The definition of live birth is a sign of life such as breathing, heartbeat, or voluntary muscular movements of the newborn after separation from the mother, regardless of the gestational age [2]. The majority of these deaths occur by preventable or treatable diseases, especially in low- and middle-income countries (LMICs). The most common causes of death under 5 years old are acute respiratory infections, diarrhea, malaria, and birth complications [3]. Underlying problems are also critical in U5MR. Malnutrition is the leading cause of about 45% of all childhood deaths [4].

The World Bank divides the world's economies into four groups according to their income status: low-income, lower-middle-income, upper-middle-income, and high-income countries. The classification is made annually based on the gross national income (GNI) per capita in US dollars (USD) of the preceding year. According to the current data for 2021, countries with a GNI per capita of less than 1046 USD are classified as low-income countries, and those with less than 12,695 USD are classified as middle-income countries [5].

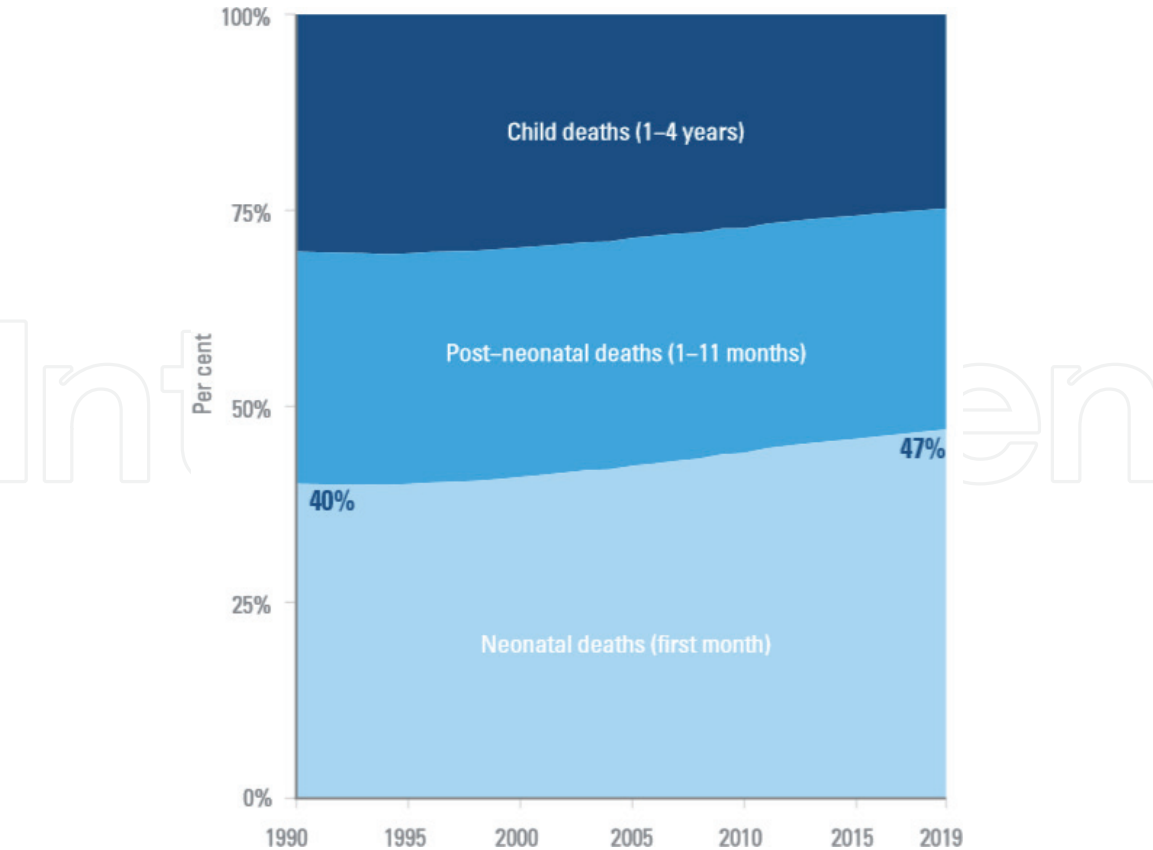


Figure 1.
Distribution of global under-five deaths by age, 1990–2019 [7].

Child mortality under the age of 5 consists of several subgroups. These are neonatal mortality (birth—the first month of life), infant mortality (birth—the first year of life), and child mortality (1–5 years). Looking at the U5MR in each subgroup, it is observed that the neonatal group has the highest risk. Among this population, the youngest has the highest mortality rate. A review showed that approximately one-third of all neonatal deaths occur within the first day after birth, and nearly three-fourths occur within the first week of life [6].

Data from the last three decades show that the fastest decline in U5MR occurred between 2000 and 2009. Globally, the annual rate of reduction (ARR) was 1.9 percent in 1990–1999, 4.0 percent in 2000–2009, and 3.4 percent in 2010–2019. While 1 out of every 11 children could not see their 5th birthday in the 1990s, this number dropped to 1 in 27 in 2019. In 34 LMICs, U5MR was reduced by more than two-thirds between 1990 and 2019 [7].

Although there was a similar decrease in neonatal mortality rates (NMR), it was slower than the decline in child mortality rates between 1 and 59 months. Between 1990 and 2019, the average ARR for child mortality in the first 1–59 months was 3.6 percent, compared to only 2.5 percent in the neonatal period. As a result of these rates, deaths in children under 5 years of age began to concentrate in the neonatal period. While the ratio of newborn deaths to all childhood deaths under 5 was 40 percent in 1990, this rate increased to 47 percent in 2019 (**Figure 1**) [7].

The U5MR is a good indicator of the healthcare system and general social-economic development. The reasons are as follows:

- First, these data precede results, not inputs. For example, the number of doctors and nurses per child is an input, it is related to child health, but positive/negative inputs do not necessarily mean that outcomes will be positive/negative. The U5MR clearly shows the extent to which these inputs achieve their goal.

- The U5MR is closely related to some negative socio-economic factors (malnutrition, low immunization rates, poor maternal health, and education). Therefore, it is a strong indicator of inequality and systemic health problems.
- At the same time, as many of these deaths are preventable, the rate reflects better than any other measure the lack of access to critical and essential quality health care, including family planning, antenatal and postnatal services, and disease prevention and case management.

For these and similar reasons, many global initiatives, mainly the United Nations Global Strategy for Women's Children's and Adolescents' Health (2016–2030) [8] and the Sustainable Development Goals (SDG) [9], have set child survival goals to improve the U5MR.

In this chapter, we aim to examine the causes of death under the age of 5 and the methods of prevention.

2. Causes

In LMICs, maternal and neonatal diseases, respiratory infections and tuberculosis, enteric and other infections, and malaria are the leading causes of under-five mortality. While in high-income countries, complex neonatal conditions such as prematurity top the list of causes of under-five mortality, in LMICs, infectious diseases still rank high among causes of death.

2.1 Maternal and neonatal disease

Since the decline in NMR has not been achieved to a similar extent as in U5MR, the rate of deaths due to maternal and neonatal diseases among under-five mortality has increased recently, especially in high-income countries. In one study, the two most common causes of death in the neonatal period in LMICs were perinatal asphyxia and severe infections such as sepsis, meningitis, and pneumonia [10]. Approximately 23% of the 2.5 million annual infant deaths in the neonatal period are related to infections [7]. Deaths due to complications associated with prematurity account for about one-fifth of neonatal deaths in these countries. These three causes account for 90% of total neonatal deaths in LMICs [11].

2.2 Respiratory infections and tuberculosis

Despite improvements in living conditions and increases in vaccination rates, respiratory infections are the leading cause of under-five death after neonatal diseases in LMICs. It is estimated that approximately 100 million pneumonia episodes occur annually under 5 [12]. With the increase in Pneumococcal conjugate and Haemophilus influenza type b vaccination, changes in the etiology of pneumonia have occurred recently. Among bacterial pathogens, non-type b Haemophilus influenza and Staphylococcus aureus are more common, whereas RSV stands out among viral pathogens. Although less common, CMV pneumonia can be fatal in HIV-infected and immunosuppressed patients [12].

Within this group of diseases, tuberculosis occupies a special place in LMICs. About a quarter of the world's population is infected with Mycobacterium tuberculosis, which is not always easy to treat with its extrapulmonary involvement and resistant strains [13]. About half of all people with tuberculosis live in eight countries: Bangladesh, China, India, Indonesia, Nigeria, Pakistan, Philippines, and

South Africa [14]. In 2019, there were a total of 50,000 deaths due to tuberculosis in children under 5 years of age [15].

2.3 Enteric infections

Enteral infections are the leading cause of death in children under 5 years among all infections, causing 1.5–2 million deaths per year [16, 17]. In LMICs, there are six episodes of diarrhea per year in infants and three episodes per year in children [18]. Rotavirus, *Cryptosporidium*, *Shigella*, and enterotoxigenic *Escherichia coli* (ETEC) are the most common pathogens observed in the moderate and severe diarrheal disease under 5 years of age in LMICs [19]. In the past, severe dehydration and fluid loss were the main causes of death from diarrhea. Other causes, such as septic bacterial infections, are now increasingly responsible for all diarrheal deaths [20].

2.4 Malaria

Infection with *Plasmodium falciparum* potentially is fatal and most commonly manifests as a nonspecific febrile illness often without localizing signs. About 635,000 deaths from malaria occurred in LMICs in 2019, of which more than 50% were children under 5 years of age [14]. Moreover, malaria in pregnancy leads to fetal growth retardation, low birth weight, and later malaria infection in the infant, which increases neonatal mortality [21, 22]. In sub-Saharan Africa, a region at high risk of malaria, peripheral malaria is detected in the blood of about half of pregnant women during antenatal care [23].

In addition to these main causes, some factors increase the frequency and treatability or mortality of these diseases. The Covid-19 pandemic, which has been ongoing for about two years, has placed a heavy burden on the health care system. A survey by UNICEF conducted in 77 countries shows that almost 68 percent of countries reported slight reductions in health checks and immunizations for children. In addition, 63 percent of countries reported interruptions in antenatal checkups and 59 percent in postnatal care [24]. In regions with a high burden of HIV, malaria, and tuberculosis, the Covid-19 pandemic may increase HIV-related deaths by 10%, tuberculosis-related deaths by 20%, and malaria-related deaths by up to 36% over 5 years [7].

Some other exacerbating underlying factors include food insecurity, inadequate feeding practices, household air pollution, lack of hygiene, and access to safe water or adequate sanitation.

3. Trends in under-five mortality

While the U5MR was about 85 per 1000 live births worldwide in 1990, it dropped to 38 per 1000 live births by 2019, a decline of over 50%. According to 2019 data, the global NMR was 17 per 1000 live births. While this rate was 11 per 1000 for children aged 1 month to 1 year, it was 10 per 1000 for children aged 1–5 years. The gap between the highest and lowest regional U5MR narrowed from 171 deaths per 1000 live births in 1990 to 73 in 2019. In 1990, the number of countries with a mortality rate above 100 per 1000 live births was over 50, while this number has dropped to 5 in 2019. Variation in NMR and U5MR in LMICs by year is shown in **Figures 2–5**.

Despite these developments, U5MR in low-income countries remains high. These countries are all located in sub-Saharan Africa. In sub-Saharan Africa, the region with the highest U5MR, one in 13 children does not reach the age of five. This rate is

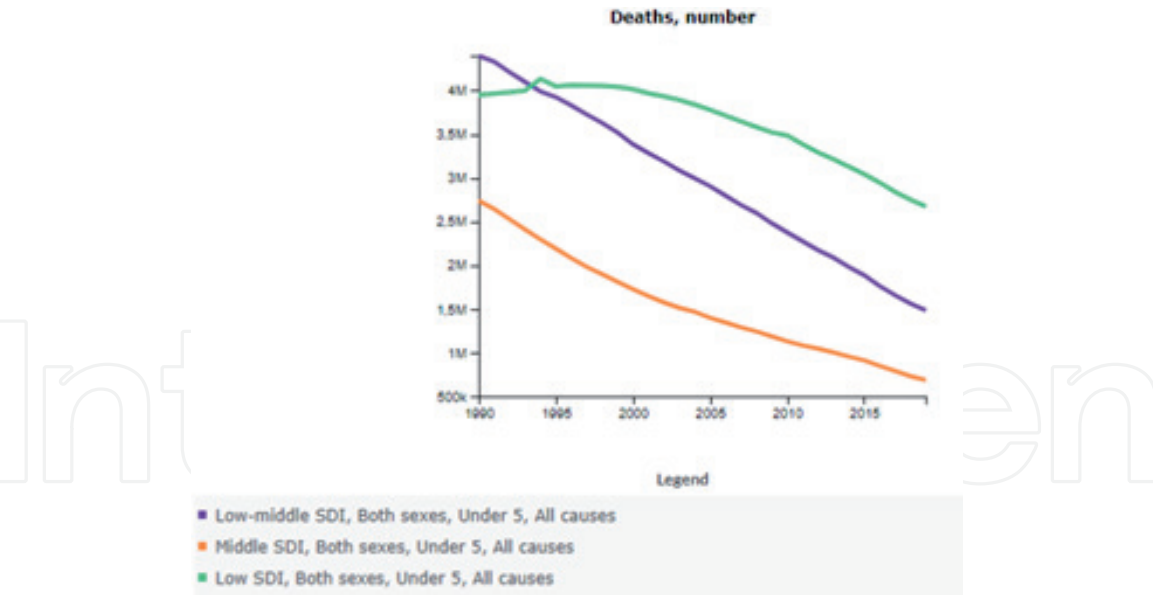


Figure 2.
Number of under-5 deaths between 1990 and 2019. Data were obtained from the healthdata.org website.

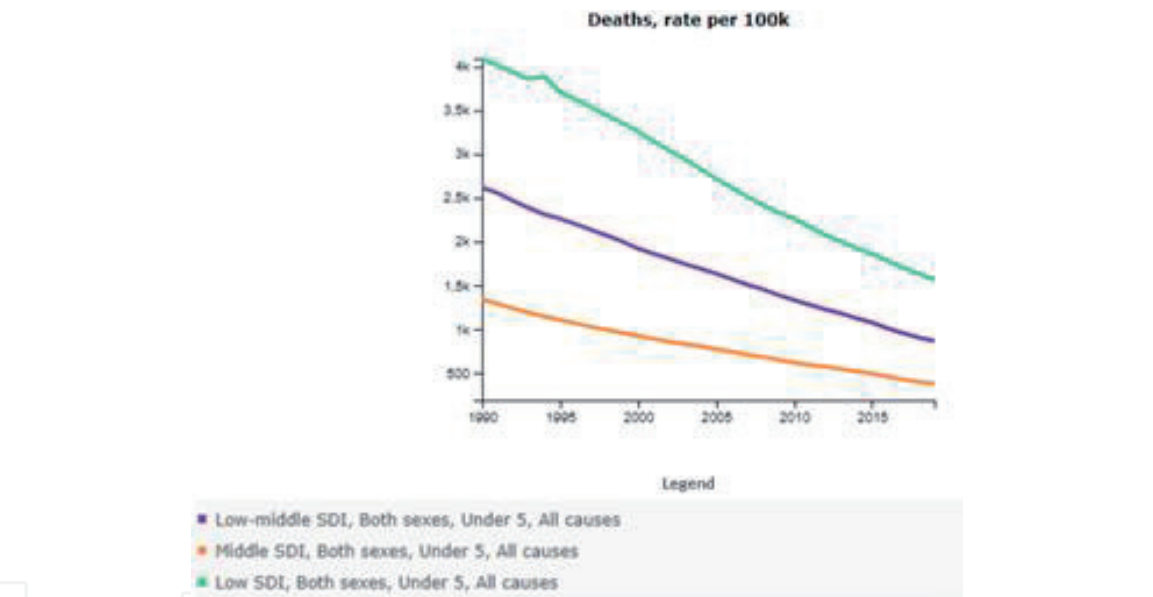


Figure 3.
U5MR between 1990 and 2019. Data were obtained from the healthdata.org website.

15–20 times higher than in developed countries. Of the 37 countries in this region, 31 have a high mortality rate (U5MR above 50 per 1000 live births). Although sub-Saharan Africa and Central and South Asia account for about 50% of children under 5, 80% of all under 5 deaths in 2019. On a country basis, nearly half of under-five deaths in 2019 occurred in five countries: Nigeria, India, Pakistan, the Democratic Republic of the Congo and, Ethiopia. Nigeria and India alone account for nearly a third. The alteration of mortality rates by regions over time is shown in **Figure 6**.

When evaluating neonatal mortality, sub-Saharan Africa has the highest rate in 2019 (27 per 1000), followed by Central and South Asia (24 per 1000). Nearly 80% of neonatal deaths in 2019 occurred in these two regions. From 1990 to 2019, sub-Saharan Africa was the only SDG region without a decline in neonatal mortality due to the relatively low decrease in NMR and increase in the birth rate. In this period, newborn deaths did not decline in 21 of 48 countries in sub-Saharan Africa, and the total number of newborn deaths remained stable at about 1 million per year.

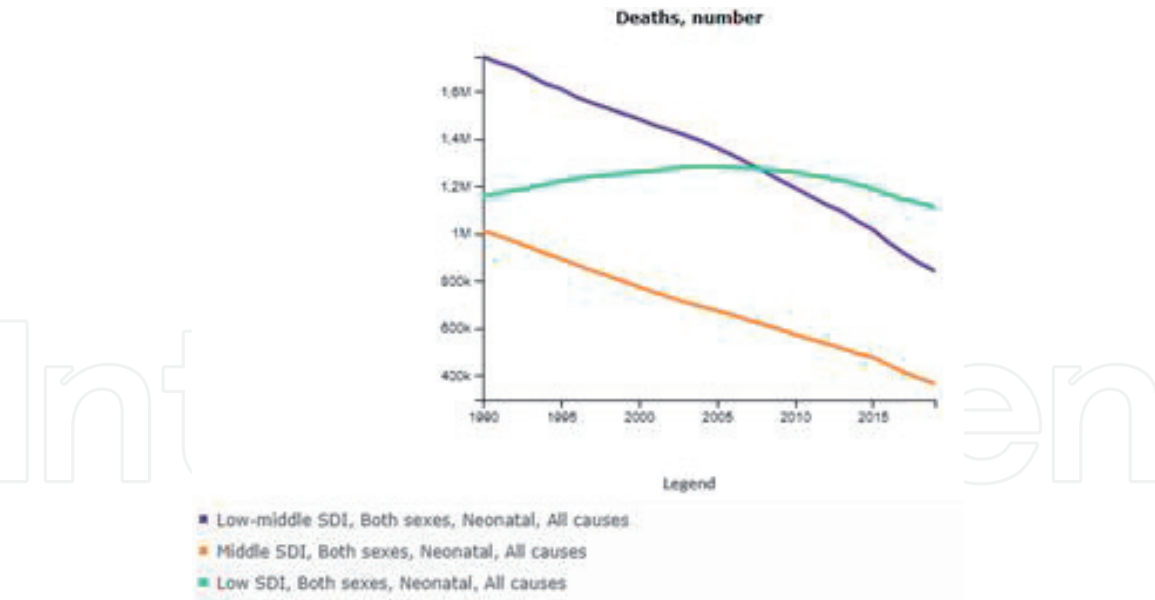


Figure 4. Number of neonatal deaths between 1990 and 2019. Data were obtained from the healthdata.org website.

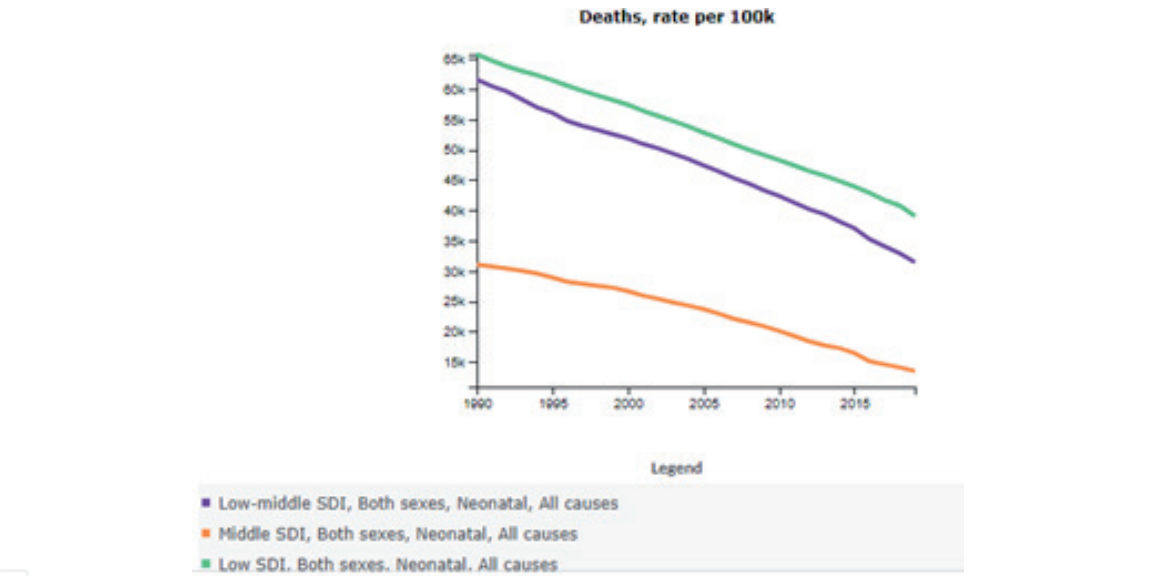


Figure 5. NMR between 1990 and 2019. Data were obtained from the healthdata.org website.

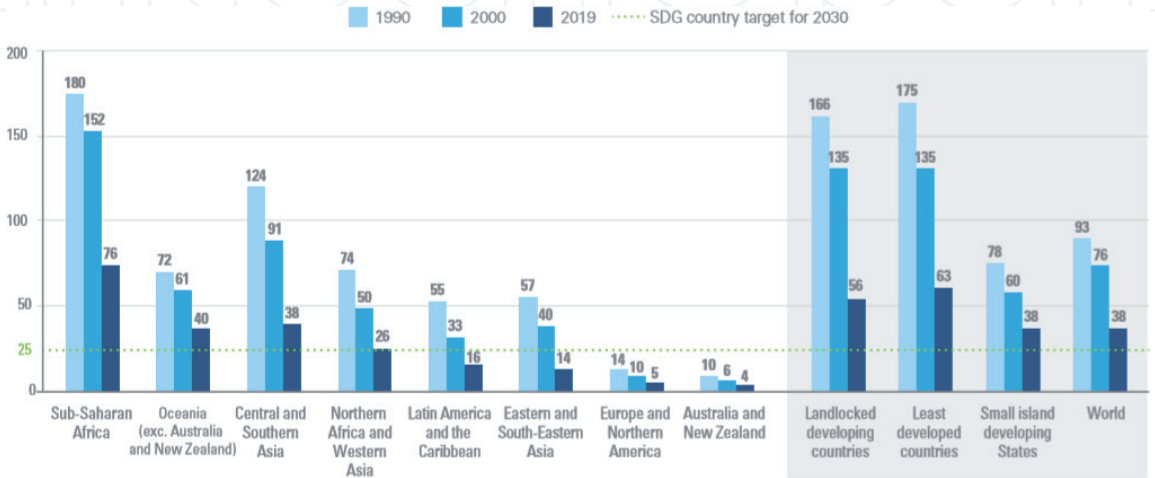


Figure 6. U5MR (deaths per 1000 live births) by regions, 1990, 2000, and 2019 [7].

The difference between the sexes has tended to narrow over time in under-five mortality. In general, the risk of death is higher for boys under the age of 5 than for girls. However, due to regional risks, the mortality rate of girls is much higher than expected in some countries. These countries are located in the South and West Asia. After 1990, there were similar developments in this area, and the number of countries with higher than expected girl mortality dropped from 25 to 7.

The SDG aims to finish under-five mortality from preventable causes by reducing the NMR to 12 and below per 1000 live births and the U5MR to 25 and below per 1000 live births by 2030. If the current trend in under-five mortality continues, 27 percent of the 195 countries evaluated in the latest UNICEF report will not meet the SDG target. Achieving the 2030 target requires high-level efforts and a focus on child mortality in the remaining 53 countries. All these countries are in the status of LMICs. In light of current data, it is estimated that 48 million children under the age of 5 will die between 2020 and 2030. Nearly 80% of these deaths are expected to occur in sub-Saharan Africa and Central and South Asia, where almost all of the countries they host are LMICs. Moreover, if current trends continue, it does not seem possible for nearly 90% of sub-Saharan African countries to reach the neonatal mortality target of the SDG [7].

4. Prevention

Access to life-saving interventions is at the forefront of consistently reducing mortality in LMICs. Examining the main causes of under-five deaths in these countries, it is observed that care during and after birth, vaccinations, and preventive and therapeutic services in early childhood play a crucial role [25]. An analysis conducted in 118 LMICs found that disrupting access to basic life-saving interventions could cause millions of under-five deaths in as little as six months [26]. We can consider protective interventions under several headings:

4.1 Perinatal care

Due to the increase in the birth rate and the dependence of mother-infant life on basic life-saving interventions, prenatal, natal and postnatal care is a priority issue in LMICs. At this point, comprehensive prenatal care, skilled and rapid care during childbirth, regular postnatal care for mother and child, and high-quality and adequate care for premature and sick newborns should be the goal. For reasons other than congenital anomalies causing one in 10 neonatal deaths [27], the following precautions should be taken:

Home visits during pregnancy can play an active role in reducing NMR. A large-scale study in India has shown that antenatal care provided by Accredited Social Health Activists significantly reduces infant mortality rates under 1-year-old [28]. All pregnant women should be visited by experienced teams at least four times during pregnancy, including one visit in the first trimester. At these visits, preeclampsia and eclampsia can be diagnosed and treatment initiated in appropriate cases. In addition, these visits provide an opportunity to start folic acid and iron supplements that improve fetal health and to test for HIV, which is at risk of transmission from mother to fetus. Home visits can also help ensure that adequate precautions are taken in areas where malaria is common. Tetanus vaccinations recommended during pregnancy can be given during these visits. Finally, these visits can encourage pregnant women to deliver in the hospital and provide information about birth complications and nutrition.

Facility-based delivery should be provided to all pregnant women and, expectant mothers should be encouraged in this regard. Basic hygiene rules such as hand

washing, sterile cord-cutting, and cord care should be followed in these facilities. To achieve this, using clean delivery kits (CDK) should be expanded for both home and facility deliveries. The use of CDK containing soap, gloves, cord ties, and other sterile equipment has been shown to reduce neonatal mortality and neonatal tetanus in studies in LMIC countries [29–31]. Drugs (oxytocin, etc.) and materials (partograph, etc.) used in the active management of labor should also be available. In communities where access to facilities is not possible, the number of staff with basic emergency obstetric and newborn care (BEmONC) training should be increased. However, a fast and safe referral and transport system should be ready in case of complications where the capabilities and knowledge of these staff may be inadequate. The purpose of this transportation is to transport the patient to facilities where comprehensive emergency obstetric and newborn care (CEmONC) can be provided.

In the postnatal period, attention should be paid to hypothermia and allow the mother to feed her baby within the first hour of life. It should be ensured that the mother and newborn stay in the facility for the first 24 hours, and an early postnatal visit should be scheduled to recognize the danger signs. In cases of suspected or proven infection, neonates should be treated with antibiotics, and newborns at risk should be followed up in neonatal intensive care units with adequate personnel and equipment.

4.2 Vaccination and medication

Vaccination is an essential component of primary health care and an indisputable human right. Also, it is the single most effective prevention method for reducing mortality in children under 5. The following vaccines are at the forefront of preventing early childhood deaths: measles, polio, diphtheria, tetanus and pertussis, Haemophilus influenza type B, pneumococcal, and rotavirus vaccines. Reaching large populations with effective community health programs is crucial for vaccination success. Despite significant advances in immunization, too many children worldwide—including around 20 million infants each year—do not have adequate access to vaccines [32].

Since it is more difficult to diagnose tuberculosis (TB) in childhood, prevention may be more feasible than cure. At this point, neonatal use of the BCG vaccine, which is still the only vaccine against tuberculosis, could be the solution. Neonatal administration of BCG has been associated with a lower prevalence of TB disease [33].

Access to antibiotics and antimalarial to treat diarrhea, malaria, and lower respiratory tract infections also contribute to reducing child mortality. In diarrhea, oral rehydration solution and zinc supplementation help reduce mortality.

4.3 Community-based prevention

Community health workers play a vital role in providing health care to underprivileged communities. Public health workers organize public education programs, especially in the field of preventive health services. The performance of these workers is critical to increasing vaccination and breastfeeding rates, disseminating malaria prophylaxis devices such as insecticide-treated bed nets, and improving hygiene behaviors.

Studies in rural areas of three LMICs found that proximity to health facilities was a significant risk factor for infant, child, and general under-five mortality [34–36]. Similarly, a meta-analysis found that a distance of over 5 km from the health facility can increase mortality by up to 60% in newborns and children under

five years of age [37]. In these and similar situations, governments should eliminate inequality of opportunity among communities and ensure access to health services for all. For example, maternity waiting homes, initiated under the leadership of the World Health Organization (WHO), can be expanded for pregnant women with limited access to facilities.

The integrated management of childhood diseases, in collaboration with national and international organizations, will help to address regional and cross-national disparities and share experience and knowledge. Finally, it is essential to build a people-centered and high-quality health system to implement all these preventive measures. At the same time, families' desire for medical care and behavior to seek medical help when their children are ill should be encouraged.

4.4 Nutrition education and management of malnutrition

Encouraging breastfeeding is a practical and cost-effective method of preventing early childhood deaths. However, about two out of three infants do not have access to exclusive breastfeeding for 6 months. Breast milk provides all the energy and nutrients a baby needs in the first months of life, and continues to meet at least one-third of the baby's nutritional needs during the second half of the first year [38]. Breastfeeding not only improves the child's nutrition but also protects the child from the dirty water used in food preparation and cleaning kitchen utensils. Vitamin A supplementation should be encouraged as it has been proven to reduce the risk of illness and death from measles and diarrhea. Access to clean water and ensuring hygiene will be particularly effective in reducing the incidence of diarrheal diseases. Screening for acute malnutrition allows early detection of cases with a risk for mortality.

5. Conclusion

The U5MR has been significantly reduced over the last 30 years through concerted action and resource allocation. The next goal of countries achieving the SDG targets should be to ensure the protection of children by eliminating inequalities that arise for reasons such as household income, race and ethnicity, and subnational division. While there are some developments in child health globally, 75% of countries failing to meet the SDG targets are found in sub-Saharan Africa clearly showing the inequality that children face in terms of their chances of survival due to birthplace. These inequalities are exacerbated in times of crisis, such as the Covid-19 pandemic, and have an even more negative impact on vulnerable children [39]. Attention should be given to sub-Saharan Africa, where mortality rates are highest in all age groups and the population continues to grow, considering that 11 million children could be saved by 2030 if all countries achieve the SDG targets.

On the other hand, newborns, whose mortality rate is declining more slowly than other age groups and therefore continues to increase their share in the under-five mortality rate, also deserve special attention. Moreover, it is more difficult to reduce the number of deaths during this period due to the establishment of more advanced health care facilities and the need for quality health care services over a longer time, beginning with the antenatal period. In addition to these, it is necessary to provide adequate health services during childbirth and in the early postnatal period. These services, along with NMR, will also reduce maternal mortality rates, the risk of stillbirths, and disability.

When we look at under-five deaths as a whole, it is essential that evidence-based life-saving interventions are accessible and accepted in the community. In addition,

the impact of contextual factors such as female empowerment, nutrition, and health system resources should not be ignored in achieving success.

Another issue that should not be ignored in child mortality is the reliability of the data. In resource-poor areas, deaths may not be reported, or the cause of death may not be identified. This information may not be made available to national authorities and international health organizations promptly. Therefore, there is a need for a high-level integrated database at local, national, regional, and global levels, especially for under-five mortality data.

In summary, ending preventable child deaths is only possible by improving access to well-equipped health care professionals during pregnancy and childbirth, life-saving interventions such as vaccinations, breastfeeding, and the provision of low-cost medicines, and access to water and sanitation, which are now lacking in low-income countries.

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