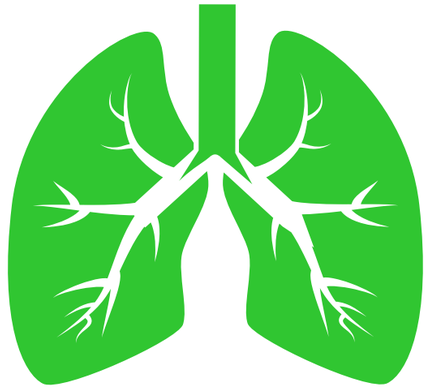
THE MISSING PIECE

Why the global pandemic is an inflection point for pneumonia control

Revised and updated for COVID-19 and the Global Burden of Disease 2019

JUSTACTIONS
WORKGOOD

EVERY BREATH COUNTS



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Why the global pandemic is an inflection point for pneumonia control

Revised and updated for COVID-19 and the Global Burden of Disease 2019

Acknowledgments

This report was written by Leith Greenslade at JustActions. It relies extensively on Global Burden of Disease (GBD) 2019 data provided by the Institute for Health Metrics and Evaluation (IHME) and on an updated 2020 analysis of OECD Official Development Assistance (ODA) and private contributions to pneumonia-related activities conducted by Development Initiatives. The report also summarizes the results of a 2020 study of global investments in pneumonia research by the Research Investments in Global Health (ResIn) project based at the University of Southampton.

Special thanks to Chris Troeger from IHME, Duncan Knox from Development Initiatives, and Michael Head from ResIn and to the many members of the Every Breath Counts Coalition whose work has contributed to this report.

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Contents

Overview

Pneumonia is a leading cause of death and disability and the leading infectious cause of death in the world. In 2019, pneumonia caused an estimated 2.5 million deaths across all ages according to the Global Burden of Disease (GBD).

Three-quarters of pneumonia deaths are concentrated among two vulnerable populations—the very young and the very old. An estimated 672,000 pneumonia deaths are among children under five years and 1.2 million deaths are among adults over 69 years. Unlike most other leading infectious disease killers, pneumonia deaths follow a "U-shaped curve" across the life course, peaking in the early and later years of life. [1]

Pneumonia is truly a "global health" issue that affects every country. Two-thirds of pneumonia deaths cluster in a diverse group of 20 low-, middle-, and high-income countries drawn mostly from Sub-Saharan Africa, South Asia, East Asia and the Pacific, and the Americas. In low-income countries, the burden of pneumonia deaths falls disproportionately on children under five years, while in high-income countries it is adults aged over 69 years who shoulder the burden. Importantly, many middle-income countries carry "double-burdens" of pneumonia deaths, losing both large numbers of children and the elderly each year.

Despite recent gains in reducing child pneumonia mortality, progress in reducing all-age pneumonia deaths has not kept pace with other leading infectious diseases in most countries. And pneumonia deaths among adults are rising, including from COVID-19, so that the overall pneumonia burden is increasing in many countries. In fact, deaths from COVID-19 could add up to two million deaths to the global respiratory infection death toll for 2020. Even after the pandemic ends, increases in risk-related pneumonia deaths from air pollution, tobacco smoking, and temperature extremes among elderly

1 Deaths from HIV/AIDS and tuberculosis follow an "N" shaped curve as deaths concentrate among adults of working age, and malaria deaths follow an "L" shaped curve as deaths concentrate among children under five years.

populations will continue to make it difficult for many countries to reduce pneumonia deaths.

Continued lack of action on pneumonia, from COVID-19 and other causes, will prevent many countries from achieving the Sustainable Development Goals (SDGs) for health by 2030. For these countries, pneumonia is the "missing piece" and a major barrier to reducing child deaths to at least 25 per 1,000 births (SDG 3.2), to combatting the overall communicable and non-communicable disease burdens (SDGs 3.3, 3.4), and to increasing access to quality healthcare services, essential medicines, and vaccines for all (SDG 3.8).

Specific pneumonia control strategies are needed to reduce the major risk factors and rapidly increase coverage of the interventions that are most cost-effective at preventing, diagnosing, and treating pneumonia, especially among children under five years and adults over 69 years. The pandemic response plans that many countries have introduced already include many of the actions required for effective pneumonia control and could provide the foundation for continued declines in deaths from all-cause respiratory infections over the next decade. Governments need to set ambitious pneumonia mortality reduction targets for both children and adults and ensure that interventions are targeted to the populations at greatest risk of death. This "precision public health"[2] focus on pneumonia control has the potential to both significantly accelerate achievement of national health goals and strengthen pandemic preparedness and response.

For countries struggling with child pneumonia deaths, reductions in child wasting, household air pollution, and low birth weight, combined with full coverage of the pneumonia-fighting vaccines, improved access to diagnostic tools such as pulse oximetry, and treatment with recommended antibiotics, oxygen, and therapeutic foods will save the most children's lives. Where the pneumonia burden falls among the elderly, reductions in air pollution and tobacco smoking, together with increases in vaccination coverage, including with COVID-19 vaccines, will be critical. Access to quality, affordable pneumonia diagnosis and care for elderly populations will increasingly be a priority in many low- and middle-income countries (LMICs). When new tools like a respiratory syncytial virus (RSV) vaccine become available, both very young and very old populations will benefit.

2 Precision public health can be defined as "the application and combination of new and existing technologies, which more precisely describe and analyse individuals and their environment over the life course, to tailor preventive inter-ventions for at-risk groups and improve the overall health of the population." See Weeramanthri, T.S. et al., 2018. Editorial: Precision Public Health. Frontiers in Public Health, 6. Available at: http://dx.doi.org/10.3389/fpubh.2018.00121.

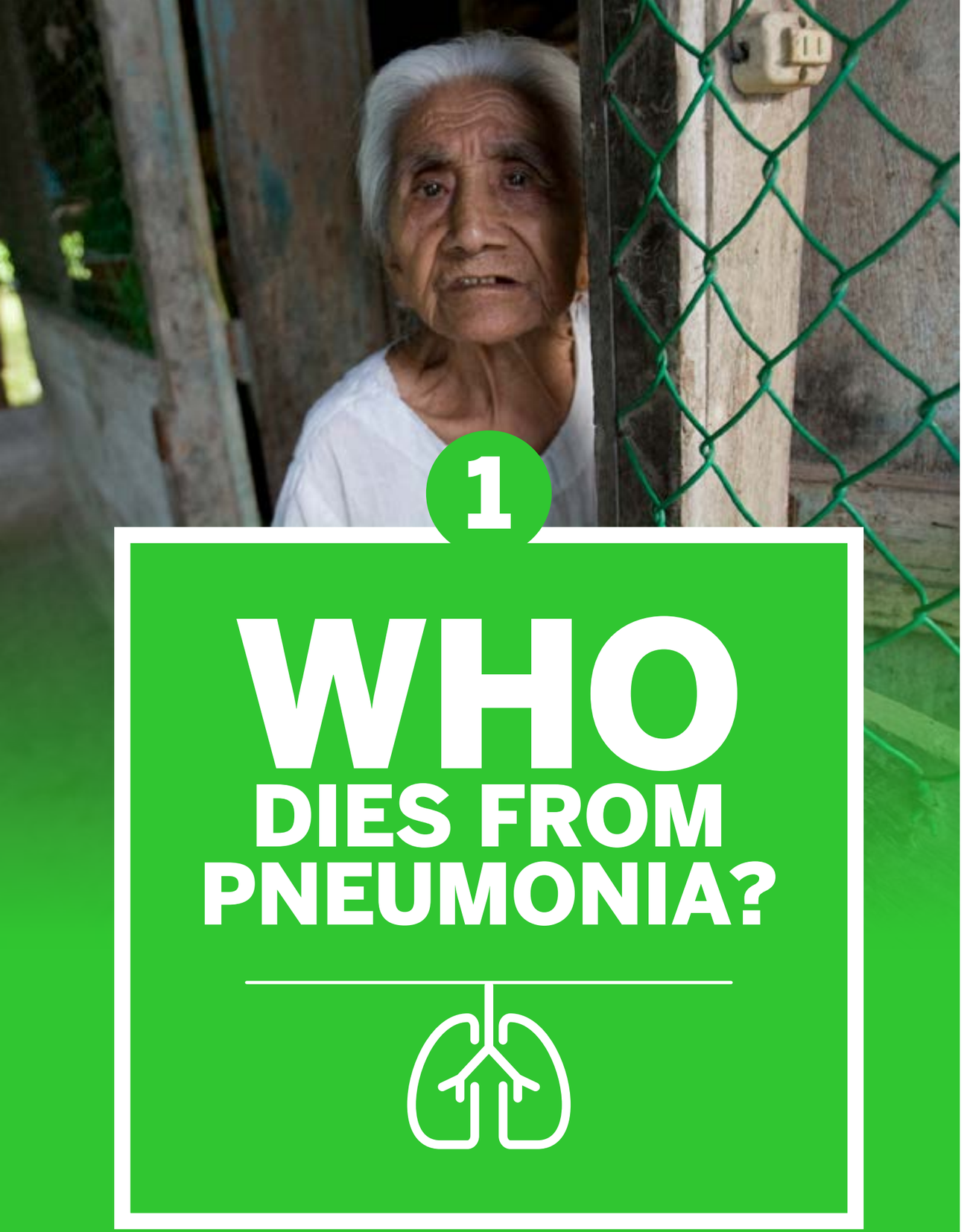
75% **Share of two vulnerable populations—children under five years and adults over 70 years—in pneumonia deaths**

Leadership for developing, financing, and implementing pneumonia control strategies rests with the government leaders and agencies responsible for health in the countries where pneumonia deaths are concentrated. The current movement to introduce Universal Health Coverage (UHC) can contribute significantly to pneumonia reduction by fully covering the costs of vaccination, diagnosis, and treatment, especially for the most vulnerable populations of children and the elderly. A health system that is effective at reducing both the incidence of pneumonia and pneumonia deaths is not only a quality health system, but a health system that delivers equity by serving the most vulnerable.

Some countries will continue to require external support to achieve pneumonia control. Increases in the historically low levels of international development assistance for health allocated to pneumonia will continue to be essential in the countries that are struggling with large numbers and/or very high rates of pneumonia deaths and slow progress. External actors can best support these countries by working in direct partnership with governments and with organizations that align their work with government health plans, including the 12 United Nations and multilateral health, development, and humanitarian agencies that signed the Global Action Plan for Healthy Lives and Well-being For All, and as part of initiatives and coalitions such as Every Breath Counts.

Powerful champions are still needed at local, national, and international levels to put pneumonia control high on the agendas of governments and the international health and development community. These champions should advocate for investments in pneumonia control strategies targeting the most vulnerable populations as part of UHC, and for the types of research and development efforts that will uncover breakthrough technologies with the power to deliver the next generation of improved pneumonia prevention, diagnostic, and treatment tools and reduce the risk of another global respiratory pandemic.

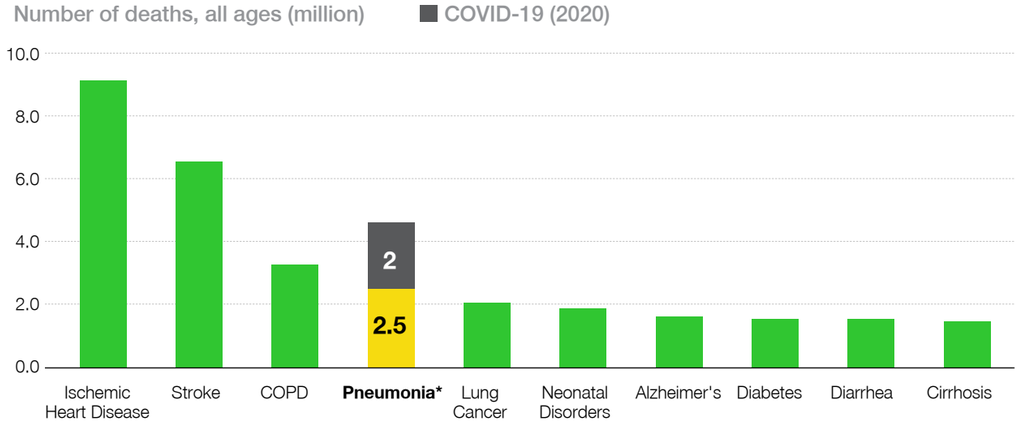
A world in which child pneumonia deaths have been driven close to zero and where pneumonia deaths among adults are rare in every country is achievable. It will be a world in which children everywhere have enough good food to eat, where the vast majority of babies are born with a healthy weight, and where the air is cleaner for everyone. It will be a world where every child and adult is fully protected with the "pneumonia-fighting" vaccines and where every family takes a child who exhibits pneumonia symptoms for healthcare confident that they will receive an accurate diagnosis and fast treatment with antibiotics, oxygen, and/or therapeutic foods if needed, without paying user fees. It will be a world where every country is operating at full speed to prevent the emergence of another respiratory pandemic and prepared to respond quickly if it does. Only then, will death from pneumonia be rare everywhere.



1 WHO DIES FROM PNEUMONIA?

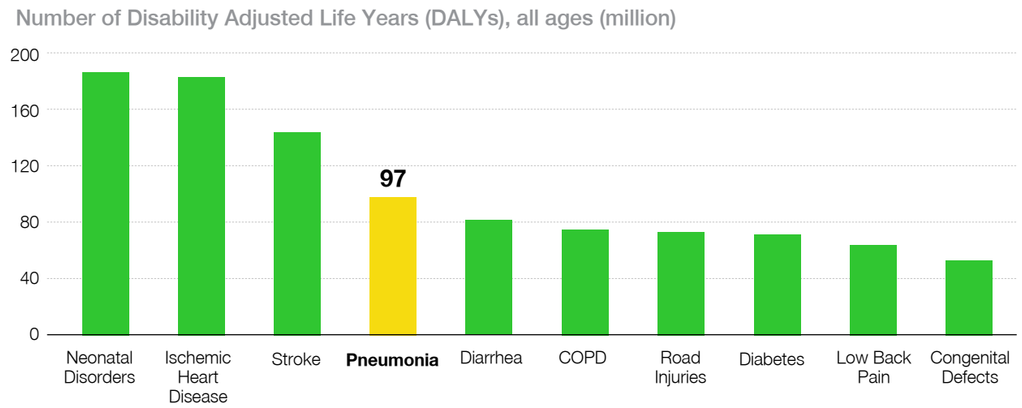
Pneumonia is a major cause of death and disability in the world. In 2019, pneumonia caused an estimated 2.5 million deaths and 97 million Disability-Adjusted Life Years (DALYs) across all age groups according to the Global Burden of Disease (GBD).[3] Pneumonia is the fourth leading cause of death after ischemic heart disease, stroke, and chronic obstructive pulmonary disease (COPD) and the fourth leading cause of DALYs after neonatal disorders, ischemic heart disease, and stroke.[4] If COVID-19 deaths are classified as "lower respiratory infections" in the Global Burden of Disease 2020, they will add 2 million to pneumonia deaths bringing the global total to almost 4.5 million deaths (Charts 1 and 2).

Chart 1: Pneumonia is the fourth leading cause of death across all ages



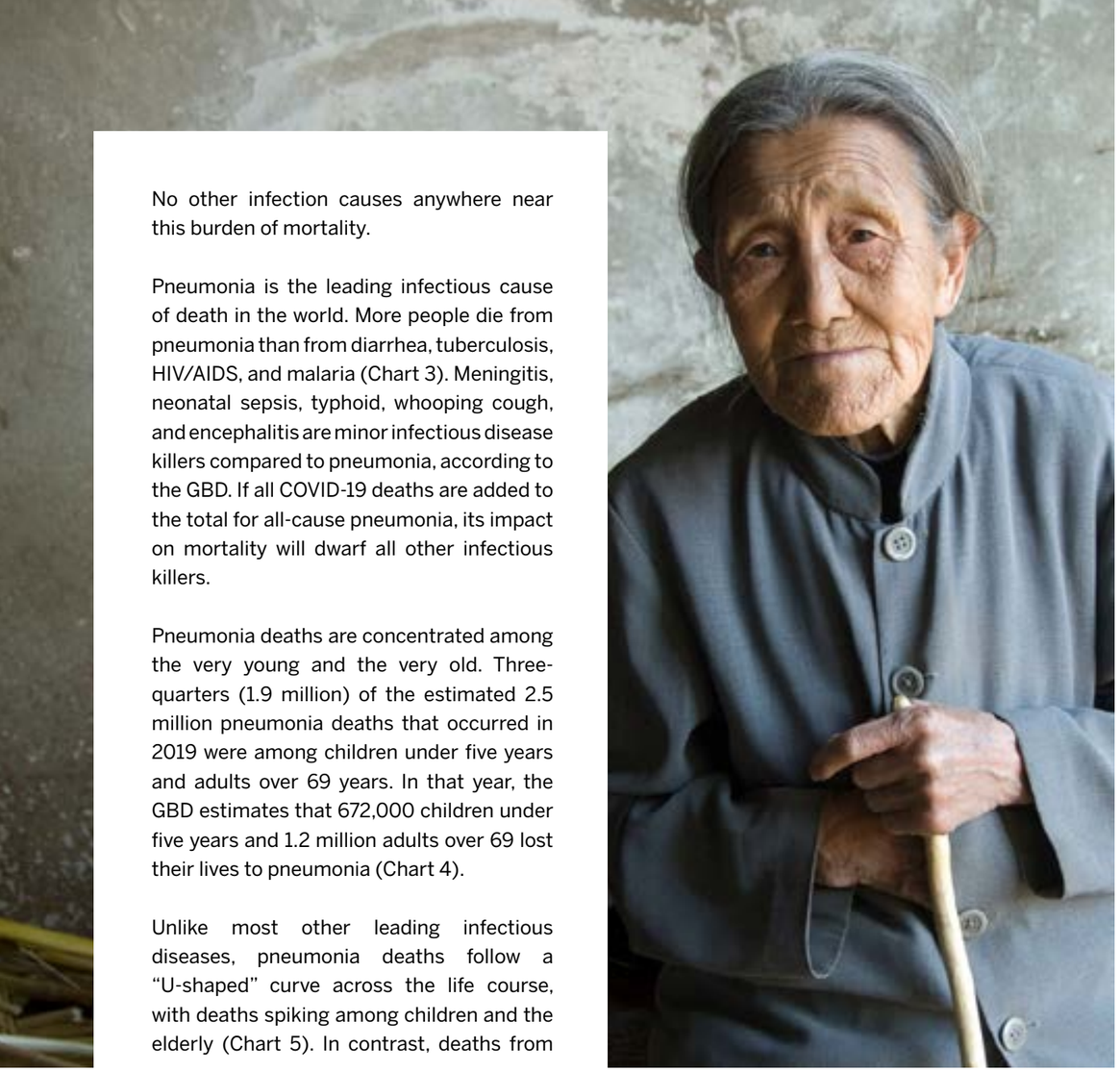
*Pneumonia refers to the category "lower respiratory infections"
Source: Global Burden of Disease 2019, Level 3

Chart 2: Pneumonia is the fourth leading cause of Disability-Adjusted Life Years (DALYs) across all ages



Source: Global Burden of Disease 2019, Level 3

3 See Note (a) for an explanation of the GBD methodology.
4 A measure of years of life lost due to sickness, disability, and early death.



No other infection causes anywhere near this burden of mortality.

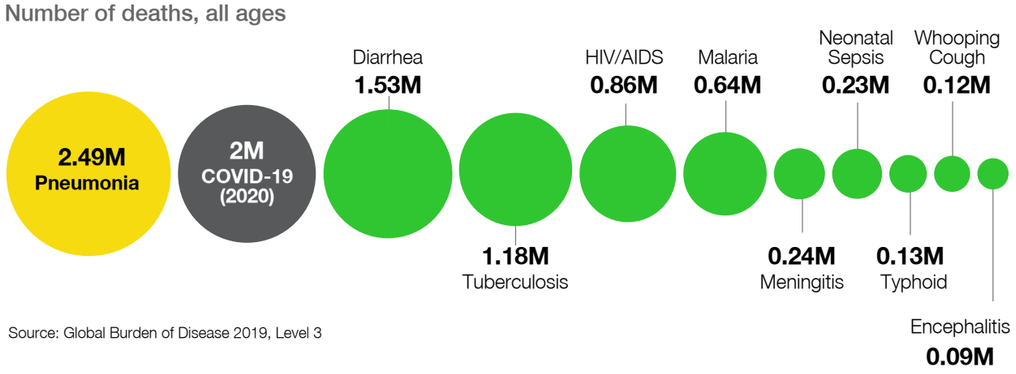
Pneumonia is the leading infectious cause of death in the world. More people die from pneumonia than from diarrhea, tuberculosis, HIV/AIDS, and malaria (Chart 3). Meningitis, neonatal sepsis, typhoid, whooping cough, and encephalitis are minor infectious disease killers compared to pneumonia, according to the GBD. If all COVID-19 deaths are added to the total for all-cause pneumonia, its impact on mortality will dwarf all other infectious killers.

Pneumonia deaths are concentrated among the very young and the very old. Three-quarters (1.9 million) of the estimated 2.5 million pneumonia deaths that occurred in 2019 were among children under five years and adults over 69 years. In that year, the GBD estimates that 672,000 children under five years and 1.2 million adults over 69 lost their lives to pneumonia (Chart 4).

Unlike most other leading infectious diseases, pneumonia deaths follow a "U-shaped" curve across the life course, with deaths spiking among children and the elderly (Chart 5). In contrast, deaths from

Chart 3: Pneumonia is the leading infectious cause of death across all ages

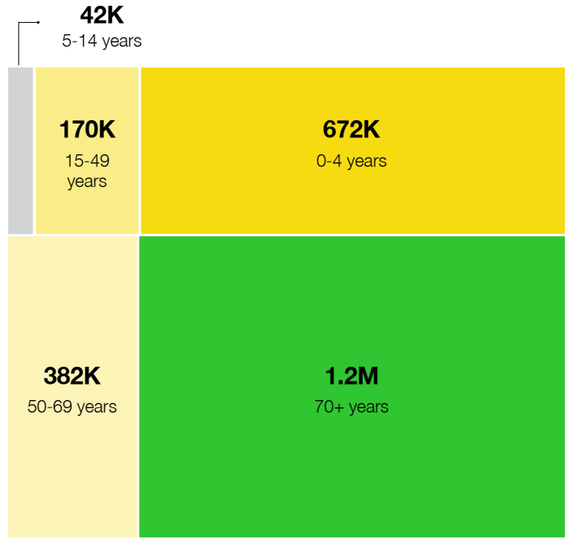
Number of deaths, all ages



Source: Global Burden of Disease 2019, Level 3

Chart 4: Pneumonia deaths cluster among children under five years and adults over 69 years

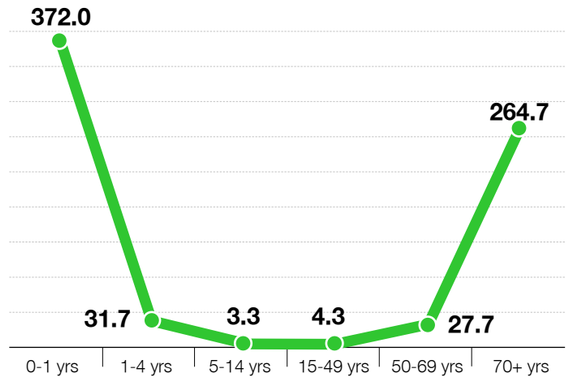
Number of pneumonia deaths, various age groups



Source: Global Burden of Disease 2019

Chart 5: Pneumonia death rates follow a "U-shaped curve" across the life course

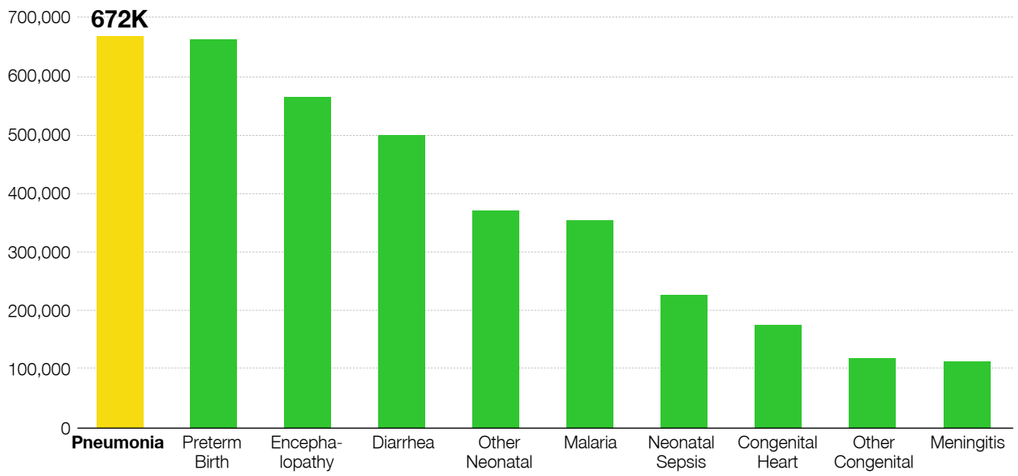
Number of pneumonia deaths per 100,000 population



Source: Global Burden of Disease 2019

Chart 6: Pneumonia is the leading cause of death among children under five years

Number of deaths, 0-4 years



Source: Global Burden of Disease 2019, Level 3

29%

Childhood pneumonia deaths that happen in the first month of life

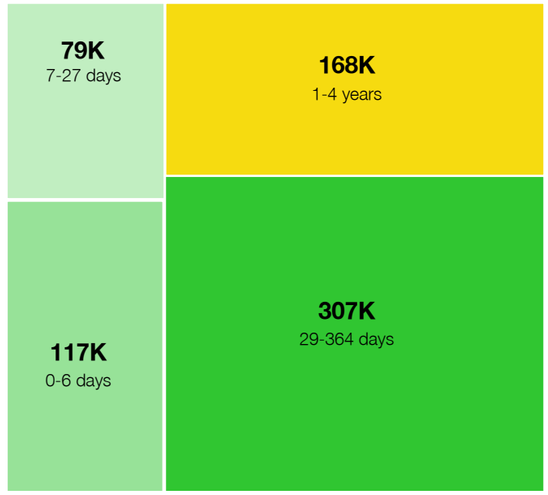
HIV/AIDS and tuberculosis follow an "n" shaped curve with deaths concentrating among adults of working age, while malaria deaths follow an "L" shaped curve with deaths concentrating among children under five years.

Pneumonia is the leading cause of death among children under five years and is responsible for many more deaths than other infections like diarrhea, malaria, neonatal sepsis, and meningitis (Chart 6). Pneumonia deaths are concentrated among infants, with 75% (504,000) occurring among children under 12 months of age. Almost 30% (196,000) of infant pneumonia deaths happen in the first month of life, and almost 20% (117,000) in the first week after birth, according to the GBD (Chart 7).

Pneumonia is the fifth leading cause of death among adults aged over 69 years after ischemic heart disease, stroke, COPD, and Alzheimer's, according to the GBD. Pneumonia is the only infectious cause of death in the top ten killers of elderly adults and the leading infectious disease killer of the elderly by a wide

Chart 7: Three-quarters of all child pneumonia deaths occur in the first year of life

Number of pneumonia deaths, various age groups



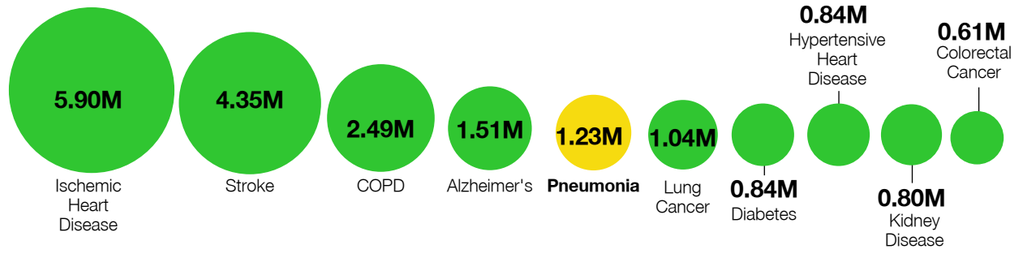
Source: Global Burden of Disease 2019

margin. Diarrhea, the second leading infectious cause of death among the elderly, caused an estimated 612,000 deaths in 2019 by comparison (Chart 8).

Pneumonia kills more males than females, largely due to the higher number of pneumonia deaths among baby boys in the first six days of life and among men aged 15 to 69 years. These 98,000 additional male deaths more than offset the additional 28,000 pneumonia deaths

Chart 8: Pneumonia is the fifth leading cause of death among adults aged over 69 years

Number of deaths, 70+ years (million)



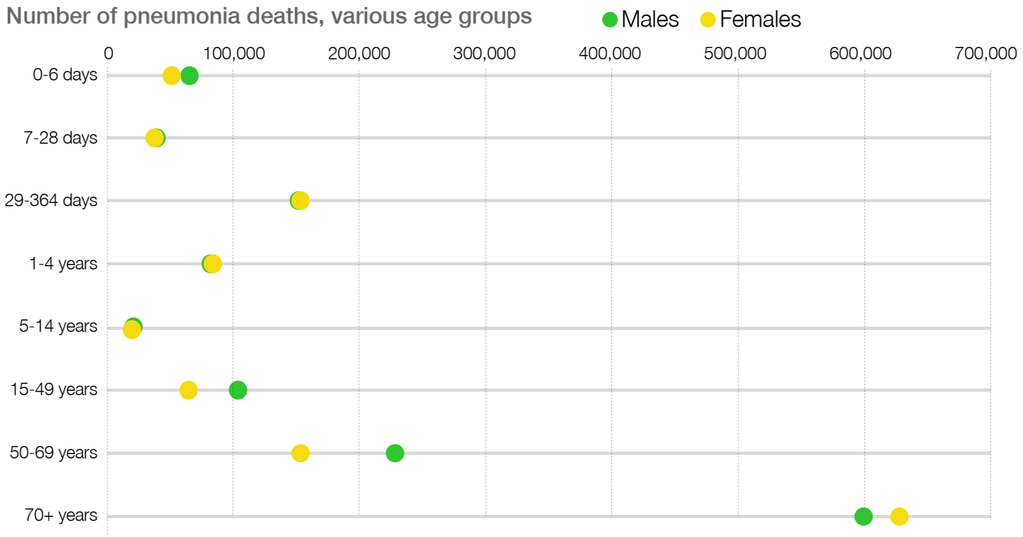
Source: Global Burden of Disease 2019, Level 3

among women aged over 69 years (Chart 9). Rates of pneumonia death per 100,000 population are also higher for males across all age groups, except among children aged one month to 14 years.

The majority of pneumonia deaths can be attributed to specific risks, especially to environmental and behavioral factors, as defined by the GBD.[5] In 2019, environmental risks contributed to an estimated 1,077,000 pneumonia deaths, followed by behavioral risks which were a factor in 1,010,000 pneumonia deaths. Major environmental risks include exposure to air pollution, lack of access to handwashing and low temperature. Major behavioral risks include child wasting, smoking, exposure to secondhand smoke, and low birth weight (Chart 10).

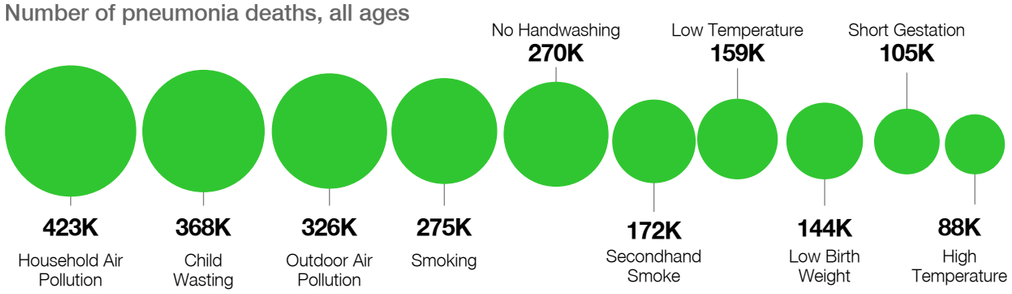
The leading risk factors for pneumonia death vary by age and by gender. Among children under five

Chart 9: Pneumonia kills more males than females in most age groups



Source: Global Burden of Disease 2019

Chart 10: Air pollution, child wasting, and smoking are the leading risk factors for pneumonia death across all ages



Source: Global Burden of Disease 2019, Level 4

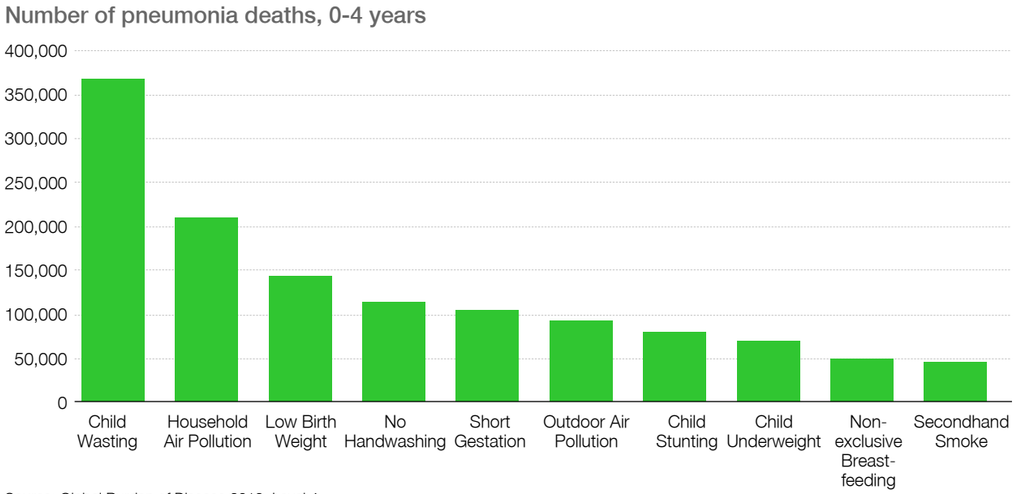
5 Note the category of "behavioral" risks in the GBD includes low birth weight and short gestation or preterm birth.

672,000

Number of children under five years who lost their lives to pneumonia in 2019

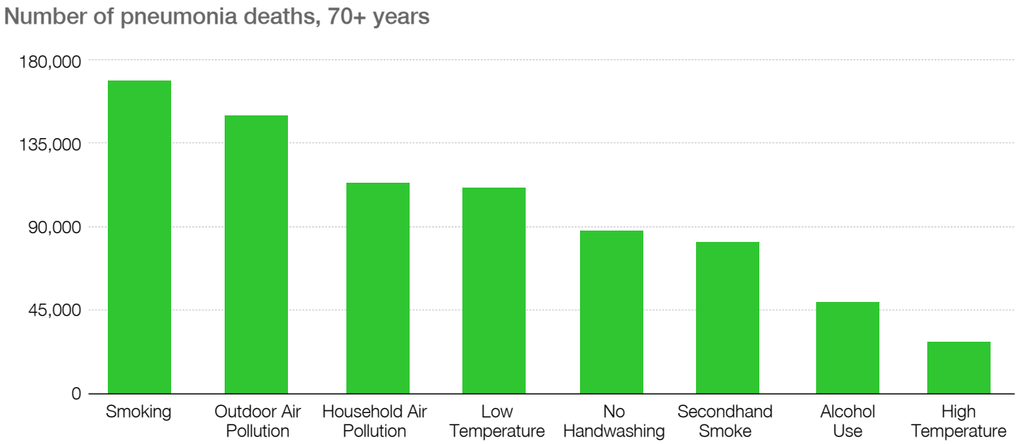
years, child wasting, air pollution, and low birth weight are the major risk factors (Chart 11). For adults aged over 69 years, smoking, air pollution, and exposure to low temperatures are major risk factors (Chart 12). There are 150,000 more risk-related pneumonia deaths among males than females, across all ages. This is because smoking contributes to a much higher number of male pneumonia deaths. While household air pollution, exposure to secondhand smoke, and wasting contribute to more pneumonia deaths among females, this is not enough to offset the impact of smoking on male pneumonia deaths (Chart 13).

Chart 11: Wasting, household air pollution, and low birth weight are the leading risk factors for pneumonia deaths among children under five



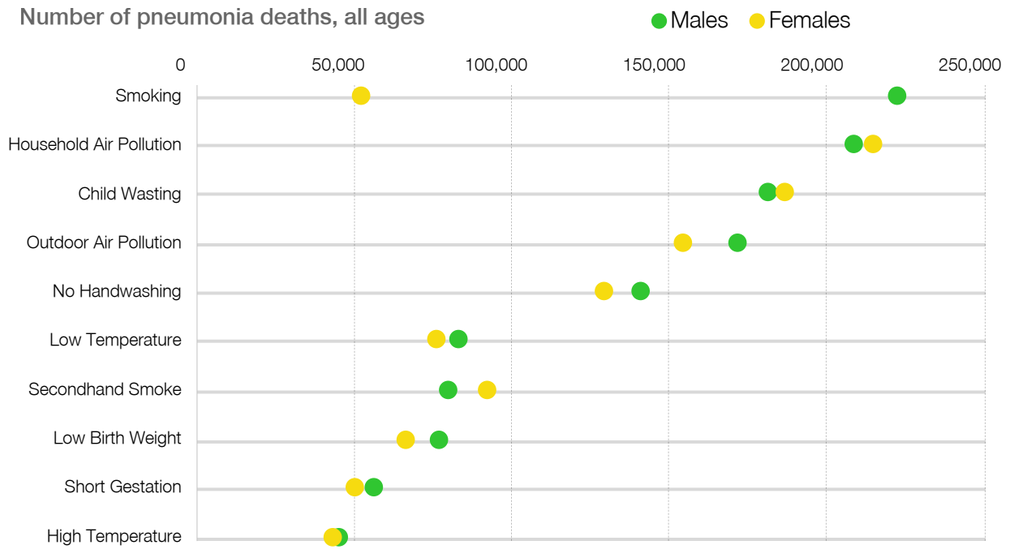
Source: Global Burden of Disease 2019, Level 4

Chart 12: Air pollution, smoking, and secondhand smoke are the leading risk factors for pneumonia death among adults over 69



Source: Global Burden of Disease 2019, Level 4

Chart 13: Risk-related pneumonia deaths are higher for males than females due to smoking



Source: Global Burden of Disease 2019, Level 4

THE STORY SO FAR...

Pneumonia is the leading infectious disease killer in the world, responsible for an estimated 2.5 million deaths and 97 million DALYs in 2019, according to the GBD. Deaths cluster among the most vulnerable—young children under five and adults over 69 years. Pneumonia kills an estimated 672,000 children under five, three-quarters of whom are under 12 months of age and 1.2 million adults over 69 years. More males than females die from pneumonia and the rate of pneumonia death is also higher for males. The populations most at risk of death from pneumonia include children who are wasted, exposed to air pollution, and/or born with low birth weight and elderly populations exposed to smoking, air pollution, and low temperatures. Smoking contributes to many more pneumonia deaths among males, while exposure to household air pollution and secondhand smoke contribute to more pneumonia deaths among females. COVID-19 could add an additional 2 million deaths to the 2020 total for lower respiratory infections. No other infection causes anywhere near this burden of death.

NEW DEVELOPMENTS

Pneumonia Definitions

Lower respiratory infection (LRI), acute respiratory infection (ARI), severe acute respiratory infection (SARI), community-acquired pneumonia, and hospital-acquired pneumonia are all names used to describe pneumonia. When SARS-CoV-2 (severe acute respiratory syndrome coronavirus 2) first appeared in Wuhan it was described as a "pneumonia of unknown cause." The proliferation of terms creates confusion, undermines the collection of data, and ultimately contributes to fragmentation of effort across clinical settings, institutions, and countries.

There are even more causes of pneumonia than terms to describe the condition, including viral, bacterial, and fungal pathogens.Pre-COVID-19 studies have shed light onto the major causes of pneumonia in low-resource settings, especially among children. **The Pneumonia Etiology Research for Child Health (PERCH)** study analysed the main causes of pneumonia in children hospitalized across seven countries including Bangladesh, Kenya, The Gambia, Mali, South Africa, Zambia, and Thailand and found that viruses caused 61% of cases, followed by bacteria (27%), tuberculosis (6%), and fungi (5%). The respiratory syncytial virus (RSV) was the leading pathogen responsible for 31% of all hospitalizations followed by rhinovirus (7.5%), human metapneumovirus/HMPV (7.5%), parainfluenza (7.4%), pneumococcus (6.7%), haemophilus influenzae type B (5.9%), tuberculosis/TB (5.9%), staphylococcus aureus/staph (2.7%), influenza (2%), and pneumocystis jirovecii (2%).

Due to the challenges of sampling the area of infection following death in low-resource settings, it is difficult to know the exact causes of pneumonia deaths. **The Child Health and Mortality Prevention Surveil-lance (CHAMPS)** network is using minimally-invasive tissue sampling (MITS) to determine specific causes of pneumonia death among neonates and children in seven countries including Ethiopia, Bangladesh, Kenya, Mali, Mozambique, Sierra Leone, and South Africa. They found that among children, lower respiratory infections were the leading immediate cause of death (47%) and the second leading underlying cause of death (12%). The pathogens Klebsiella Pneumonaie, Pneumococcus, Cytomegalovirus, Staphylococcus Aureus/Staph, Haemophilus Influenzae type B, RSV, and Pneumocystis Jirovecii were responsible for most child deaths. Pneumonia was also a major immediate cause of neonatal mortality (19%) with the pathogens Acinetobacter Baumannii and Klebsiella Pneumonaiea responsible for most deaths.

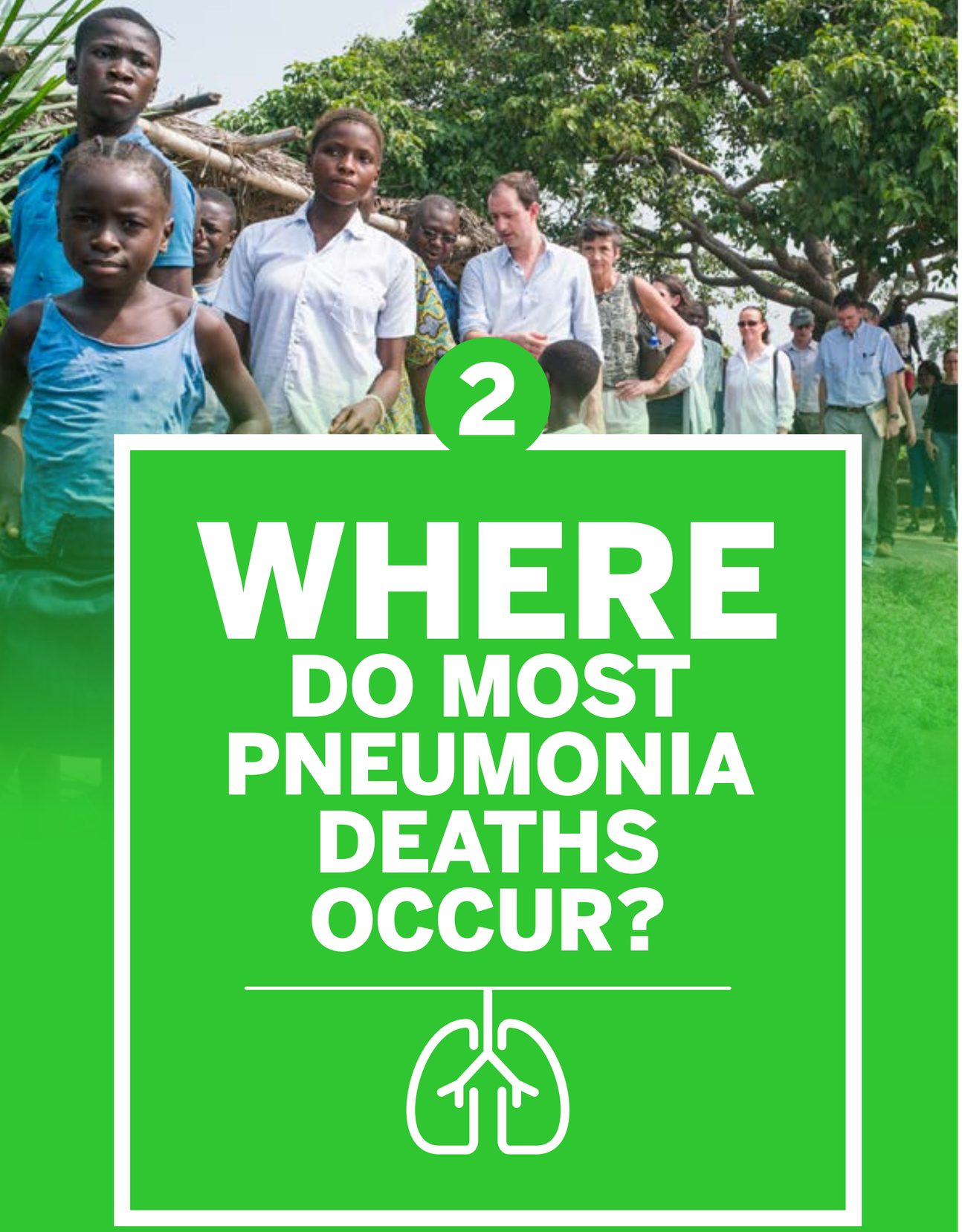
COVID-19 adds a major new viral cause of pneumonia to deaths from lower respiratory infections, primarily affecting adults to date. With two million COVID-19 deaths in 2020 according to **IHME COVID 19 projections**, all-cause pneumonia mortality could increase by a massive 80%, bringing the total to 4.5 million, assuming COVID-19 deaths are counted as lower respiratory infections in the GBD. As we deepen our understanding of the exact causes of pneumonia sickness and death across all age-groups, it is critical that efforts are made to standardize the terminology used to describe this massive burden of mortality by health experts, governments and global health agencies (e.g., WHO and IHME), in data sets (e.g., GBD, United Nations), and across low-, middle-, and high-income clinical settings.

LEARN MORE:

O'brien, K.L. Et Al., 2019. Causes of Severe Pneumonia Requiring Hospital Admission in Children Without HIV Infection from Africa and Asia: The PERCH Multi-Country Case-Control Study. The Lancet, 31;394(10200):757-779. Available at: https://doi.org/10.1016/S0140-6736(19)30721-4.

Taylor, A.W. Et Al., 2020. Initial Findings from a Novel Population-Based Child Mortality Surveillance Approach: A Descriptive Study. The Lancet Global Health, 8(7):E909-E919. Available at: https://doi.org/10.1016/S2214-109x(20)30205-9.

Zhu, Z. Et Al., 2020. From SARS and MERS to COVID-19: A Brief Summary and Comparison of Severe Acute Respiratory Infections Caused by Three Highly Pathogenic Human Coronaviruses. Respiratory Research, 21(1). Available at: http://dx.doi.org/10.1186/S12931-020-01479-W.



2

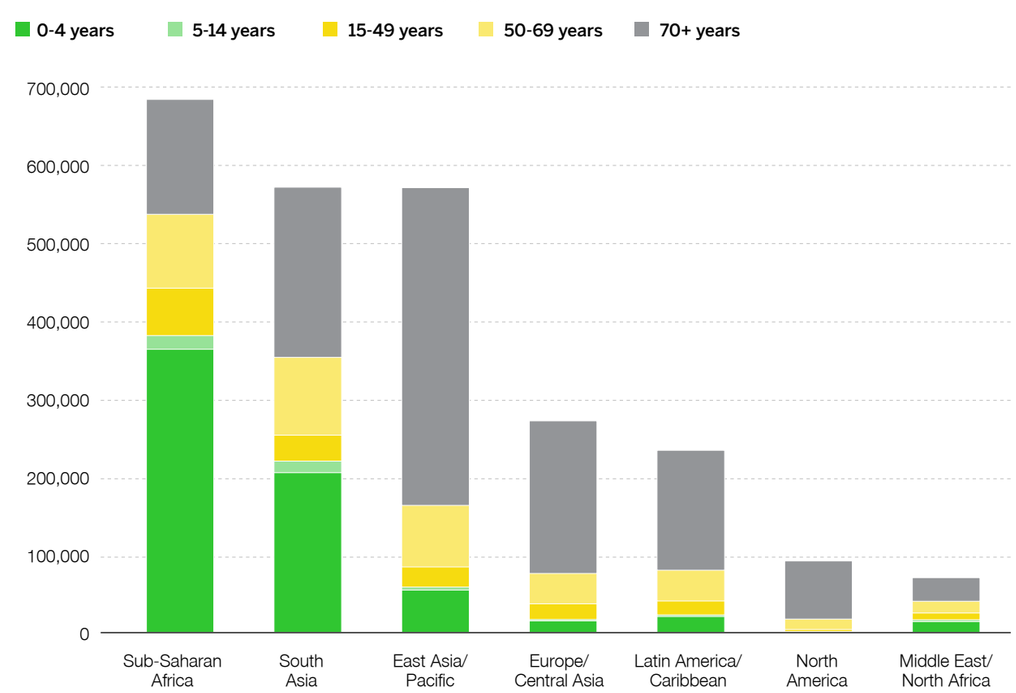
WHERE DO MOST PNEUMONIA DEATHS OCCUR?

The 2.5 million deaths from pneumonia are concentrated in Sub-Saharan Africa, South Asia, and East Asia and the Pacific. Sub-Saharan Africa is home to the largest number of pneumonia deaths followed by South Asia and East Asia and the Pacific.[6] In contrast, pneumonia causes far fewer deaths in Europe and Central Asia, Latin America and the Caribbean, North America, and the Middle East and North Africa.

In most regions the vast majority of pneumonia deaths occur among adults. In contrast, 56% of pneumonia deaths in Sub-Saharan Africa and 38% of pneumonia deaths in South Asia are among children under 15 years. These two regions also have significant pneumonia mortality among older adults and are dealing with "double burdens" of pneumonia mortality among both children and the elderly (Chart 14).

Two-thirds (1.6 million) of pneumonia deaths are further concentrated in a group of 20 low, middle-, and high-income countries. Among these countries India is the stark outlier with an estimated 434,000 pneumonia deaths—17% of all global pneumonia deaths—followed by China, Nigeria, Japan, and Brazil. There are six countries from Sub-Saharan Africa in the top 20—Nigeria, the Democratic Republic of Congo, Ethiopia, Tanzania, South Africa, and Burkina Faso—and six high-income countries—Japan, the United States of America (USA), the United Kingdom (UK), Russia, Germany, and Argentina. Of the remaining LMICs on the list,

Chart 14: Pneumonia deaths concentrate in specific regions among specific age groups



Source: Global Burden of Disease 2019

6 See Note (b) for a list of countries in each World Bank region.

20

Number of countries accounting for two-thirds of all pneumonia deaths

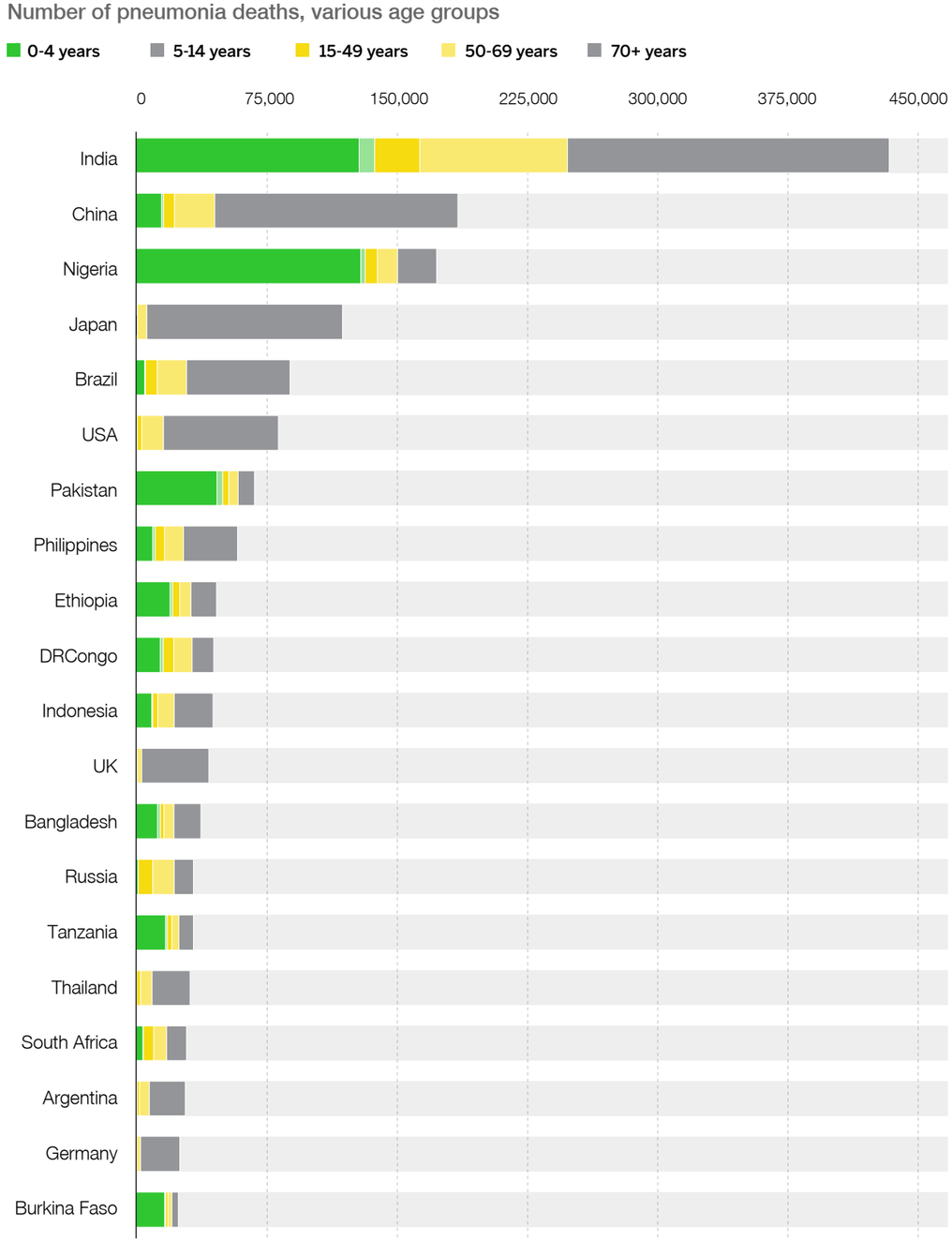
East Asia and the Pacific is home to four (China, the Philippines, Indonesia, and Thailand), South Asia to three (India, Pakistan, and Bangladesh), and Latin America and the Caribbean to one (Brazil).

The vast majority of pneumonia deaths in high-income countries occur among adults aged over 69 years, as do more than 50% of pneumonia deaths in China, Brazil, and Thailand. In contrast, over 50% of pneumonia deaths in Nigeria, Pakistan, Tanzania, and Burkina Faso are among children under five years. Critically, six of the countries are dealing with significant burdens of pneumonia death among both the very young and the very old, including India, the Philippines, Ethiopia, the Democratic Republic of Congo, Indonesia, and Bangladesh. Only Russia and South Africa are experiencing high proportions of pneumonia deaths among their working-age populations. More than one-quarter (26%) of pneumonia deaths in Russia and 20% in South Africa are among 15 to 49 year olds (Chart 15).

In three-quarters of the 20 high-burden countries, pneumonia kills more males than females. However in India, Bangladesh, the USA, the UK, and Argentina more females die from pneumonia. The largest gap is in India, where pneumonia kills an estimated 30,000 more females than males. These additional female deaths cluster among girls aged one month to 14 years and among women over 49 years (Chart 16). In Bangladesh, the USA, the UK, and Argentina additional female deaths are due to larger populations of elderly females. However, in India this is not the case as rates of pneumonia death are higher for females across all age groups except women 15 to 49 years.

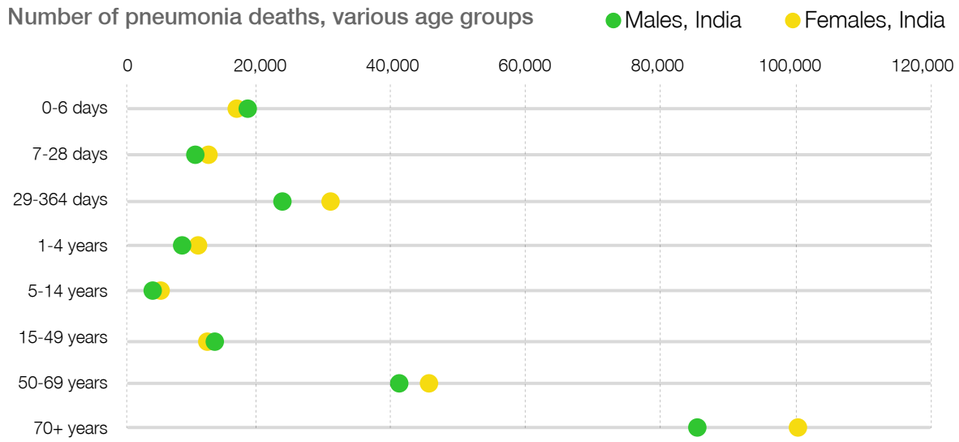
Pneumonia deaths are often further concentrated in specific populations within countries, but estimates of sub-national pneumonia mortality for all age groups do not yet exist. They are available for children under five years as part of the Local Burden of Disease analysis provided by the Institute for Health Metrics and Evaluation (IHME). These maps reveal several sub-national clusters of high-risk child pneumonia "hotspots" running across northern Africa with mortality risk peaking in eastern Burkina Faso, north-eastern Nigeria (e.g., Jigawa, Yobe, Borno, and Adamawa states), the

Chart 15: Two-thirds of pneumonia deaths are concentrated in a diverse group of 20 high-burden countries



Source: Global Burden of Disease 2019

Chart 16: Gaps between female and male pneumonia deaths are widest in India



Source: Global Burden of Disease 2019

eastern Central African Republic, southern South Sudan, and southern Somalia. In Asia, there are sub-national clusters of child pneumonia mortality risk in northern Uzbekistan, southern Afghanistan, the Sindh and Khyber Pakhtunkhwa provinces of Pakistan, and the northern states of India (e.g., Uttar Pradesh, Bihar, Madhya Pradesh, and Rajasthan). Governments and global health donors and agencies should use this data to identify exactly where the populations of children at greatest risk of death from pneumonia are located within national borders and prioritize pneumonia control efforts to them. Because the geographic areas with the greatest risk of child pneumonia death may not be the same as the populations with the greatest numbers of child pneumonia deaths, decision-makers will need to take into account broader indicators to identify the largest numbers of children at greatest risk of death from pneumonia. In the absence of sub-national maps of adult pneumonia deaths, decision-makers can identify the populations of elderly at greatest risk by using sub-national maps of exposure to air pollution and tobacco smoking as proxies.

THE STORY SO FAR...

Two-thirds of pneumonia deaths are concentrated in a diverse group of 20 low-, middle-, and high-income countries representing most regions of the world. While pneumonia mortality in some of these countries concentrates among children or the elderly, many carry "double burden" of pneumonia deaths in both age groups. In most of these countries, males are more likely to die from pneumonia than females with the exception of India where both pneumonia death numbers and rates among girls and elderly women are higher. In many countries, pneumonia deaths are further concentrated within specific geographic areas and there is an urgent need for governments and global health donors and agencies to use these maps to more effectively target prevention, diagnosis, and treatment services to accelerate the achievement of health goals. Ideally, decision-makers would have easy access to sub-national estimates of pneumonia prevalence, incidence, and mortality for all age groups so that pneumonia control efforts could be targeted for maximum impact on lives saved across the life course.

NEW DEVELOPMENTS

Pneumonia Maps

The development of online, interactive maps that pinpoint where pneumonia deaths cluster within nations has the potential to transform the impact of interventions, rapidly accelerate mortality declines, and close health inequities. The Institute for Health Metrics and Evaluation (IHME) is advancing the development of **Local Burden of Disease** maps and has applied advanced bayesian geostatistical tools to map pneumonia prevalence, incidence, and mortality rates per 1,000 children under five years across the world.

This analysis reveals clusters of child pneumonia deaths in two global "hotspots". The first runs in a band from West to East Africa, beginning in Guinea and Sierra Leone and continuing through Southern Mali, Burkina Faso, Niger, Chad, Northern Nigeria, the Central African Republic, South Sudan, Ethiopia, Kenya, and Southern Somalia. Rates of child pneumonia mortality in these populations range from three deaths per 1,000 children in Southern Mali to seven deaths per 1,000 children in north eastern Nigeria. For comparison, the lowest rate in Sub-Saharan Africa is 0.2 in South Africa.

A second pneumonia "hotspot" is in Asia and runs north to south-east from Uzbekistan to Cambodia and includes Tajikistan, Afghanistan, Pakistan, Northern India, Myanmar, and Laos. Rates of child pneumonia mortality in these populations range from 1.5 deaths per 1,000 children in parts of Myanmar to 2.9 deaths per 1,000 children in Southern Pakistan. The lowest rate in Asia is 0.1 in Thailand.

By comparing pneumonia prevalence with mortality in these sub-national populations, local burden of disease maps can also offer some assessment of the effectiveness of both population behaviors and the health system in reducing child pneumonia mortality. For example, the health system in sub-national populations experiencing high pneumonia prevalence but lower mortality may be functioning more effectively and/or the population may be practicing more "pro-health" behaviors (e.g., good nutrition, low exposure to air pollution, etc.). Populations where mortality is particularly high relative to prevalence may have limited access to quality health services and/or high exposure to the major pneumonia risk factors.

Using "precision public health" mapping has the potential to improve the targeting of pneumonia prevention, diagnosis, and treatment efforts to the populations at greatest risk of death and dramatically accelerate national achievement of child survival goals. This is not only important for children. Precision public health maps that reveal the adult populations most at risk of pneumonia death would also help many countries reduce large and growing pneumonia burdens. Maps that include pneumonia prevalence, incidence, and mortality for all age-groups have the potential to dramatically improve the cost-effectiveness of national pneumonia control efforts and international development assistance.

COVID-19 has underscored the importance of maps that can capture prevalence, incidence, and mortality rates during a pandemic in real-time and at the global, national, state, and local levels. The **WHO Coronavirus Disease (COVID-19) Dashboard** provides national estimates of confirmed COVID-19 cases and deaths while the **COVID-19 Dashboard by the Center for Systems Science and Engineering** (CSSE) at Johns Hopkins University (JHU) also provides sub-national estimates in some countries. Many other tools and apps have emerged with local COVID-19 data at the district level. Wide access to these maps and apps is not only a critical tool for government pandemic surveillance and response, but for populations to understand their local risk and change their behaviors accordingly. Governments, companies, and the global health community should significantly increase their investments to further develop disease mapping tools and their uptake as part of disease control efforts both during the pandemic and beyond.

LEARN MORE:

India State-Level Disease Burden Initiative Child Mortality Collaborators. Subnational Mapping of Under-5 and Neonatal Mortality Trends in India: The Global Burden of Disease Study 2000–17. The Lancet. 11 May 2020. Available at: https://doi.org/10.1016/S0140-6736(20)30471-2.

Institute for Health Metrics And Evaluation (IHME). Local Burden of Disease – Lower Respiratory Infections. Seattle, WA: IHME, University of Washington, 2019. Available at: https://vizhub.healthdata.org/lbd/lri.

Reiner, R.C. Et Al., 2019. Identifying Residual Hotspots and Mapping Lower Respiratory Infection Morbidity and Mortality in African Children from 2000 to 2017. Nature Microbiology, 4(12), PP.2310–2318. Available at: http://dx.doi.org/10.1038/s41564-019-0562-y.

3

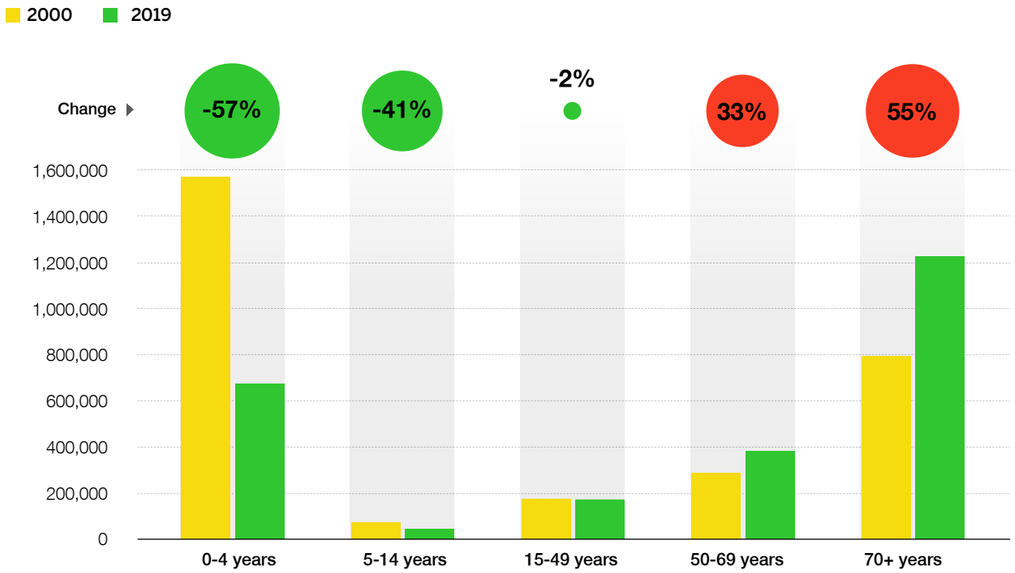
ARE PNEUMONIA DEATHS DECLINING FAST ENOUGH?

Pneumonia deaths declined by 14% between 2000 and 2019 from an estimated 2.9 million to 2.5 million according to the GBD. This decline was driven by children under five years where pneumonia deaths fell by 57%. In contrast, pneumonia deaths among adults aged 15 to 49 years remained largely flat and deaths among adults over 49 years increased, most sharply among adults aged over 69 years where pneumonia deaths rose by 55% (Chart 17). While much of this increase was driven by aging populations, little progress was made in reducing the actual rate of pneumonia deaths among adults over the period (Chart 18).

While the gender gap in pneumonia deaths (more males than females die from pneumonia) has narrowed since 2000 as deaths have fallen more quickly for males (-15%) than females (-13%), it has not been eliminated. Between 2000 and 2019 the gender gap narrowed as child pneumonia deaths

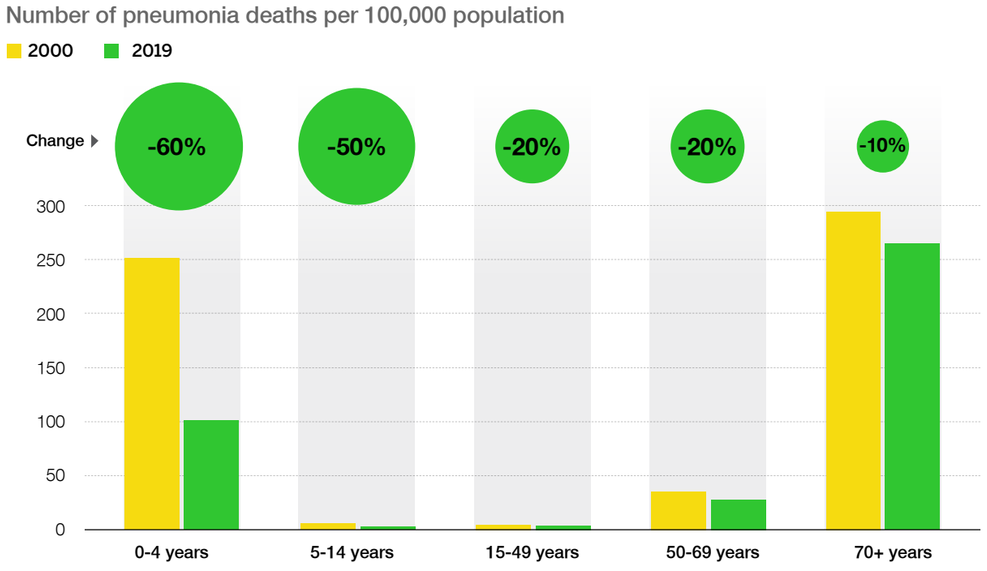
Chart 17: Pneumonia deaths have fallen among children under 15 years but risen among adults over 49 years

Number of pneumonia deaths, various age groups



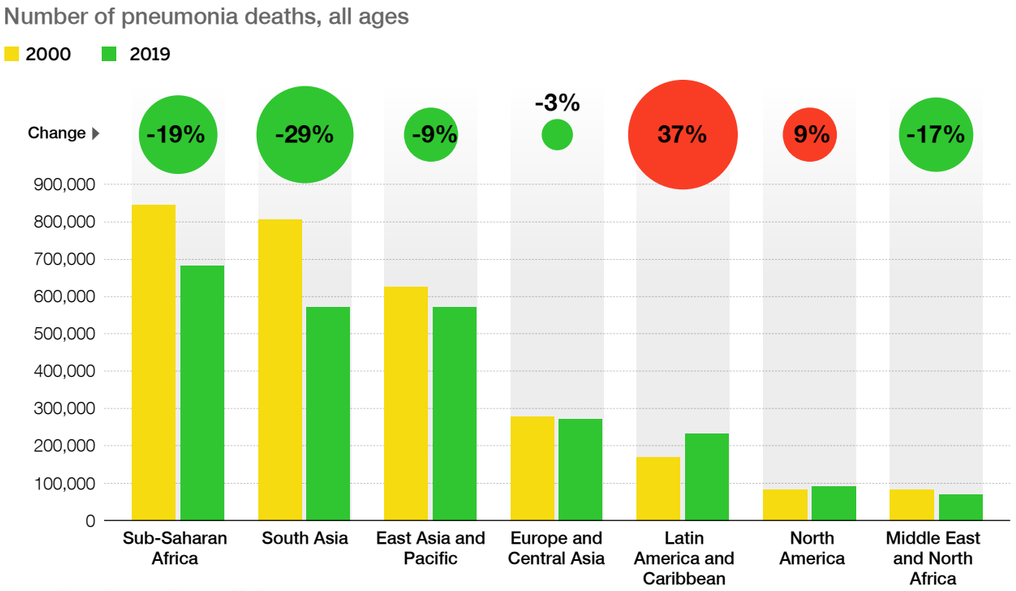
Source: Global Burden of Disease 2019

Chart 18: Rates of pneumonia death have fallen sharply among children under five years in contrast to other age groups



Source: Global Burden of Disease 2019

Chart 19: Numbers of pneumonia deaths have fallen in all regions except Latin America and the Caribbean and North America



Source: Global Burden of Disease 2019

57%

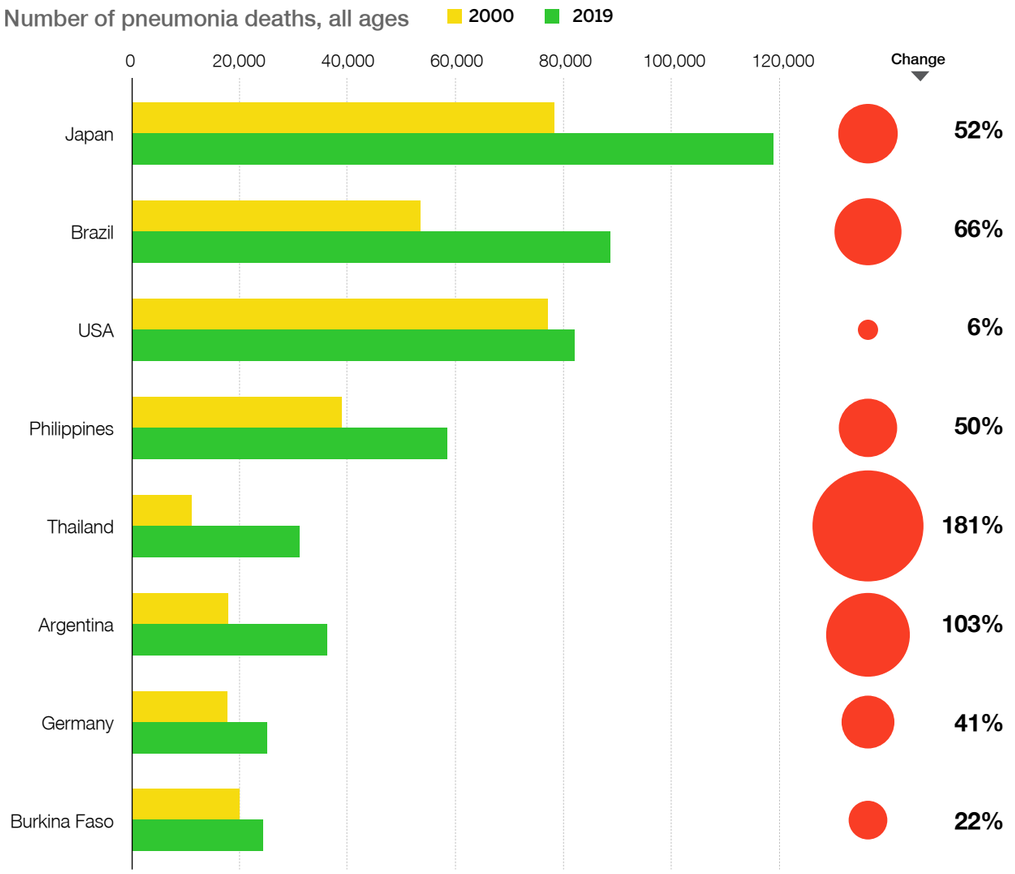
Decline in child pneumonia deaths between 2000 and 2019, from an estimated 1.6 million to 672,000

among boys under five years declined faster and the number of pneumonia deaths among women 50 to 69 years increased. However over the same period pneumonia deaths increased more rapidly for men aged 15 to 49 and men aged above 69 years than for women, offsetting the other trends. The rate of pneumonia deaths among males continues to be higher than for females—34 and 31 deaths per 100,000 respectively.

Pneumonia deaths have fallen in all regions, except in Latin America and the Caribbean and in North America. The sharpest decline of 29% occurred in South Asia, followed by Sub-Saharan Africa (-19%), and the Middle East and North Africa (-17%), all driven by sharp declines in child pneumonia deaths. In contrast, the East Asia and the Pacific region recorded smaller declines (-9%), as did Europe and Central Asia (-3%), due to rising pneumonia deaths among elderly populations. Pneumonia deaths actually rose over the period across Latin America and the Caribbean (37%) and North America (9%) due to the growing number of pneumonia deaths among adults aged over 69 years (Chart 19).

Pneumonia deaths have risen in eight of the 20 high-burden countries, with increases ranging from 6% in the USA to 181% in Thailand, according to the GBD. Steep increases occurred in middle-income countries with aging populations including in Thailand, Brazil, and the Philippines, while high-income countries also experienced this effect

Chart 20: Numbers of pneumonia deaths have risen in eight of the 20 high-burden countries

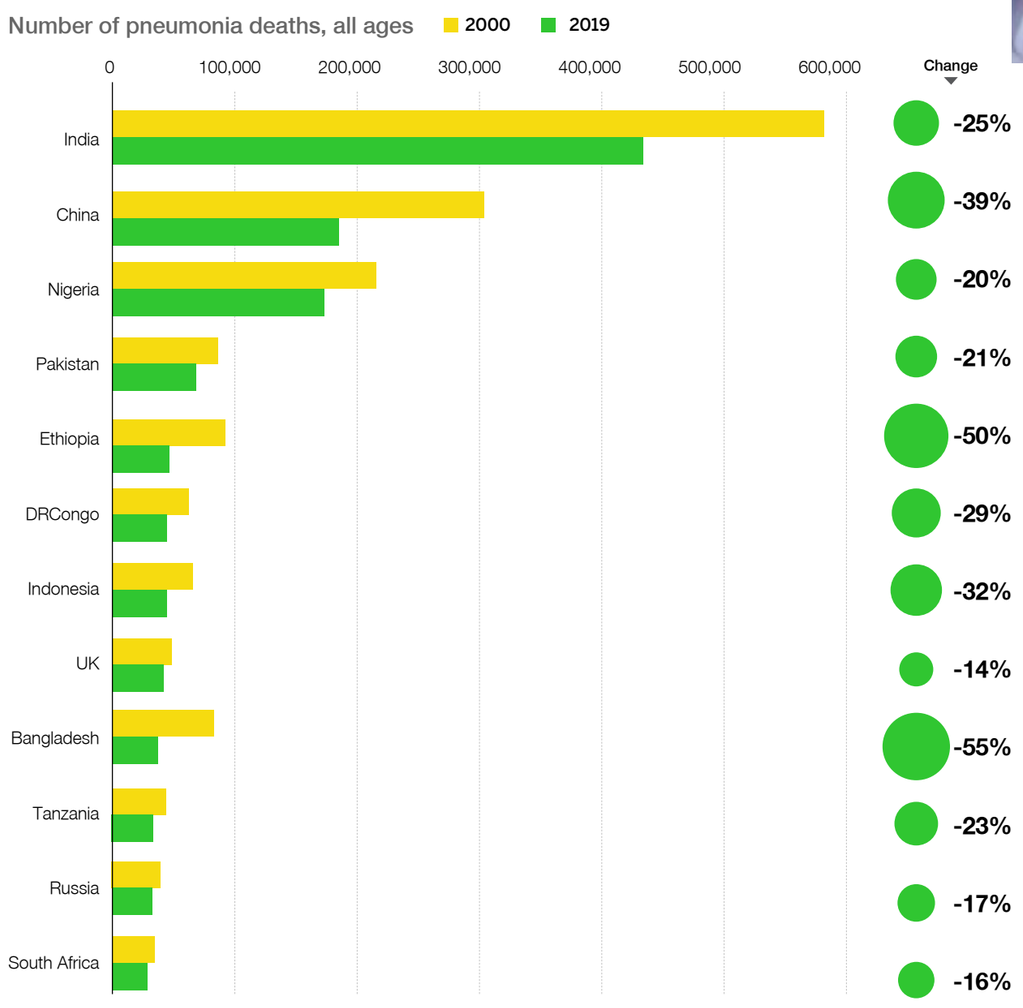


Source: Global Burden of Disease 2019

including Argentina, Japan, the USA, and Germany. However, pneumonia deaths also rose in Burkina Faso driven by increases in child pneumonia deaths (Chart 20). In the remaining 12 high-burden countries, pneumonia deaths fell with reductions ranging from 14% in the UK to 55% in Bangladesh. The reductions in pneumonia deaths achieved by Bangladesh, Ethiopia, China, and Indonesia between 2000 and 2019 are remarkable (Chart 21).

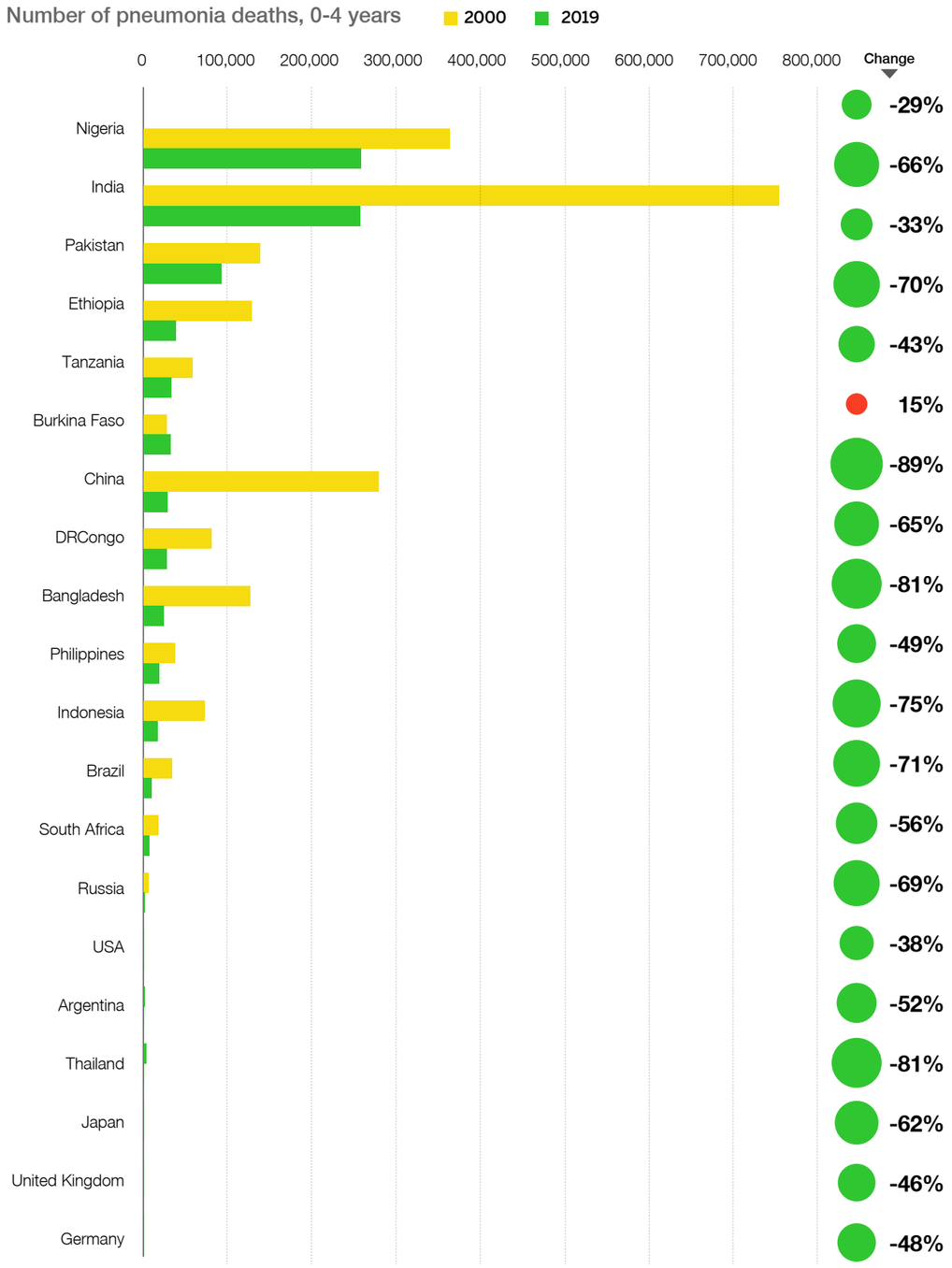
Declines in pneumonia deaths in the high-burden countries between 2000 and 2019 were driven by reductions in deaths among children under five years. Child pneumonia deaths fell in every high-burden country with the exception of Burkina Faso, with declines ranging from 29% in Nigeria to 89% in China (Chart 22). In stark contrast, numbers of pneumonia deaths among those aged over 69 years rose sharply in all of the high-burden countries except in the UK, ranging from 2% in the USA to 357% in Thailand (Chart 23). In fact, the number of pneumonia deaths among those aged over 69 years more than doubled in Brazil, the Philippines, Argentina, and Thailand over the period. These sharp increases reflect the aging of the populations in these countries and offset the impressive declines in child pneumonia deaths, especially in the Philippines and Thailand.

Chart 21: Numbers of pneumonia deaths have fallen in 12 of the 20 high-burden countries



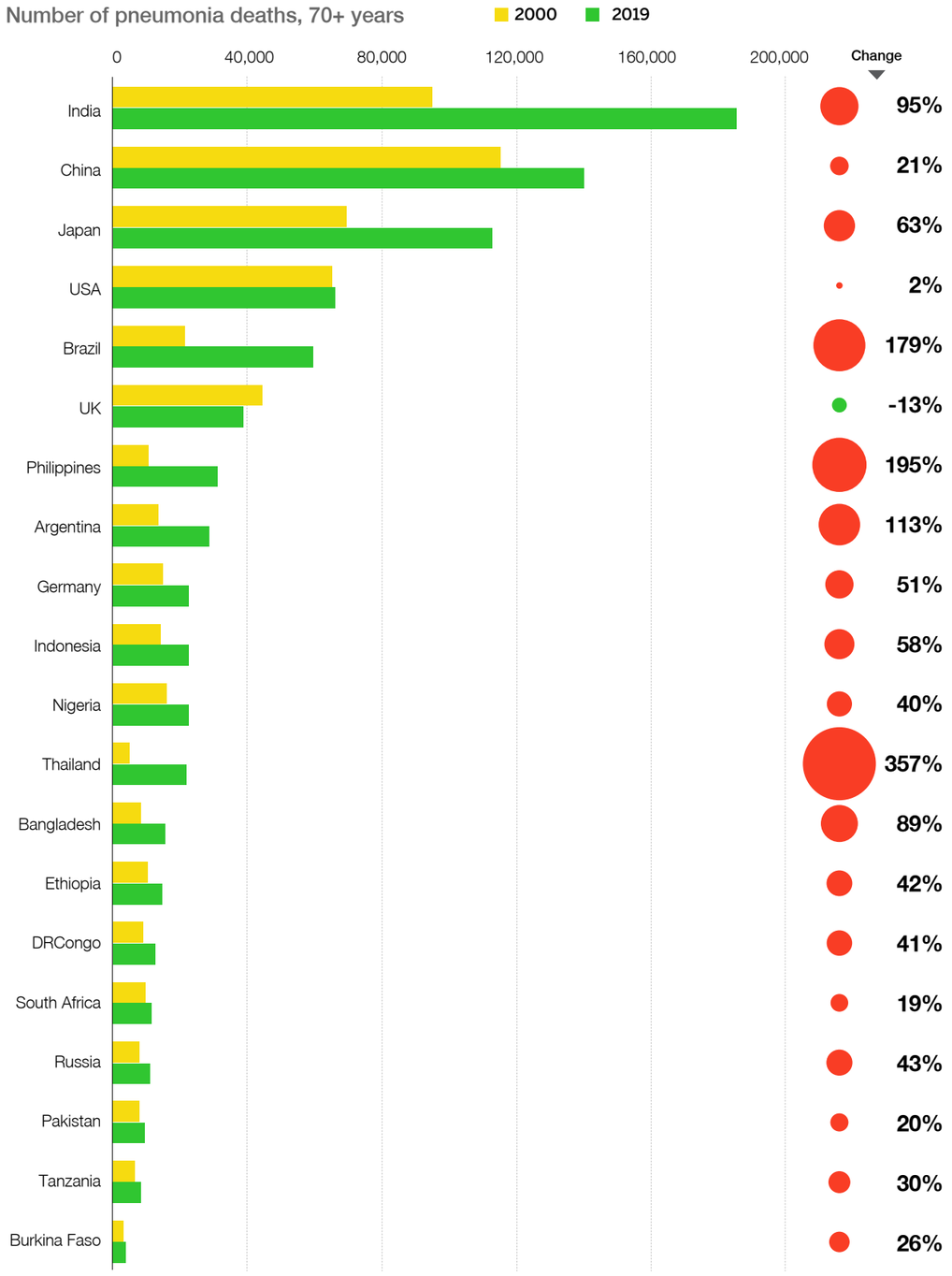
Source: Global Burden of Disease 2019

Chart 22: Pneumonia deaths among children under five years have fallen in 19 of the 20 high-burden countries



Source: Global Burden of Disease 2019

Chart 23: Pneumonia deaths among adults aged over 69 years have risen in 19 of the 20 high-burden countries



Source: Global Burden of Disease 2019

Progress in reducing pneumonia deaths has not kept pace with many other leading infectious disease killers. The 14% decline in pneumonia deaths since 2000 is lower than the declines for all other leading infectious killers including measles (-86%), HIV/AIDS (-45%), whooping cough (-41%), meningitis (-39%), diarrhea and malaria (-37%), tuberculosis (-31%), typhoid (-29%), and neonatal sepsis (-17%) (Chart 24).

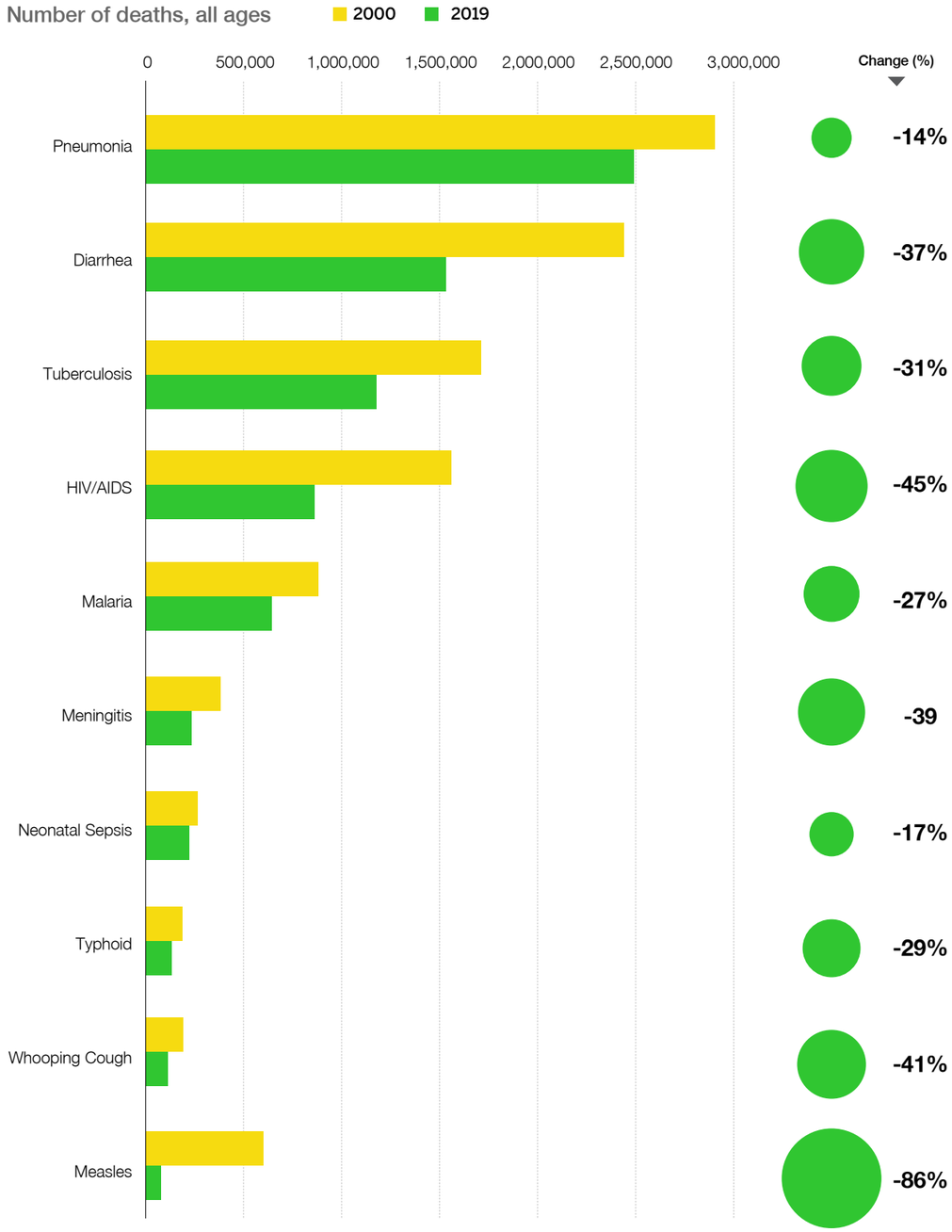
As a result of this slower decline, many countries will struggle to reduce child pneumonia deaths to the levels required for achievement of the SDG for child survival—25 child deaths per 1,000 live births by 2030. To achieve this goal, countries will need to reduce child pneumonia deaths to at least three per 1,000 live births by 2025, the target established in 2013 by the World Health Organization (WHO) and UNICEF in the Integrated Global Action Plan for Pneumonia and Diarrhoea (GAPPD).[7] At current rates of progress, seven of the high-burden countries will not achieve this target including Nigeria, India, Pakistan, Ethiopia, Tanzania, Burkina Faso, and the Philippines (Chart 25).

7 Chan, M. & Lake, A., 2013. Integrated global action plan for the prevention and control of pneumonia and diarrhoea (GAPPD). The Lancet, 381(9876), pp.1436–1437. See also the Integrated Global Action Plan for Prevention and Con-trol of Pneumonia and Diarrhoea (GAPPD), 2013. Geneva: World Health Organization (WHO) and UNICEF, available at: https://www.who.int/maternal_child_adolescent/news_events/news/2013/gappd_launch/en/.

14%

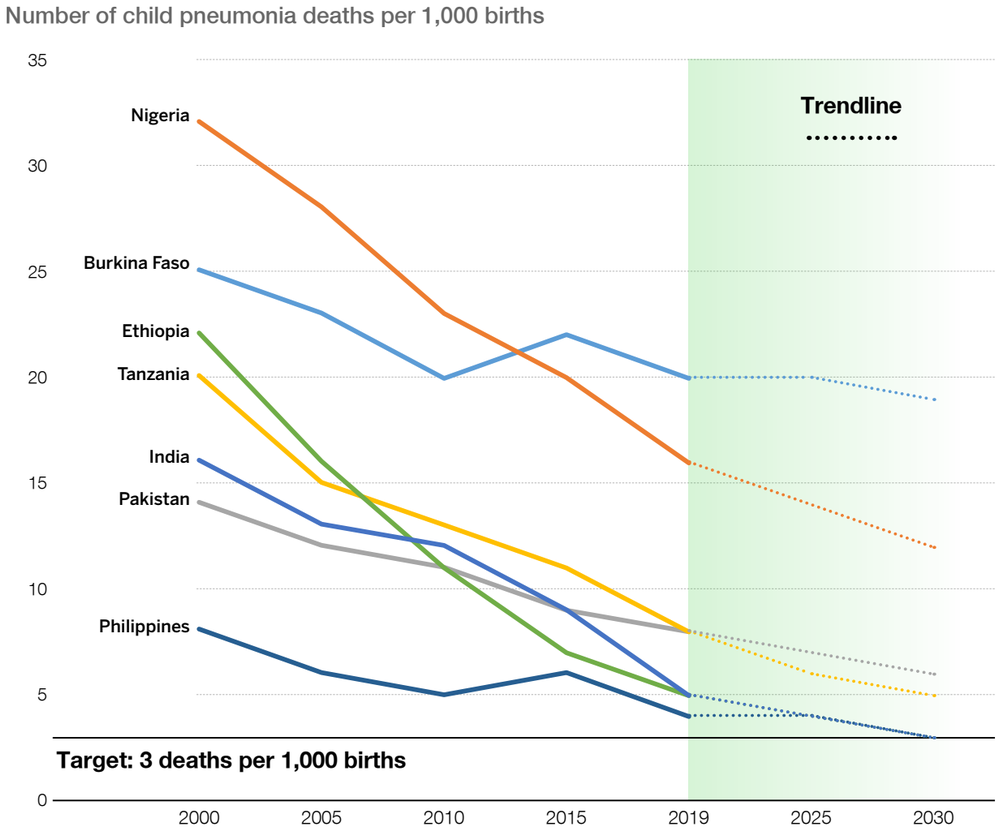
Decline in pneumonia deaths between 2000 and 2019, from an estimated 2.9 million to to 2.5 million

Chart 24: Pneumonia deaths have fallen more slowly than other leading infectious killers



Source: Global Burden of Disease 2019

Chart 25: Seven high-burden countries will struggle to achieve the child pneumonia mortality target by 2025

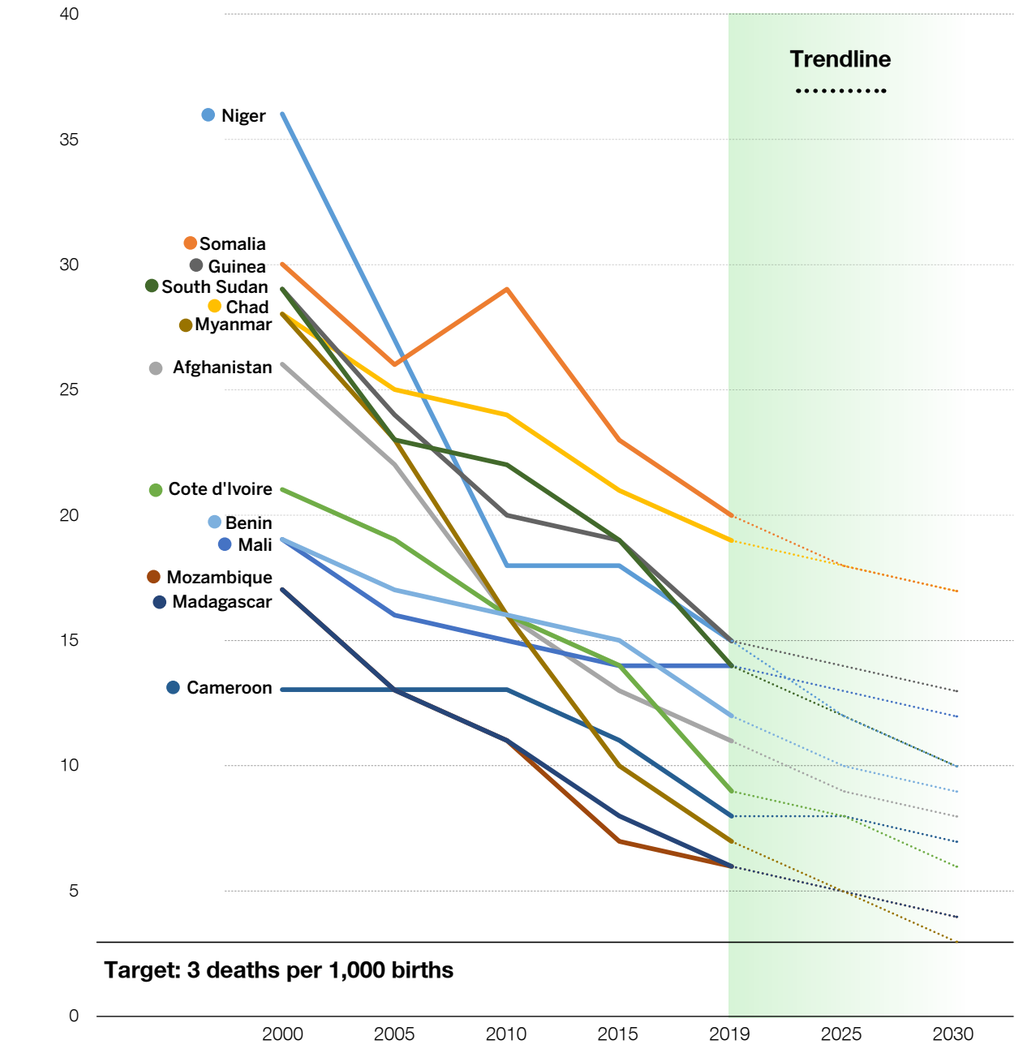


Sources: Global Burden of Disease 2019 and United Nations World Population Prospects 2019

It is important to note that many other countries not on the list 20 high-burden countries, most of them in Sub-Saharan Africa, will also fail to achieve the GAPPD target. Of special concern are the countries where more than 5,000 children are dying from pneumonia each year and where there has been little or no progress in reducing deaths. For example, at current rates of progress, more than 100,000 children will still be dying from pneumonia across Niger, Somalia, Afghanistan, Chad, Mali, Cameroon, Mozambique, Guinea, Myanmar, Madagascar, South Sudan, and Benin in 2025 (Chart 26).

Countries with rising burdens of pneumonia deaths among adults, and especially among adults, will also struggle to achieve the SDGs relating to communicable and non-communicable disease reduction, and access to healthcare for all. Achieving these goals will be extremely challenging for those countries where pneumonia deaths among adults over 69 years have risen by more than 60% since 1990, including India, the Philippines, Brazil, Thailand, Argentina, and South Africa. As many of the these countries have also been disproportionately affected by COVID-19 deaths among older adults, they will need to adopt special measures to reduce death from all-cause respiratory infections to achieve the health vision of the SDGs.

Chart 26: Many other countries with more than 5,000 child pneumonia deaths will also struggle to achieve the child pneumonia mortality target by 2025



Sources: Global Burden of Disease 2019 and United Nations World Population Prospects 2019

THE STORY SO FAR...

Despite substantial progress in reducing child pneumonia deaths in most countries, increases in adult pneumonia deaths, especially among the elderly, are contributing to a rising burden of pneumonia in many countries, which is now being exacerbated by COVID-19. Prior to the pandemic, among the 20 countries with the largest numbers of pneumonia deaths, deaths were rising in eight. Progress in reducing pneumonia deaths has not kept pace with declines in other leading infectious disease killers. There is also a persistent gender gap in pneumonia deaths, with more males than females dying from pneumonia each year. The slow pace of progress in reducing pneumonia deaths poses a significant challenge for the achievement of the health-related SDGs in many LMICs, especially the child survival (3.2), communicable and non-communicable disease reduction (3.3, 3.4), and access to healthcare (3.8) goals. These challenges will be most acute in the countries with large burdens and/or very high rates of child pneumonia deaths—almost all of them in Sub-Saharan Africa—and in the countries with sharp increases in the number of pneumonia deaths among the elderly, almost all of them middle- and high-income countries with heavy burdens of COVID-19 deaths among older adults.

NEW DEVELOPMENTS

Pneumonia Targets

At current rates of progress and in the context of the COVID-19 pandemic, it will be very difficult for many high-burden pneumonia countries to achieve the **Sustainable Development Goals** (SDGs) for health that they adopted in 2015. Countries where child pneumonia deaths remain stubbornly high, and where progress is slow, will struggle to achieve SDG 3.2 (reducing child mortality to at least 25 deaths per 1,000 live births), and countries with high and rising burdens of pneumonia deaths among adults, including from COVID-19, will be hampered in their efforts to curb both communicable and non-communicable disease deaths (SDGs 3.3, 3.4). Countries that cannot provide access to "quality healthcare services, essential medicines, and vaccines for all," including for pneumonia prevention, diagnosis, and treatment, will fail to achieve Goal 3.8. And countries where more than 90% of children with pneumonia symptoms are not taken to see a healthcare provider will struggle to achieve Universal Health Coverage (UHC), as pneumonia careseeking is one of 16 indicators in the UHC Service Coverage Index that measures national progress to UHC.

But if all governments adopted targets for pneumonia mortality and for coverage of the most critical interventions (e.g., vaccines, nutrition, clean air, pulse oximetry, oxygen, and antibiotics) and regularly measured progress as part of national child survival agendas, communicable and non-communicable disease strategies and pandemic preparedness plans, great progress towards the SDGs, UHC, and future pandemic preparedness is possible. Despite this, few high-burden countries have embraced the 2025 target for child pneumonia mortality—less than three child pneumonia deaths per 1,000 lives births—established by the WHO and UNICEF in the **Global Action Plan for the Prevention and Control of Pneumonia** (GAPPD) and this is one of the reasons so many are off-track to achieve this goal according to recent progress reports from the International Vaccine Access Center (IVAC) and the WHO GAPPD Monitoring Visualization Tool. And in the absence of accepted pneumonia mortality targets for adults, national infectious and non-communicable disease plans do not set national pneumonia mortality targets. Pneumonia is the only major infectious disease killer without specific mortality reduction targets across the life course.

Although national targets exist for vaccine coverage, wasting reduction, air quality, and low birth weight they are not part of pneumonia control strategies at the national level. And there are no coverage targets at all for pulse oximetry, oxygen, or the recommended antibiotics for pneumonia treatment. The **Every Breath Counts Coalition Indicators Working Group** has recommended new pulse oximetry and oxygen service coverage indicators and called for their adoption by the major LMIC health facility data collection and management tools and surveys.

WHO, UNICEF, and partners should revise and relaunch the GAPPD, which sunsets in 2025, and update and extend the child pneumonia mortality target to two deaths per 1,000 lives births by 2030. International health agencies should introduce a new pneumonia mortality target for vulnerable adult populations that is consistent with the broader SDG health targets. Targets and measurement indicators for all of the major risk factors for pneumonia death and for the most effective health interventions should be widely adopted and routinely measured, including for pulse oximetry, oxygen, and the recommended antibiotics.

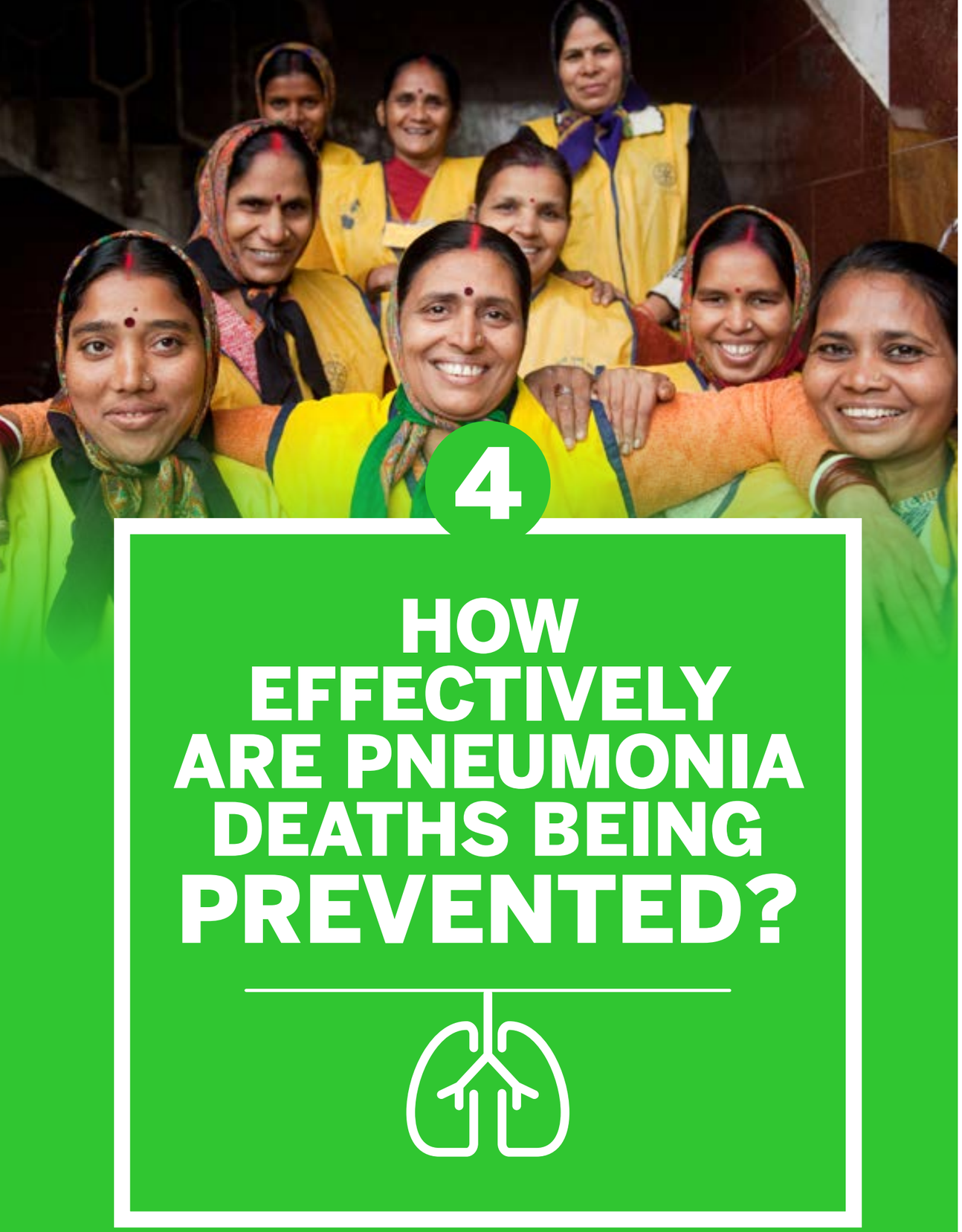
If this approach was endorsed by the World Health Assembly in 2022, national governments would have two 2030 pneumonia mortality targets—for children and for adults—and a suite of intervention targets and indicators to use as the basis for national pneumonia control strategies. COVID-19 has demonstrated the threat of respiratory infection and if all countries were actively working to protect their vulnerable populations from all causes of pneumonia and measuring their progress each year, this would strengthen pandemic preparedness and reduce the risk that future respiratory pandemics will kill millions more.

LEARN MORE:

Chan, M. & Lake, A., 2013. Integrated action for the prevention and control of pneumonia and diarrhoea. The Lancet, 381(9876), pp.1436–1437. See also the Integrated Global Action Plan for Prevention and Control of Pneumonia and Diarrhoea (GAPPD), 2013. Geneva: World Health Organization (WHO) and UNICEF, available at: https://www.who.int/maternal_child_adolescent/news_events/news/2013/gappd_launch/en/ , and the WHO GAPPD Monitoring Visualization Tool, available at: https://www.who.int/maternal_child_adolescent/epidemiology/gappd-monitoring/en/.

International Vaccine Access Centre (IVAC), 2020. Johns Hopkins Bloomberg School of Public Health. (2020). Pneumonia and Diarrhea Progress Report. Available at: https://www.jhsph.edu/ivac/wp-content/uploads/2020/11/IVAC_PDPR_2020.pdf

Lam, F. et al., Good data is critical to equitably improve oxygen access. A call to action to fill data gaps & ensure every breath counts, on behalf of the Every Breath Counts Coalition Indicators Working Group, 2020. Available at: https://stoppneumonia.org/good-data-is-critical-to-equitably-improve-oxygen-access-a-call-to-action-to-fill-data-gaps-ensure-every-breath-counts/.



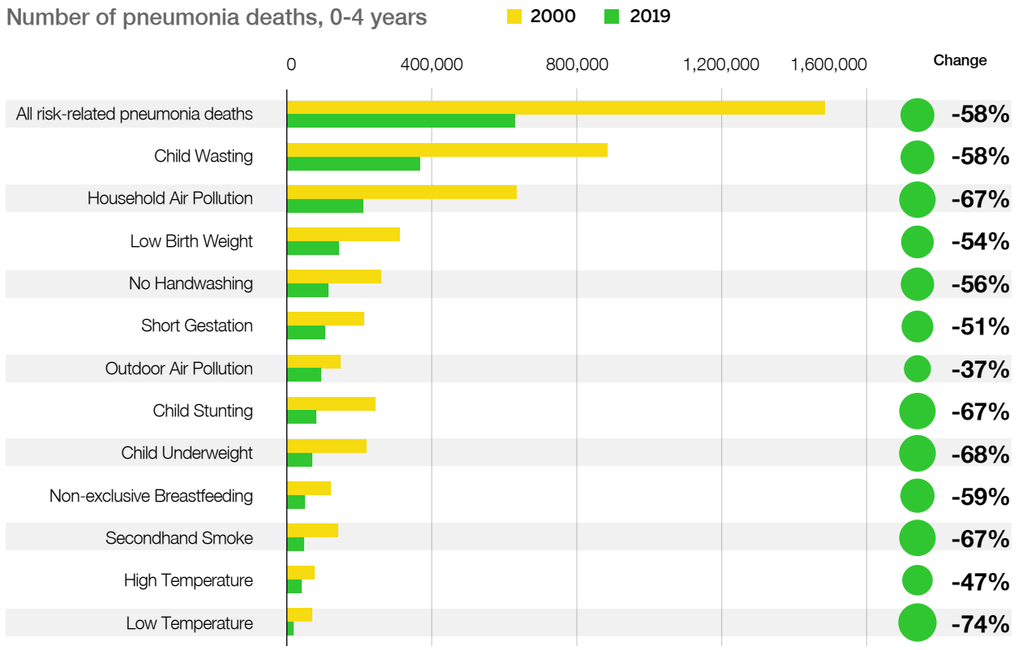
4

HOW EFFECTIVELY ARE PNEUMONIA DEATHS BEING PREVENTED?

To reduce pneumonia deaths to the levels required for the achievement of the SDGs, countries will need to minimize risk factors and improve coverage of the most effective prevention, diagnostic, and treatment interventions, especially among the most vulnerable populations. Although there has been significant progress in reducing risk-related child pneumonia deaths in most countries, large populations of children remain exposed to wasting, air pollution, low birth weight, and other risks and subsequently die from pneumonia (Chart 27).

The most urgent priority in pneumonia risk reduction is to further reduce child wasting. More than 70% of the estimated 47 million wasted children in the world live in the high-burden pneumonia countries. India alone is home to 20 million wasted children and has a wasting rate of 17.3%. 2.4 million (10.2%) of children in Indonesia are wasted, 2.3 million (6.8%) in Nigeria, 2 million (7.1%) in Pakistan, 1.6 million (1.9%) in China, and 1.2 million each in Ethiopia (7.2%), Bangladesh (8.4%), and the Democratic Republic of Congo (8.1%). There are also large populations of wasted children in the Philippines (603,000), Tanzania (333,000), Burkina Faso (286,000), and Brazil (262,000).[8] Wasted children are further concentrated within countries. For example, wasting rates across India range from less than 1% to 19%, from less than 1% to 17% in Ethiopia, and from less than 1% to 15% in Nigeria and Pakistan.[9] These very high sub-national wasting rates far exceed the new global target of 3% by 2030.[10]

Chart 27: Risk-related child pneumonia deaths are declining



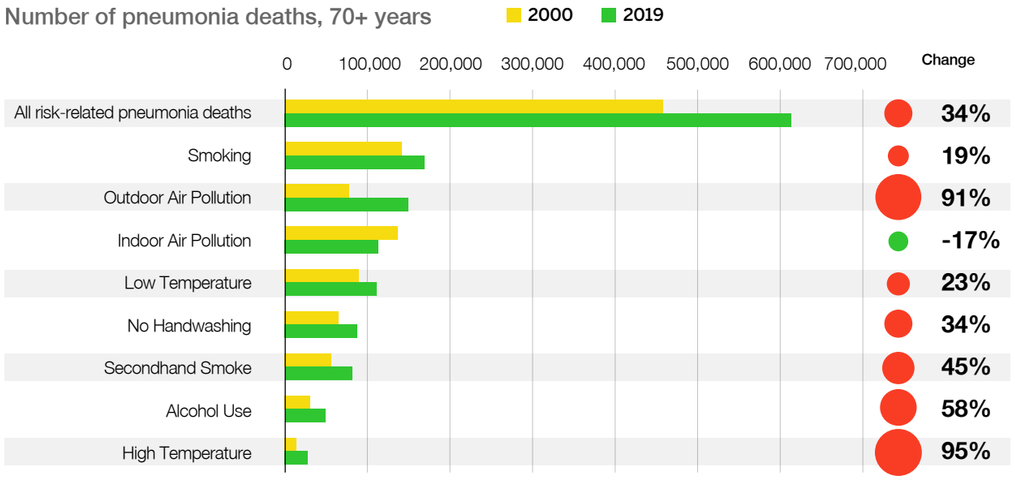
Source: Global Burden of Disease 2019

8 UNICEF, WHO, World Bank, 2020. Levels and Trends in Child Malnutrition. Key Findings of the 2020 Edition of the Joint Child Malnutrition Estimates. Geneva. Available at: https://www.unicef.org/reports/joint-child-malnutrition-estimates-levels-and-trends-child-malnutrition-2020.

9 Institute for Health Metrics and Evaluation (IHME), 2020. Local Burden of Disease – Child Growth Failure. Seattle, WA: IHME, University of Washington. Available at: http://vizhub.healthdata.org/lbd/cgf.

10 This extends the World Health Assembly target of 5% child wasting by 2025 to 3% by 2030.

Chart 28: Most risk-related pneumonia deaths among adults over 69 years are increasing



Source: Global Burden of Disease 2019

Reducing children's exposure to air pollution, especially in the countries where a majority of households do not have access to clean fuels and technologies for cooking, where outdoor air pollution rates are significantly above safe levels, and where smoking prevalence is high, will also be critical.[11] One-half of the high-burden pneumonia countries have rates of access to clean household energy below the global average of 60%. Rates in Asia range from 18% in Bangladesh to 41% in India, to 43% in Pakistan and the Philippines, and to 58% in Indonesia. Rates in Sub-Saharan Africa are much lower. For example, less than 10% of households in Nigeria, the Democratic Republic of Congo, Ethiopia, Tanzania, and Burkina Faso cook with clean fuels and technologies, according to the WHO.[12] Reducing children's exposure to secondhand smoking and outdoor air pollution levels will also be important.

Reductions in the number of babies born with low birth weight and/or preterm will also help to reduce pneumonia deaths among newborns. An estimated 200,000 newborns die from pneumonia in the first month of life, 60% of those in the first week after birth, according to the GBD.

The vast majority of the estimated 20 million babies born weighing less than 2,500 grams and the 15 million babies born preterm (before 37 weeks gestation) are in the high-burden pneumonia countries. India is home to an estimated 3.5 million preterm births, followed by 1.2 million in China, 800,000 in Nigeria, 600,000 in Bangladesh, 530,000 in Indonesia, 450,000 in Pakistan, 380,000 in the USA, 380,000 in Ethiopia, 350,000 in the Philippines, 340,000 in Tanzania, and 340,000 in Brazil. Rates of preterm birth across these countries are above the global average of 11 per 100 births, except in China (7) and Brazil (9).[13] Although there is progress in reducing newborn deaths from preterm birth complications, much greater efforts are needed to reduce rates of preterm birth, as these babies remain especially vulnerable to infections, including to pneumonia. National estimates of low birth weight populations are too incomplete to draw conclusions.[14]

11 UNICEF, 2016. Clear the Air for Children: the Impact of Air Pollution on Children, New York. Available at: https://www.unicef.org/publications/index_92957.html.
12 World Bank, Sustainable Energy for All (SE4ALL) from the WHO Global Household Energy database.
13 Chawanpaiboon, S. et al., 2019. Global, regional, and national estimates of levels of preterm birth in 2014: a system-atic review and modelling analysis. The Lancet Global Health, 7(1), pp.e37–e46. Available at: http://dx.doi.org/10.1016/s2214-109x(18)30451-0.
14 UNICEF, World Health Organization (WHO), 2019. UNICEF-WHO Low birthweight estimates: Levels and trends 2000–2015. Geneva: World Health Organization. Available at: https://www.who.int/nutrition/publications/UNICEF-WHO-lowbirthweight-estimates-2019/en/.

In contrast to risk-related child pneumonia mortality, risk-related deaths among adults aged over 69 years are rising, especially from exposure to high temperatures, outdoor air pollution, and alcohol consumption (Chart 28). Efforts to reduce exposure to outdoor air pollution and alcohol use among the most vulnerable elderly populations will be important in many of the high-burden countries, as will mitigating exposure to heat during increasingly hot Summers in many parts of the world. Reducing outdoor air pollution will be especially critical in India, Pakistan, Thailand, the Philippines, Bangladesh and Brazil where elderly pneumonia deaths from exposure to outdoor air pollution have risen by more than 100% since 2000. Of special note, alcohol use as a risk factor in elderly pneumonia deaths is rapidly increasing in India, Brazil, Pakistan, the Philippines, Ethiopia, the Democratic Republic of Congo, Bangladesh, and Thailand where related pneumonia deaths have also increased by more than 100% since 2000. Continued efforts to reduce alcohol consumption should also reduce pneumonia deaths among adults, especially in these countries. It is important to note that exposure to high temperatures is rapidly emerging as a high risk for pneumonia death among the elderly as climate-change induced heat waves are now a major health risk for vulnerable populations. Mitigating extremes of temperature and their impact should be included as part of an effective public health response to pneumonia. Finally, efforts to reduce smoking prevalence and exposure to secondhand smoke remain critical public health goals in India, Brazil, the Philippines, Indonesia, Russia, Thailand and Argentina where smoking-related pneumonia deaths among the elderly have increased by more than 50% since 2000. Action on smoking will not only slow the rising numbers of pneumonia death among the elderly but will deliver a raft of other health benefits across all populations.

Beyond risk reduction strategies, there are very effective technologies to prevent, diagnose, and treat pneumonia. Chief among prevention tools is a group of pneumonia-fighting vaccines which include the pneumococcal conjugate vaccine (PCV), the Haemophilus influenzae type b vaccine (Hib), the measles vaccine, influenza vaccines, and an emerging vaccine to prevent respiratory syncytial virus (RSV). The PCV and the Hib vaccine are particularly powerful because they target the major bacterial causes of severe pneumonia among children and are especially effective at

Table 1: Rates of coverage of the pneumococcal (PCV), Hib, and measles vaccines among children under five years (2019)

High-burden pneumonia countries	PCV (3 doses) Children <5 years	Hib vaccine (3 doses) Children <5 years	Measles vaccine (2 doses) Children <5 years
India	15%	91%	84%
China	Unknown	Unknown	98%
Nigeria	57%	57%	9%
Japan	97%	98%	93%
Brazil	84%	80%	54%
USA	92%	91%	95%
Pakistan	75%	75%	71%
Philippines	43%	65%	40%
Ethiopia	63%	68%	41%
DRCongo	58%	57%	Unknown
Indonesia	3%	85%	71%
UK	91%	93%	87%
Bangladesh	97%	98%	95%
Russia	85%	Unknown	97%
Tanzania	83%	89%	72%
Thailand	Unknown	Unknown	87%
South Africa	76%	77%	54%
Argentina	88%	86%	89%
Germany	84%	92%	93%
Burkina Faso	91%	91%	71%

Source: World Health Organization (WHO), UNICEF 2019

reducing deaths.[15] Measles vaccination remains critical, as pneumonia is often a complication of measles and remains a risk in the countries where less than 90% of children are fully protected and in the countries where historically high rates of measles coverage are now slipping, including as a result of the pandemic.[16] Flu vaccines are also important as influenza A and B viruses are common viral causes of pneumonia, especially in adults. COVID-19 vaccines add another vital tool in the arsenal of pneumonia-fighting vaccines and a key priority for 2021 is to achieve vaccination at the levels required for herd immunity from the SARS-Cov-2 virus in every country.

It is important to note that an RSV vaccine, when available, could considerably accelerate declines in child pneumonia mortality, especially among babies under six months. A recent study estimated that global deaths due to RSV could be as high as 118,200, and that the virus is responsible for 3.2 million hospital admissions and 59,600 in-hospital deaths among children under five years with almost one-half (27,300) among babies under six months. Further, a study from Buenos Aires revealed estimates of RSV-associated deaths among babies under six months that were much higher than previous estimates. In this study, 9.6% of all at-home deaths among children under five years were associated with RSV infection.[17] Although there is currently no licensed RSV vaccine, more than 15 RSV vaccines are in clinical trials and a vaccine should be available for introduction in less than five years.[18] This vaccine should be highly effective at reducing pneumonia deaths among babies in the first months of life and will also benefit the elderly.

At full coverage among children under five years, the pneumonia-fighting vaccines could prevent more than one-half of all child pneumonia deaths and also reduce deaths among adults, especially the elderly. Studies have shown that when children are fully vaccinated against the leading causes of pneumonia, deaths among adults and especially among the elderly also fall.[19] This is why vaccination is a critical pneumonia control strategy for all high-burden countries, and especially cost-effective for countries struggling with double burdens of pneumonia among children and adults.

Despite the potential of vaccination to prevent a majority of pneumonia deaths among children and to significantly reduce the burden among adults, coverage is low in many of the high-burden countries (Table 1). Globally, just 48% of children are protected with three doses of the PCV, 72% of children receive three doses of the Hib vaccine, and 71% receive two doses of the measles vaccine according to the WHO. Among the high-burden

Table 2: Rates of careseeking with an appropriate health provider for children with suspected pneumonia (2010-20)

High-burden pneumonia countries	% children <5 years
India	78%
China	Unknown
Nigeria	75%
Japan	Unknown
Brazil	Unknown
USA	Unknown
Pakistan	84%
Philippines	67%
Ethiopia	31%
DRCongo	34%
Indonesia	92%
UK	Unknown
Bangladesh	46%
Russia	Unknown
Tanzania	55%
Thailand	80%
South Africa	88%
Argentina	94%
Germany	Unknown
Burkina Faso	52%

Source: UNICEF 2010-20

15 Wahl, B. et al., 2018. Burden of Streptococcus pneumoniae and Haemophilus influenzae type b disease in children in the era of conjugate vaccines: global, regional, and national estimates for 2000–15. The Lancet Global Health, 6(7), pp.e744–e757. Available at: http://dx.doi.org/10.1016/s2214-109x(18)30247-x.
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pneumonia countries, PCV coverage is below 48% in India, China, the Philippines, Indonesia, and Thailand.

While Hib and measles vaccine coverage is above the global averages in most of the high-burden countries, of concern is the lower coverage of both vaccines in the countries that are home to one-half of all child pneumonia deaths, including India, Nigeria, Ethiopia, the Democratic Republic of Congo, Pakistan, and Indonesia. Despite strong increases in coverage of the measles vaccine and a sharp decline in measles deaths in recent decades,[20] further efforts are needed to close remaining measles coverage gaps and to prevent historically high coverage rates from falling, especially during the pandemic. Rates of influenza vaccine coverage are also low. Although the WHO does not provide national estimates of flu vaccine coverage, individual country estimates reveal suboptimal coverage among both children and the elderly.[21]

Full vaccination of vulnerable populations with the pneumonia-fighting vaccines is essential but not sufficient to achieve pneumonia control.[22] Even at full coverage, hundreds of millions of children and adults will still contract pneumonia each year with their survival dependent on timely access to accurate diagnosis and effective treatment. Yet rates of careseeking, diagnosis, and treatment in many countries are low, especially among children. Just 60% of children under five years with symptoms of pneumonia are taken to an appropriate healthcare provider according to UNICEF.[23] In the high-burden countries, careseeking rates are as low as 31% in Ethiopia, 34% in the Democratic Republic of Congo, and 46% in Bangladesh (Table 2). Of great concern, pneumonia careseeking rates are below 50% in Somalia, Chad, Cote d'Ivoire, Madagascar, Angola, South Sudan, Benin, the Central African Republic, Haiti, Sudan, and Yemen.[24]

Increasing timely careseeking is a critical first step to closing pneumonia diagnosis and treatment gaps and will require attention to a range of factors including the costs of seeking healthcare for sick children (financial and time), the levels of adult female literacy and household agency,[25] and the low levels of trust in the health system, which are often related to quality of care.[26] Among these, female literacy is extremely important as studies have repeatedly shown that the more educated a mother, the greater the chances her children will survive childhood.[27] In four of the high-burden pneumonia countries, literacy rates among women are below 50%, including in Nigeria (41%), Pakistan (44%), Ethiopia (29%), and Burkina Faso (33%). Literacy rates are even lower among adult women in many of the other countries struggling with heavy burdens of child pneumonia, especially in Benin (31%), Afghanistan (30%), South Sudan (29%), Niger (27%), Mali (26%), the Central African Republic (26%), Guinea (22%), and Chad (14%), according to UNESCO.[28]

As pneumonia careseeking is now one of 16 indicators measured by the UHC Service Coverage Index,[29] countries will need to close the wide gaps in careseeking to make progress to UHC. Increased female literacy coupled with the removal of user fees for healthcare has the potential to increase the proportion of children with pneumonia symptoms seeking timely care enabling countries to make progress towards Universal Health Coverage (UHC). All LMICs should be closely monitoring pneumonia careseeking and international health and development agencies should provide support to countries to increase their rates, where needed.

Even when the vast majority of children with suspected pneumonia are taken to a healthcare facility, accurate diagnoses, appropriate prescriptions, and availability of quality and affordable treatments are particularly challenging in low-resource settings. Cost-effective diagnostic tools that can correctly identify the children at greatest risk of death from pneumonia, or the source of their infection (viral or bacterial, or both), do not yet exist. And very effective tools like pulse oximetry that can identify children with hypoxemia by measuring oxygen levels in the blood—a strong predictor of severe illness and pneumonia death—exist but are not in wide use. A recent study in Malawi found that pulse oximetry identified fatal pneumonia episodes among children that would otherwise have been missed by the WHO referral guidelines alone, and concluded that pulse oximetry could be beneficial in supplementing clinical signs to identify children with pneumonia at high risk of mortality.[30] Another study found that oxygen saturation was the most specific single sign for pneumonia and concluded that combining pulse oximetry with temperature and respiratory rate would improve the identification of pneumonia in children.[31]

However in the absence of diagnostic tools, pneumonia is often diagnosed through the assessment of clinical signs and symptoms, including respiratory rate, and many cases go undetected or are incorrectly classified. Recent studies from Malawi have shown that only one in five children with pneumonia was correctly diagnosed,[32] and that while healthcare was frequently sought for children who died of suspected pneumonia, lack of drugs, availability of staff, and dysfunctional referral systems led to multiple delays in care and child deaths.[33] There are promising signs that new technologies like lung ultrasound will transform the diagnosis of pneumonia in low-resource settings and together with pulse oximetry dramatically improve the identification of the children at greatest risk of death from pneumonia.[34] Developing rapid point-of-care diagnostic tests for pneumonia similar to what is available for malaria is a urgent research and development priority.

It is difficult to determine antibiotic coverage for children with pneumonia as no reliable indicator exists for routine use across settings.[35] Some studies continue to report very low coverage of antibiotics among children with pneumonia across LMICs and very low usage of the WHO-recommended antibiotic—amoxicillin dispersible tablets.[36] Other studies report wide use, and

48%

Percentage of children who are fully protected with three doses of the pneumococcal conjugate vaccine (PCV)

20 Between 2000 and 2019, measles deaths declined by 87% from an estimated 520,000 to 70,000, according to the GBD. Over the same period the proportion of one year-olds with two doses of the measles vaccine increased from less than 50% to 71%, according to the WHO.
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over-use, of antibiotics in both community and hospital settings.[37] While some countries permit community health workers to dispense antibiotics for children with pneumonia, others do not, and where some countries permit community dispensation, the recommended antibiotic is often unavailable. A recent study showed that less than one-half of public health facilities in Tanzania stocked the recommended treatment for non-severe pneumonia - amoxicillin dispersible tablets, and nearly two-thirds of these facilities had experienced stock-outs in the previous 90 days. Even at the hospital level, availability of amoxicillin dispersible tablets was not substantially higher. The study also found that in private drug shops, where a large proportion of careseeking for pneumonia in Tanzania occurs, no retailer had amoxicillin dispersible tablets.[38]

Until an acceptable indicator to measure antibiotic coverage among children with pneumonia becomes available, countries will need to determine their own antibiotic coverage gaps and adherence to recommended antibiotics. Some countries will expose large gaps in antibiotic treatment that need to be closed, while others will uncover overuse of inappropriate antibiotics and a heightened risk of antimicrobial resistance. While at the global level greater access to antibiotics for sick children could prevent more deaths than are currently caused by antimicrobial resistance, this situation may be changing.[39] This is another reason why wider vaccine coverage together with improved diagnostic tools are so critical, because vaccination has the potential to reduce the need for antibiotics and improved diagnostic tools will better target antibiotics to the children who really need them, reducing the risk of antimicrobial resistance.

Perhaps the single largest gap in access to appropriate treatment for pneumonia in low-resource settings is medical oxygen. Routine data on oxygen use in LMICs is scant,[40] although the urgent need to increase access for COVID-19 has exposed wide gaps in coverage in many countries.[41] WHO and other global health agencies have accelerated the collection of data on oxygen use using new survey tools but this data is not yet publicly available.[42] Pre-pandemic studies from specific hospitals within LMICs reveal very limited medical oxygen access across many of the high-burden pneumonia countries, especially those in Sub-Saharan Africa and South Asia.[43] A recent study of 78 hospitals across three states in Nigeria found that only 2% had pulse oximeters and 25% of pediatric wards had functional oxygen systems. The study concluded that among the children with pneumonia who reached a health facility, 47% of non-severe pneumonia cases were missed, only 4% of severe pneumonia cases were correctly diagnosed, and just one in 10 children received the oxygen needed.

In Ethiopia, the situation was only slightly better. 45% of hospital pediatric wards had pulse oximeters and 64% had fully functional oxygen delivery devices. However, only 14% of the hospitals studied had standard operating procedures on oxygen use or healthcare workers trained in oxygen therapy, and only 41% had biomedical engineers and technicians who could maintain oxygen equipment.[44] High rates of mortality among children with pneumonia in hospital settings across Sub-Saharan Africa have also been reported in Kenya,[45] Malawi,[46] and Uganda,[47] suggesting similar problems with access to medical oxygen. Closing medical oxygen gaps can save many lives during the pandemic and beyond. A recent study found that oxygen supported by quality improvement was associated with a 40% reduction in overall child mortality and a 50% reduction in pneumonia mortality across nine rural provinces in Papua New Guinea.[48]

Treatment rates for wasted children are also alarmingly low and this continues to place many children at risk of pneumonia. Just one in four of the 17 million severely wasted children in the world are admitted to treatment programs, according to the United Nations.[49] Funding to care for children with severe wasting is often short-term and focused primarily on humanitarian situations and few health systems integrate the diagnosis and treatment of child wasting with other health services, such as vaccination and treatment for pneumonia. Routine growth monitoring at the point of vaccination could help identify children at risk of wasting, or already wasted, and in need of preventive or therapeutic treatment. Ready-to-use therapeutic foods (RUTFs) and supplements should be integrated with other treatments for children with severe pneumonia.

Data measuring pneumonia diagnosis and treatment rates among the elderly are not routinely collected by governments or the United Nations, however studies indicate wide gaps also exist especially among elderly populations in low-resource settings.[50] Antibiotic overuse is a growing problem among adults in high-income countries where better diagnostic tests could also improve the rational use of antibiotics and their continued efficacy. More national data is needed on careseeking and access to proper diagnosis, antibiotics, oxygen, and therapeutic nutrition among elderly populations with pneumonia. Better measurement and routine tracking of pneumonia prevention, diagnostic, and treatment rates across all vulnerable populations is critical to create national accountability and to measure progress.

10%

Percentage of children with severe pneumonia who received the oxygen they needed across several hospitals in Nigeria

38 Results for Development. Monitoring availability, stocking and dispensing of pneumonia treatments in public and private sector markets in Tanzania – a health facility and accredited drug dispensing outlet survey, 2017.
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THE STORY SO FAR...

The slow pace of change in reducing risk factors, increasing coverage of the pneumonia-fighting vaccines and closing careseeking, diagnosis, and treatment gaps in many of the high-burden countries is compromising the achievement of national health goals in many countries. Countries with high child pneumonia burdens must focus more on reducing child wasting, air pollution, and low birth weight while increasing coverage of the PCV, Hib, and measles vaccines and closing gaps in careseeking, diagnosis, and treatment. Countries with high elderly pneumonia burdens must focus on reducing outdoor air pollution, smoking, and alcohol use, while increasing coverage of the PCV and influenza vaccines. Full coverage of COVID-19 vaccines is critical to reducing pneumonia deaths caused by SARS-CoV-2. When RSV vaccines become available they should also be part of pneumonia control efforts, as their potential to reduce pneumonia deaths will likely be significant. Similarly, as new diagnostic tools that can rapidly and accurately identify the children and adults most at risk of death from pneumonia become available, countries should adopt them and remove one of the major obstacles to effective pneumonia treatment, rational antibiotic use, and continued antibiotic effectiveness.

NEW DEVELOPMENTS

Pneumonia Vaccines

In the context of low rates of timely careseeking for children with pneumonia symptoms, in the absence of simple, affordable and effective tools to diagnose pneumonia in low-resource settings, and in the context of the COVID-19 pandemic, vaccination is a powerful and essential tool for pneumonia control in every country. Effective vaccines exist to prevent the leading causes of bacterial pneumonia—the pneumococcal conjugate vaccine (PCV) and the Haemophilus influenzae type b (Hib) vaccine—and to prevent conditions that can lead to pneumonia, including the measles, influenza, and pertussis (whooping cough) vaccines. With vaccines to combat the leading viral causes of pneumonia in children (e.g., respiratory syncytial virus or RSV) and in adults (e.g., SARS-CoV-2), arriving, all countries should soon have at their disposal a group of "pneumonia-fighting" vaccines that have the power to reduce the incidence of pneumonia by more than half.

To effectively control pneumonia and to reduce the risk of future respiratory pandemics, every country needs to fully protect its population with all of the pneumonia-fighting vaccines. Among children, the priority is to increase coverage of the recommended doses of the PCV, Hib, pertussis, influenza, and measles vaccines to above 90% by 2025 and to reach universal coverage by 2030. New vaccines such as RSV should be incorporated into national vaccine schedules as soon as they are available. Among adults, the most urgent priority is full coverage of the COVID-19 vaccine, beginning with the adults most vulnerable to infection and death and proceeding until herd immunity is achieved in every country.

To achieve this level of coverage, most low- and middle-income countries (LMICs) will need support. Gavi, the Vaccine Alliance (Gavi), has provided financial support to help many countries introduce the pneumonia-fighting vaccines for children, including to increase coverage of the PCV by implementing an **Advanced Market Commitment** and by working with the Serum Institute of India to develop a lower-priced PCV, which is now available at 30% of the price of other PCVs. Further, Gavi is now supporting countries to introduce the COVID-19 vaccine via the COVAX Facility in partnership with the World Health Organization (WHO) and the Coalition for Epidemic Preparedness (CEPI). The Bill & Melinda Gates Foundation continues to support COVAX and the development of new vaccines such as RSV and others targeting viral and bacterial causes of pneumonia among children. It is critical that the new **Gavi 2021-2025 Strategy** (Gavi 5.0) prioritizes coverage of the pneumonia-fighting vaccines among both children and vulnerable adults.

For the countries with heavy burdens of pneumonia deaths that are not Gavi-eligible, new methods of support to increase coverage of the pneumonia-fighting vaccines will be needed. The pandemic has demonstrated just how vital vaccines are to prevent respiratory infections in all countries and it is now imperative that national governments, industry, and international health agencies collaborate to prioritize full coverage of the pneumonia-fighting vaccines. The WHO's **Immunisation Agenda 2030** should ensure that all LMICs can benefit from new and more affordable pneumonia vaccines so that they can cover the costs of both introduction and high coverage over time. Innovations that increase the cost-effectiveness of the pneumonia-fighting vaccines are now a global public health good.

LEARN MORE:

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5

HOW ADEQUATE ARE INVESTMENTS TO REDUCE PNEUMONIA DEATHS?

The vast majority of spending on health is national and paid for by governments out of national, state, and local health budgets and by citizens in out-of-pocket costs. In most of the high-burden pneumonia countries these forms of domestic spending cover more than 90% of health spending and only Ethiopia, the Democratic Republic of Congo, Tanzania, and Burkina Faso rely on external donor financing to cover more than 10% of their healthcare spending. Specifically, Ethiopia and the Democratic Republic of Congo rely on external donors to cover 36% and 35% of national health spending respectively while 32% of Tanzania's and 15% of Burkina Faso's health budget is externally financed according to the WHO. [51]

Table 3: Spending on health in the high-burden pneumonia countries varies widely

High-burden pneumonia countries	Health spending % of GDP	Health spending $US per capita	Out-of-pocket costs % of health spending
India	3.50%	$73	63%
China	5.40%	$501	36%
Nigeria	3.90%	$84	77%
Japan	11%	$4,267	13%
USA	9.50%	$848	28%
Brazil	16.90%	$10,624	11%
Philippines	3.20%	$43	56%
Ethiopia	4.40%	$137	54%
DRC	3.30%	$24	35%
Pakistan	3.30%	$19	42%
UK	2.90%	$112	35%
Tanzania	10%	$4,315	17%
Indonesia	2.30%	$42	74%
Russia	5.30%	$609	38%
Thailand	3.60%	$37	24%
Bangladesh	3.80%	$276	11%
South Africa	8.30%	$526	8%
Argentina	9.60%	$998	28%
Kenya	11.40%	$5,472	13%
Germany	5.60%	$40	36%

Source: World Health Organization (WHO) 2018

51 World Health Organization (WHO), Global Health Expenditure Database, 2020. Available at: https://apps.who.int/nha/database/Select/Indicators/en.

96%

Percentage of international development assistance for pneumonia allocated to vaccines

Across the high-burden pneumonia countries spending on healthcare varies widely from 2.3% of Gross Domestic Product (GDP) in Bangladesh to 16.9% of GDP in the USA, and from $US19 per person in the Democratic Republic of Congo to $US10,624 per person in the USA. Healthcare spending is highest in the countries where pneumonia deaths concentrate among the elderly and lowest in the countries with very high child pneumonia burdens and where out-of-pocket healthcare costs are particularly high, especially in Nigeria (77%), Bangladesh (74%), India (63%), and Pakistan (56%) (Table 3).

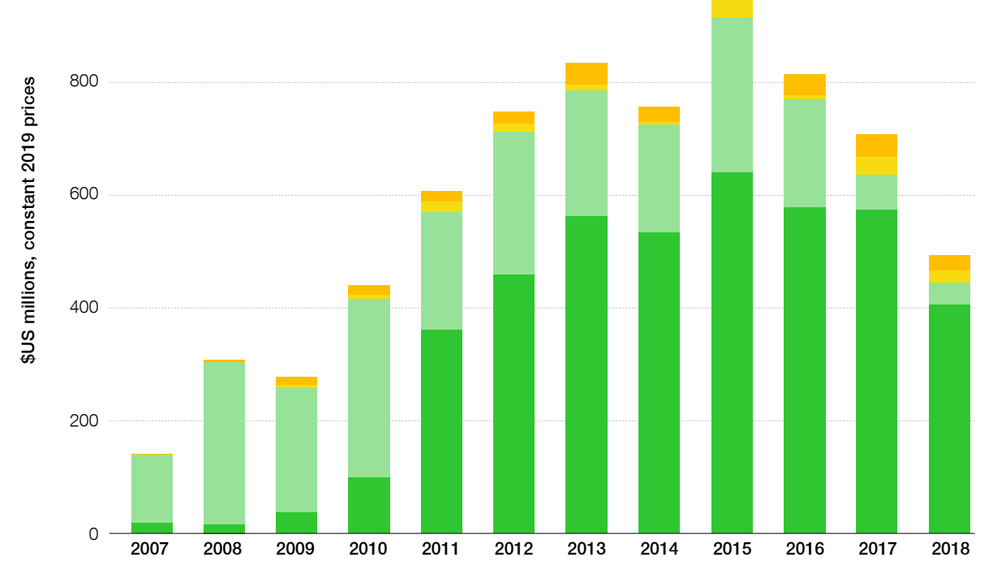
Determining what proportion of domestic healthcare spending is allocated to preventing, diagnosing, and treating pneumonia is extremely difficult especially in low-resource settings where public access to government budget information is very limited. Where health budgets are available, pneumonia is rarely mentioned. For example, the two countries with the largest burden of child pneumonia deaths—Nigeria and India—do not prioritize pneumonia in national health budgets although they contain many references to other leading infectious killers including malaria, HIV/AIDS, tuberculosis, and hepatitis. [52]

The high out-of-pocket costs that many LMIC households pay to treat children with pneumonia are a reflection of the very low levels of government spending on pneumonia prevention, diagnosis, and treatment. Studies have shown that these households incur considerable, and often catastrophic, costs for pneumonia treatment especially when hospital care for a sick child is involved.[53] For example, in Bangladesh 42% of households borrowed money and 11% mortgaged or sold household assets to pay for hospital care for a child with pneumonia.[54] In Ethiopia an estimated 11% of pneumonia cases were considered "catastrophic" in their effect on household budgets.[55] A Pakistan study found that families with children hospitalized with pneumonia spent 40% of their annual expenditure on health for treatment of a single episode of severe pneumonia.[56] And recent analysis from Nepal showed that the average cost per episode of child pneumonia was $US177 and that 39% of the poorest households experienced financial catastrophe as a result. [57]

The movement to introduce UHC is a major opportunity to better align national health spending with national burden of disease, to increase government spending on pneumonia, and to reduce out-of-pocket costs. Specific allocations in government health budgets for the prevention, diagnosis, and treatment of pneumonia, especially in the high-burden pneumonia countries, would not only accelerate achievement of health goals but would alleviate a significant cause of household poverty—the catastrophic healthcare costs associated with sick children and other family members. [58]

In the absence of adequate national spending to reduce pneumonia deaths, many LMICs have relied on international development assistance from two sources—Official Development Assistance (ODA) from high-income countries and multilateral organizations together with philanthropic support from private funders including the Bill & Melinda Gates Foundation (BMGF).[59] Between 2007 and

Chart 29: Most development assistance for pneumonia has supported vaccine introduction



Source: Development Initiatives, based on Organisation for Economic Cooperation and Development (OECD) Creditor Reporting System (CRS) 2020

52 Federal Republic of Nigeria, Health Appropriations, 2016 and India National Health Plan, 2017.
53 Zhang, S. et al., 2016. Cost of management of severe pneumonia in young children: systematic analysis. Journal of Global Health, 6(1). Available at: http://dx.doi.org/10.7189/jogh.06.010408.
54 Sultana, M. et al., 2017. Economic Burden Of Household For Treating Severe Pneumonia Among Under Five Chil-dren In Bangladesh. Value in Health, 20(9), p.A498. Available at: http://dx.doi.org/10.1016/j.jval.2017.08.566.
55 Memirie, S.T. et al., 2017. Household expenditures on pneumonia and diarrhoea treatment in Ethiopia: a facility-based study. BMJ Global Health, 2(1), p.e000166. Available at: http://dx.doi.org/10.1136/bmjgh-2016-000166.
56 Sadruddin, S. et al., 2012. Household Costs for Treatment of Severe Pneumonia in Pakistan. The American Journal of Tropical Medicine and Hygiene, 87(5_Suppl), pp.137–143. Available at: http://dx.doi.org/10.4269/ajtmh.2012.12-0242.
57 Garcia, C., 2020. Estimating the costs of pneumococcal disease and the potential for PCV to prevent these costs. Preliminary Results: a Significant Cost to Nepal, (unpublished). Available at: https://pneumonepal.org/the-studies/assessment-of-economic-impact/.
58 Verguet, S. et al., 2016. Health Gains and Financial Risk Protection Afforded by Treatment and Prevention of Diar-rhea and Pneumonia in Ethiopia: An Extended Cost-Effectiveness Analysis. Disease Control Priorities, Third Edition (Volume 2): Reproductive, Maternal, Newborn, and Child Health, pp.345–361. Available at: http://dx.doi.org/10.1596/978-1-4648-0348-2_ch19.
59 Together, ODA and BMGF financing is described as "international development assistance" throughout this report.

2018, international development assistance for pneumonia increased from $US140 million to $US494 million, totaling $US7.1 billion over the period. $US6.5 billion was in the form of ODA and $US626 million was philanthropic giving, according to analysis conducted by Development Initiatives.[60] International development assistance to pneumonia has fallen in recent years since reaching its peak of $US1 billion in 2015.

More than 96% of international development assistance for pneumonia from 2007 to 2018 was to finance pneumonia-fighting vaccines in low-resource settings, especially the PCV and Hib vaccines. Non-vaccine assistance represented just 3.9% of all international development assistance for pneumonia over this period. Spending on the PCV rose from $US18 million in 2007, peaking in 2015 at $US641 million and falling to $US406 million in 2018 (Chart 29). Financing for the PCV was boosted in 2009 when the governments of Italy, the UK, Russia, Canada, Norway, and the BMGF pledged $US1.5 billion to procure the vaccine through a financing mechanism called the Advanced Market Commitment (AMC). The AMC has accelerated PCV development and manufacturing at affordable prices for low-resource countries and by the end of 2018, 59 countries, 80% of those eligible, had introduce the PCV with Gavi support, reaching 183 million children. However, even with this support, 52% of the world's children are still missing out on the PCV as many zero-dose and low-dose PCV children live in low-coverage, Gavi-eligible countries (e.g., Nigeria and India) and in large population, non-Gavi eligible countries (e.g., China and Egypt). There are an estimated 430 million children under 15 living in countries with zero coverage of the PCV vaccine.[61]

Most pneumonia-related development assistance is provided by a small group of governments, including the UK, Canada, Australia, the USA, and Norway. Most private support is provided by the BMGF and a small group of foundations including the Children's Investment Fund Foundation, "la Caixa" Foundation, Comic Relief, and others. Due to the focus on vaccine spending, the majority of these donors channel their pneumonia support through Gavi. Between 2007 and 2018, more than 85% of pneumonia assistance flowed to countries through Gavi. Other channels included United Nations agencies (principally UNICEF), large international non-government organizations including PATH Vaccine Solutions, Population

60 See Note (c) for an explanation of Development Initiatives methodology.
61 JustActions, 2019. Zero-Dose PCV Children: dangerously exposed to pneumonia. Available at: http://justactions.org/campaign/zero-dose-pcv-children-dangerously-exposed-to-pneumonia/.

Table 4: Most of the top 20 recipients of development assistance for pneumonia are in Sub-Saharan Africa

2007-18, at constant 2019 prices ($US million)

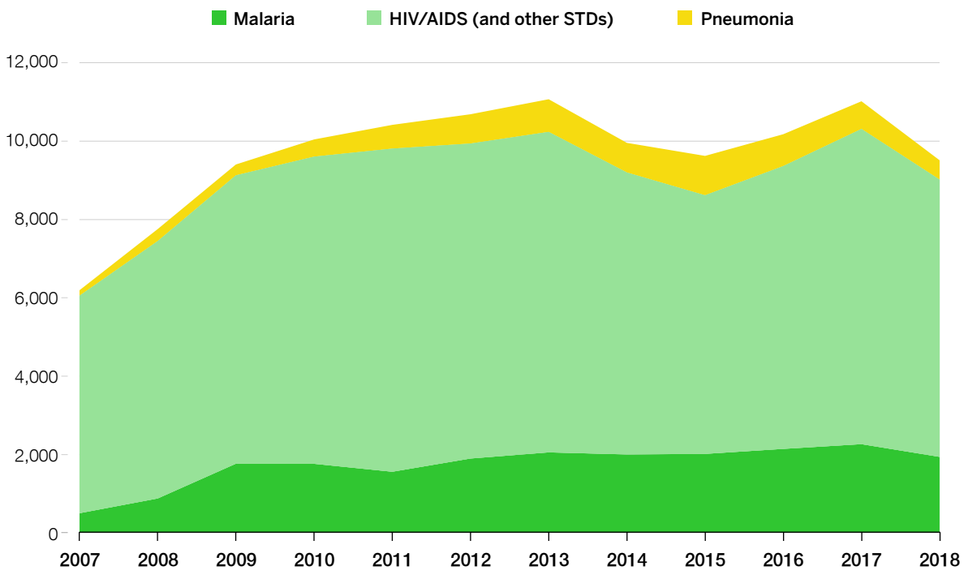
Each square is $US10 million

$734M Pakistan	**$507M** Ethiopia	**$402M** DRCongo	**$387M** Bangladesh
$387M India	**$374M** Nigeria	**$277M** Kenya	**$254M** Tanzania
$201M Afghanistan	**$199M** Uganda	**$177M** Sudan	**$148M** Mozambique
$144M Malawi	**$141M** Yemen	**$133M** Ghana	**$124M** Cameroon
$120M Mali	**$119M** Madagascar	**$106M** Burkina Faso	**$97M** Niger

Source: Development Initiatives, based on Organisation for Economic Cooperation and Development (OECD) Creditor Reporting System (CRS) 2020

Chart 30: Development assistance for pneumonia is well below other leading infectious diseases

$US millions, constant 2019 prices



Source: Development Initiatives, based on Organisation for Economic Cooperation and Development (OECD) Creditor Reporting System (CRS) 2020

Services International (PSI), and others as well as universities including Johns Hopkins University in the USA, the Murdoch Children's Research Institute in Australia, and others.

The regions and countries where child pneumonia deaths are concentrated received the majority of pneumonia-related international development assistance. Between 2007 and 2018 just under a third (32%) was disbursed to the Asia region, the vast majority to South and Central Asian countries. The share to Asia increased from 6% in 2007 to a high of 39% in 2017 before falling to 33% in 2018. The share to Africa fell from 72% to 54% over the period. 57% of philanthropic giving to pneumonia was spent in the "unspecified" region due in large part to pneumonia research funding from the BMGF to institutions based in donor countries. That proportion also grew over the period from 8% in 2008 to 12% in 2018, although it has varied significantly over the years from a high of 17% in 2009 to a low of 3% in 2014.

Most of the 20 largest national recipients of international development assistance for pneumonia from 2007 to 2018 are high-burden pneumonia countries losing more than 3,000 children each year. Nine of the ten countries with the largest numbers of child pneumonia deaths (Nigeria, India, Pakistan, Ethiopia, Niger, Tanzania, Burkina Faso, the Democratic Republic of Congo, and Afghanistan) are among the top ten recipients. Somalia was the exception.

Pakistan is the largest recipient and received 1.4 times as much as the next largest recipient (Ethiopia)—$US734 million compared to $US507 million over the period (Table 4). In addition to Somalia, high-burden pneumonia countries not among the top twenty recipients of international development assistance for pneumonia include China, Chad, the Philippines, Indonesia, Côte d'Ivoire, Guinea, Myanmar, Egypt, Angola, South Sudan, Benin, Papua New Guinea, Zimbabwe, Sierra Leone, South Africa, Zambia, Nepal, Cambodia, Central African Republic, and Haiti. The only countries on the list that are not high-burden pneumonia countries are Sudan and Yemen.

Although pneumonia-related international development assistance has been critical to the introduction of both the PCV and the Hib vaccine in many high-burden countries, the low levels allocated to pneumonia diagnosis and treatment are very concerning in the context of the wide coverage gaps that exist. Just 3.9% ($US275 million) of pneumonia-related support was spent on non-vaccine activities, including diagnosis and treatment support, between 2007 and 2018, according to Development Initiatives. This is one of the reasons so many LMICs have been so unprepared to respond to a pandemic of respiratory infections where effective diagnosis and treatment, especially with oxygen, have been the only way to reduce deaths while they wait for vaccines.

Further, the overall levels of support allocated to pneumonia pale in comparison to other leading infectious killers and relative to pneumonia's heavy disease burden. For example, between 2007 and 2018 international development assistance for HIV/AIDS[62] and malaria was US$US88 billion and $US20.7 billion respectively, while just $US7.1 billion was targeted to pneumonia. Of the total $US115.9 billion, HIV/AIDS received 76%, malaria 18%, and pneumonia 6% (Chart 30). While the share disbursed to pneumonia increased from 2% in 2007 to 5% in 2018, it fell from a high of 10% in 2015. These vastly different amounts were not well aligned with disease burden as in 2019 HIV/AIDS caused 11% of all infectious disease deaths, malaria caused 8%, and pneumonia caused 32% according to the GBD.[63] Even tuberculosis caused far fewer deaths than pneumonia—15% of all infectious disease deaths. A better alignment between both ODA and private investments for health and disease burden would not only improve health outcomes, but also the cost-effectiveness of increasingly scarce resource allocation.

5%

Pneumonia's share of international development assistance for leading infectious diseases despite causing 32% of infectious disease deaths

62 And other STDs.
63 See also the Institute for Health Metrics and Evaluation (IHME), Pushing the Pace: Progress and Challenges in Fighting Child Pneumonia, 2014. Available at: http://www.healthdata.org/policy-report/pushing-pace-progress-and-challenges-fighting-childhood-pneumonia.

THE STORY SO FAR...

Current levels of investment in pneumonia by both national governments and international development agencies are inadequate for the rapid reductions in pneumonia deaths required to respond effectively to COVID-19 and achieve the SDGs. Despite significant growth in vaccine financing, especially for the PCV and the Hib vaccine in Gavi-eligible countries, wide gaps in vaccine coverage remain across countries. Of special concern are the very low levels of domestic spending and international development assistance spent on improving pneumonia diagnosis and treatment. In the absence of government financing and external support, the burden continues to fall on households who pay very high out-of-pocket costs to care for sick family members and especially children with pneumonia. The introduction of UHC is a major opportunity to correct the historically low levels of government spending on pneumonia prevention, diagnosis, and treatment. Where health insurance fully covers the costs of vaccination, diagnosis, and treatment for the most vulnerable children and adults, major health gains can be made. For the countries who will still need external support to finance pneumonia control, the more closely aligned ODA and private investments are with national disease burdens, the more cost-effectively they will contribute to country efforts to improve population health and minimize the risks of another respiratory infection pandemic causing mass fatalities.

NEW DEVELOPMENTS

Pulse Oximetry & Oxygen

By measuring levels of oxygen saturation in the blood, pulse oximetry is the gateway to safe and effective oxygen use for all populations. Although COVID-19 has tested the capacity of hospitals in high-income countries to provide oxygen, deaths due to lack of oxygen in these settings are rare. In contrast, even prior to the pandemic, deaths due to lack of oxygen were common across low- and middle-income countries (LMICs) and the pandemic has exacerbated a crisis that already existed. Provision of pulse oximeters and medical oxygen has become an urgent priority across LMICs.

Although international agencies including the World Health Organization (WHO), UNICEF, and the World Bank, and donor governments and NGOs have provided tens of thousands of pulse oximeters, oxygen concentrators, and ventilators to LMICs during the pandemic, wide gaps in access remain. The daily COVID-19-related need for oxygen across all LMICs is above 10 million cubic meters or 1.5 million large cylinders, according to the **COVID-19 Oxygen Needs Tracker**. The oxygen needs of other populations, including newborns, children, women in childbirth, as well as patients suffering from communicable and non-communicable diseases and accident and injury victims add considerably to this total in many countries.

Meeting all of the pulse oximetry and oxygen needs of LMIC health systems will require large-scale capital investments in medical oxygen infrastructure and human capital investments to train healthcare workers and biomedical engineers to install, operate, and maintain the equipment. Pulse oximetry should be made available as a routine screening tool at the primary healthcare level and in all hospitals, where all babies should be screened after birth. Oxygen should be routinely available in all hospitals and even in lower-level healthcare facilities in rural and remote regions. Mobile oxygen solutions will also be needed to ensure that patients who need oxygen don't die in transit to higher-level health facilities. Recent studies have demonstrated both the power of pulse oximetry and medical oxygen to save lives.

National governments must prioritize investments in pulse oximetry and oxygen and international agencies should invest more to support them, during the pandemic and beyond. Unitaid is already supporting pulse oximetry access in seven countries via the **Tools for Integrated Management of Childhood Illness** (TIMCI) project with PATH in Myanmar, Senegal, Tanzania, and the Indian state of Uttar Pradesh (UP), and also the Improving the **Identification of Respiratory Distress in Children** (AIRE) project with ALIMA in Burkina Faso, Guinea, Mali, and Niger. They are also financing oxygen innovation through the UnitaidExplore grants. WHO, UNICEF, and USAID are supporting several LMICs to install oxygen plants co-located with hospitals and the UK is supporting an Oxygen CoLab to improve the impact of oxygen concentrators. But more is needed. International health and development agencies must provide more support to LMICs to increase access to pulse oximetry and medical oxygen as part of the **Access to COVID-19 Tools Accelerator** (ACT-A) and work in partnership with industry just as they are doing for vaccines, diagnostics, and other therapeutics.

LEARN MORE:

PATH, Clinton Health Access Initiative (CHAI) and the Every Breath Counts Coalition, 2020. The COVID-19 Oxygen Needs Tracker. Available at: https://www.path.org/programs/market-dynamics/covid-19-oxygen-needs-tracker/.

Unitaid, 2019. The Tools for Integrated Management of Childhood Illness (TIMCI) project with PATH and the Identification of Respiratory Distress in Children (AIRE) project with ALIMA. Available at: https://unitaid.org/news-blog/new-projects-aim-to-better-identify-critically-ill-children/#en.

Unitaid, 2020. UnitaidExplore Grants to Vayu Global Health Innovations and Essential Tech. Available at: https://unitaid.org/news-blog/unitaidexplore-innovations-to-increase-access-to-oxygen-therapy/#en.

6

WHERE WILL FUTURE BREAKTHROUGHS COME FROM?

The development of breakthrough technologies that improve the quality and cost-effectiveness of pneumonia prevention, diagnosis, and treatment would hasten the achievement of health goals and improve pandemic preparedness as another respiratory pandemic is likely. However, the level of infectious disease research spending on pneumonia is low. Between 2000 and 2017, pneumonia received just $US3.5 billion (3%) of the $US105 billion that public and philanthropic funders in the G20 countries invested in infectious disease research according to analysis conducted by the Research Investments in Global Health (ResIn) study.[64] HIV/AIDS, tuberculosis, malaria, and influenza all received more investment.

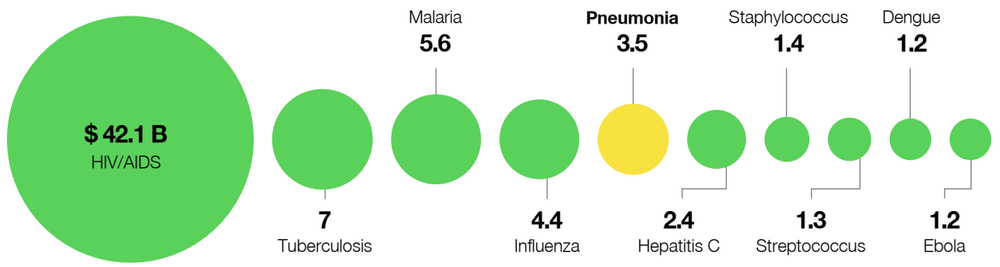
The authors noted that while viral respiratory infections are known to be one of the most likely causes of a pandemic and are already the cause of high mortality in young children and older people, pneumonia attracted "pitifully low levels of funding" relative to other infectious diseases (Chart 31). Further, based on funding relative to disease burden, pneumonia received just $US33 per DALY compared to $US772 for HIV/AIDS, $US156 for tuberculosis, and $US125 malaria. The authors observed a very weak positive correlation (r=0.30) between infectious disease research investment and disease burden.

According to the ResIn analysis, pneumonia research did increase between 2000 and 2017, from $US67 million to $US484 million, driven by strong growth in research on pneumonia vaccines and treatments. In fact, the majority of the $US3.5 billion invested in pneumonia research over the entire 18 year period was allocated to vaccine research ($US858 million) followed by treatment ($US839 million). In contrast, diagnostics received just $US164 million over the period.

An earlier ResIn analysis of the sources of pneumonia research funding between 2000 and 2015 found just three funders provided most of the funding over the period. The Innovative Medicines Initiative (IMI) and other projects from the European Commission provided $US635 million, mostly for research into therapeutics including two large trials of treatments for Staphylococcus aureus and Pseudomonas aeruginosa infections in 2013 and 2015 respectively. These trials cost $US523 million or 17% of all pneumonia research funding between 2000 and 2015. The Bill & Melinda Gates Foundation (BMGF) provided $US625 million over the period, including $US545 million for vaccine research. And the USA National Institutes of Health (NIH) provided $US383 million, mostly for vaccine and therapeutics research.[65] In contrast, very little was spent on pneumonia diagnostics research. The NIH spent $US54 million followed closely by the European Commission ($US43 million), and the BMGF ($US39 million).

Chart 31: Pneumonia receives less research funding than other infectious diseases

$US billions, 2000-2017



Source: Research Investments in Global Health 2020

64 Head, M.G. et al., 2020. The allocation of US$105 billion in global funding from G20 countries for infectious dis-ease research between 2000 and 2017: a content analysis of investments. The Lancet Global Health, 8(10), pp.e1295–e1304. Available at: http://dx.doi.org/10.1016/s2214-109x(20)30357-0.

65 Research Investments in Global Health Study (ResIn). Sizing Up Pneumonia Research: Assessing Global Invest-ments in Pneumonia Research 2000-2015. Southampton, UK: ResIn, 2018.

Of concern, just 8% of pneumonia research ($US258 million) over the period was focused on LMICs, mostly in Sub-Saharan Africa (60%) and South Asia (40%). High-burden child pneumonia countries were the focus of more than one-half of this investment, especially India, Nigeria, Pakistan, Ethiopia, South Africa, Kenya, the Democratic Republic of Congo, and Tanzania. Other African nations with leading research facilities, especially The Gambia and Uganda, also received funds. In fact, The Gambia received more pneumonia research funding than any other Sub-Saharan African country. The LMIC high-burden pneumonia countries that did not receive significant pneumonia research funding included Bangladesh, Indonesia, and the Philippines.

Approximately $US1.04 billion of pneumonia research between 2000 and 2015 was targeted to pediatric research, the majority funded by the BMGF. Funding for this age-group increased from $US1 million in 2000 to $US370 million in 2015, representing 76% of all pneumonia research in that year. In contrast, just 1.4% ($US43 million) of pneumonia research over the period was allocated to research relating to the elderly. It is important to note that the majority of pneumonia research ($US1.9 billion) was not targeted to any specific age-group and that much of this research had the potential to benefit all age groups. However, with rising burdens of pneumonia among the elderly in most countries, and recent experience with COVID-19 which disproportionately affects older adults, it will be increasingly important that more infectious research dollars are allocated to this population.

Despite the rise in pneumonia research funding, the current levels of investment, the small number of funders contributing significant funds, and the tiny proportions targeted to the most vulnerable populations are a major concern. Investments are needed that are commensurate with pneumonia's infectious disease burden—32% of all communicable disease deaths according to the GBD—specifically in the areas where breakthroughs could save the most lives.[66] Critical research topics include how specific risk factors (child wasting, air pollution,[67] low birth weight birth, etc.) impact pneumonia deaths, why careseeking is still so low in so many settings, which risk factors are the strongest predictors of death in children and the elderly, how to most cost-effectively diagnose pneumonia and deliver treatments (e.g., pulse oximetry, antibiotics, oxygen, and therapeutic foods) in both community and hospital settings, and how to reengineer the delivery of vaccines, diagnostics, and medicines to reduce the costs of prevention and care. Several trials are currently underway that will advance understanding on some of these questions,[68] but the vast majority are not currently the subject of adequate research. And now that the world has witnessed the devastating impact of a global respiratory infection pandemic, research into both preventing future pandemics and improving the response should we fail to do so has become an urgent infectious disease research priority.

Another issue that has been consistently raised is the need to better understand the role of co-morbidities as risk factors for pneumonia death. It is well known that malnutrition significantly increases the risk of death from pneumonia, especially among children, and studies have shown the prevalence of multiple pathogens (viral and bacterial) in children who die from pneumonia in hospital settings, but the interplay of these conditions and pathogens is not well understood.[69] The presence of chronic diseases, as well as neurological conditions, in pneumonia deaths among the elderly also warrants more attention. The knowledge generated by a serious effort to advance understanding on all of these areas is needed to inform the next generation of technologies that will enable governments to make faster progress towards reducing the heavy burden of pneumonia deaths.

66 Rudan, I. et al., 2011. Setting Research Priorities to Reduce Global Mortality from Childhood Pneumonia by 2015. PLoS Medicine, 8(9), p.e1001099. Available at: http://dx.doi.org/10.1371/journal.pmed.1001099.

67 A recent study found that outdoor air pollution contributed to 22% of child deaths in Africa. See Heft-Neal, S. et al., 2018. Robust relationship between air quality and infant mortality in Africa. Nature, 559(7713), pp.254–258. Availa-ble at: http://dx.doi.org/10.1038/s41586-018-0263-3.

68 See the Household Air Pollution and Health: A Multi-country LPG Intervention Trial (HAPIN), supported by the NIH, the Bill & Melinda Gates Foundation, the Global Alliance for Clean Cookstoves (GACC), and the Global Alliance for Chronic Diseases (GACD); and the Enhanced Management of Pneumonia in the Community (EMPIC) trials led by the WHO in Bangladesh, Ethiopia, India, and Malawi. The trials are testing the benefits of an "enhanced" approach to community case management for pneumonia and the use of pulse oximetry by community health workers.

69 Mulholland, K., 2005. Commentary: Comorbidity as a factor in child health and child survival in developing coun-tries. International Journal of Epidemiology, 34(2), pp.375–377. Available at: http://dx.doi.org/10.1093/ije/dyi028.

3%

Share of infectious disease research funding allocated to pneumonia between 2000 and 2017

THE STORY SO FAR...

Current levels of pneumonia research spending, the number of funders and the proportion targeted to the most vulnerable populations in the high-burden countries are inadequate to answer the major research questions and drive the next wave of technological innovation. Levels of research allocated to pneumonia are very low relative to pneumonia's disease burden and to the levels spent on other infectious diseases. Just 3% of infectious disease research spending was allocated to pneumonia between 2000 and 2017, despite pneumonia causing almost one-third of all infectious disease deaths over this period, and this does not include COVID-19 mortality. This lack of investment has contributed to both the slow pace of technological innovation in pneumonia interventions, to the slower rate of decline in pneumonia deaths, and to the lack of preparedness to respond to a viral respiratory pandemic. Major research questions remain, relating to risk factors—including co-morbidities—careseeking, service intervention coverage and service delivery. Without greater research investment, the technologies needed to increase the effectiveness and reduce the costs of pneumonia prevention and care are not keeping pace with the rising burden in an era where we can expect future respiratory pandemics and rising climate change induced air pollution and temperature-related deaths. More research funding, more funders and a greater focus on vulnerable populations are needed to develop the next generation of pneumonia-fighting tools. Strategies to support the rapid introduction and sustained high use of new technologies in the high-burden populations will be critically important.

NEW DEVELOPMENTS

Pneumonia Financing

Pneumonia control is a highly cost-effective investment for governments seeking to improve health and health equity. Due to the very large populations affected by pneumonia, including from COVID-19, the existence of effective vaccines and treatments and the wide gaps in coverage, investments in pneumonia can prevent many deaths at relatively low cost. But few low- and middle-income governments adequately finance pneumonia control, and beyond vaccine support from GAVI, the Vaccine Alliance, few global health agencies provide support to help countries protect their populations from pneumonia. This lack of investment in pneumonia control is one of the reasons so many low- and middle-income countries (LMICS) have been so unprepared to respond effectively to COVID-19.

All national governments need to finance pneumonia control and introduce specific policies, plans and programs to reduce all-cause pneumonia deaths and protect populations against future respiratory pandemics. As part of universal health coverage (UHC), all governments should set aside a specific portion of national health budgets for pneumonia control and ministries of health should finance vaccination, diagnosis and treatment services as well as efforts to reduce the major risk factors for pneumonia within their borders. Currently, in most LMICS, it is families who shoulder the burden of pneumonia control in the high out-of-pocket costs they incur every time they seek care. These costs are very high, and recent studies in Nepal by the **PneumoNepal Project** have demonstrated their catastrophic impact on families.

International health and development agencies should supplement national pneumonia control strategies where needed, in the spirit of the **Global Action Plan for Healthy Lives and Wellbeing**, signed by twelve global health agencies in 2019. GAVI should continue to support eligible countries to increase coverage of the pneumonia-fighting vaccines, including the new COVID-19 vaccines through the COVAX facility. In the absence of a specific global health agency with the responsibility for pneumonia diagnosis and treatment, existing global health agencies must fill the gaps. Unitaid should lead on the development of better diagnostic tests, including pulse oximetry, the Global Fund should help countries ensure access to diagnosis and treatment for pneumonia, integrated with HIV/AIDS, tuberculosis and malaria services, and including the financing of recommended antibiotics. The World Bank is well-placed to support governments to finance oxygen infrastructure and the Global Financing Facility (GFF) has a role to play in coordinating and incentivizing this level of integration.

The **Access to COVID-19 Tools Accelerator**, the global effort to raise funds to support an effective pandemic response, is another opportunity to the diagnostics "pillar" of the accelerator should prioritize efforts to develop better diagnostic tools for respiratory infections, including pulse oximetry, and the therapeutics pillars should support oxygen. The very wide gaps in oxygen coverage across LMICS are contributing to higher COVID-19 case fatality and while these countries wait for the COVID-19 vaccines, oxygen is the one therapy available to keep very sick patients alive.

LEARN MORE:

ACT-Accelerator: An Economic Investment Case & Financing Requirements, September 2020 – December 2021 and ACT-Accelerator Commitment Tracker. Available at:

World Health Organization (WHO), 2019. Stronger Collaboration, Better Health. Global Action Plan for Healthy Lives and Well-being for All. Strengthening collaboration Among Multilateral Organizations to Accelerate Country Progress on the Health-Related Sustainable Development Goals. Available at: https://www.who.int/publications/i/item/9789241516433.

Patan Academy of Health Sciences, the University of Oxford, International Vaccine Access Center, Johns Hopkins Bloomberg School of Public Health and the University of Otago, 2020. The Pneumo Nepal Project: Investigating Pneumonia, Pneumococcal Disease, and Vaccine Impact in Nepal. Available at: https://pneumonepal.org/.

7

WHAT DOES SUCCESS IN THE FIGHT AGAINST PNEUMONIA LOOK LIKE?

Ultimate success in the fight against pneumonia will be achieved when child pneumonia deaths have fallen well below three per 1,000 births in every country, where pneumonia is a tiny proportion of overall infectious disease deaths across all age groups, and where the risk of another respiratory infection pandemic is extremely low. This will not be achievable by 2030 without dramatic improvements in vaccination, diagnosis, and treatment coverage as well as reductions in the leading risk factors for pneumonia, especially in the countries with large populations of vulnerable children and adults, and where COVID-19 has caused major increases in deaths from respiratory infection.

The key to success is to fully protect vulnerable populations with the pneumonia-fighting vaccines and to ensure routine access to the most effective diagnostic tools, including pulse oximetry, and treatments, including oxygen, recommended antibiotics, and therapeutic foods when needed. Specifically, countries should be aiming for above 90% coverage of the PCV, Hib, measles, and influenza vaccines and the COVID-19 and RSV vaccines when available, paying particular attention to high coverage among the children and adults at greatest risk of death from all-cause pneumonia. Striving for 100% pneumonia careseeking rates by families, routine access to new diagnostic tools including pulse oximetry and recommended antibiotics at the primary healthcare and hospital levels, and adequate provision of medical oxygen in 100% of hospitals are also critical targets.

Further, countries should be working to reduce the major risk factors for pneumonia death, by significantly reducing child wasting, low birth weight and preterm birth rates, and exposure to air pollution, especially by increasing the use of clean cooking fuels and technologies and reducing the many causes of outdoor air pollution. Setting ambitious national targets for reducing tobacco smoking and controlling elderly population exposure to climate change-induced temperature extremes will also help reduce pneumonia deaths across the life course.

Achieving pneumonia control will require a new approach to the financing of pneumonia prevention, diagnosis, and treatment. UHC is

90%

Target coverage rates for pneumonia-fighting vaccines, diagnosis, and treatment services as part of UHC

Table 5: Regional leaders in child pneumonia mortality reduction, 2000-2019

Countries	% decline in child pneumonia deaths (2000-2019)	% children wasted 0-4 years (latest)	% households access to clean fuels for cooking (latest)	% children PCV coverage 3 doses (2019)	% children Hib vaccine coverage 3 doses (2019)	% children measles vaccine coverage 2 doses (2019)	% children with pneumonia taken for care (latest)
China	89%	2%	59%	No data	No data	98%	80%
Rwanda	70%	2%	57%	98%	98%	92%	54%
Bangladesh	81%	8%	18%	97%	98%	95%	42%
Peru	78%	0.05%	75%	80%	88%	66%	62%
Turkey	94%	2%	No data	97%	99%	88%	87%
Iran	87%	4%	98%	No data	99%	98%	76%

Sources: Global Burden of Disease 2019, World Health Organization (WHO), UNICEF, World Bank, latest

a major opportunity to provide a package of pneumonia prevention, diagnosis, and treatment services and to ensure that the children and adult populations most at risk of death are fully covered for the cost of these services. Because investments in pneumonia control strengthen the way health systems work for children and the elderly, they not only benefit all-cause child mortality and prolong lifespans, but improve equity in the health system by targeting two of the populations most vulnerable to sickness and death. In this way, the rate of pneumonia mortality reduction is an indicator of a quality health system that is also delivering on equity.

Countries that require additional support to provide this level of pneumonia control should work in partnership with international health and development agencies, including the Access to COVID-19 Tools Accelerator (ACT-A), which is supporting the COVID-19 response in LMICs, and the 12 multilateral health, development, and humanitarian agencies that signed the Global Action Plan for Healthy Lives and Wellbeing to better align their ways of working, to reduce inefficiencies, and to provide more streamlined support to countries.[70] These agencies are already demonstrating new levels of collaboration to fill gaps in health services in Mali, Pakistan, Somalia, Ghana, and Cote d'Ivoire.[71] The ACT-A is helping LMICs gain access to COVID-19 vaccines, personal protective equipment (PPE), as well as diagnostic tests and medicines like dexamethasone. More recently the ACT-A is helping LMICs increase access to pulse oximetry and oxygen, two vital tools desperately needed to keep very sick COVID-19 patients alive. Investments in both will not just reduce COVID-19 deaths, but deaths from other causes of pneumonia as well and also many other causes among children and adults enabling countries to make faster progress to the achievement of many of the health SDGs.

LMICs should also engage the Every Breath Counts Coalition in their national pneumonia control efforts as the coalition now includes 50

70 World Health Organization (WHO), Gavi, the GFF, Global Fund, UNAIDS, UNDP, UNFPA, UNICEF, Unitaid, UN Women, WFP, World Bank, 2019. Global Action Plan for Healthy Lives and Wellbeing World Health Organization (WHO), 2019. Stronger Collaboration, Better Health. Global Action Plan for Healthy Lives and Well-being for All. Strengthening collaboration among multilateral organizations to accelerate country progress on the health-related Sustainable Development Goals. Available at: https://www.who.int/publications/i/item/9789241516433.

71 World Health Organization (WHO), 2020. Stronger Collaboration, 2020 progress report on the Global Action Plan for Healthy Lives and Well-being for All. Geneva. Available at: https://www.who.int/publications/i/item/9789240010277.

organizations that have joined forces to support governments to reduce pneumonia deaths, including from COVID-19, by 2030. The Coalition is working with governments to identify the most critical gaps in the prevention, diagnosis, and treatment of pneumonia, to develop national strategies to close those gaps by investing in the most cost-effective interventions, and to mobilize partners to support the implementation of the strategy. The Coalition also advocates for national adoption of best practice pneumonia prevention, diagnosis, and treatment indicators and their inclusion in national pneumonia control strategies. Coalition members are also working on the development of an agreed set of pneumonia indicators that will allow governments to consistently measure and report progress on pneumonia mortality reduction. Specific working groups on air pollution, child nutrition and research focus on reducing the major risk factors for pneumonia death and on increasing funding for an agreed set of pneumonia research priorities.

Success is possible. In each region of the world where LMICs cluster there are countries that have reduced child pneumonia deaths by more than 70% since 2000, achieving the GAPPD target of less than three child pneumonia deaths per 1,000 live births well before the 2025 deadline. These countries are very different in many ways, but share three key achievements. First, they have all been able to sustain high rates of coverage of the pneumonia-fighting vaccines, with the exception of China, which is yet to introduce the PCV and Hib vaccines into the national vaccination scheme. Second, all have reduced child malnutrition, and particularly child wasting, to relatively low levels, with the exception of Bangladesh which still has a long way to go. Third, all have made improvements in ensuring households have access to clean energy for cooking and heating, with the exception of Bangladesh (Table 5). Further, all of these countries have achieved relatively high rates of adult female literacy (above 70%),[72] and all score above regional averages on the UHC Service Coverage Index, except Bangladesh.

It is important to note that all of these countries have experienced large burdens of COVID-19 deaths, which will dramatically increase the number of respiratory infection deaths in 2020. To maintain their strong performance, these countries will need to ensure that routine pneumonia prevention, diagnosis, and treatment services for children are maintained throughout the pandemic and that the new support provided for adult COVID-19 patients (e.g., pulse oximetry, oxygen, etc.) also benefits children. It will be especially important for countries with large burdens of COVID-19 mortality and child pneumonia deaths from other causes to develop and implement national pneumonia control strategies that address both populations.

72 UNESCO Institute for Statistics, 2019. Available at uis.unesco.org.

NEW DEVELOPMENTS

Pneumonia Control

Governments seeking to reduce pneumonia deaths, including from COVID-19, to the levels required to achieve the health-related Sustainable Development Goals (SDGs) should implement national pneumonia control strategies. These strategies should determine the number of pneumonia deaths that need to be prevented by 2030 and identify the most-affected populations, the deadliest risk factors, and major causes of death. They should adopt annual mortality reduction and service coverage targets and determine baseline levels of coverage of the pneumonia-fighting vaccines, diagnostic, and treatment services. Tools like the Global and Local Burden of Disease data from the Institute for Health Metrics and Evaluation (IHME) and the Lives Saved Tool (LiST) from the Johns Hopkins Bloomberg School of Public Health (JHBSPH) are critical resources for governments in the development of pneumonia control strategies.

Pneumonia control strategies should be nested within broader national health and pandemic preparedness plans, and implemented as part of integrated health services for both children and adults at both the community and hospital levels. Pneumonia control is also a critical part of health plans to provide quality care to aging populations—a major issue for many countries. As reductions in child malnutrition, exposure to air pollution, low birth weight, tobacco smoking and temperature extremes are all critical factors in reducing the risk of death from pneumonia, the nutrition, environment, newborn, and non-communicable disease communities must all be engaged in the development and implementation of effective pneumonia control.

Pneumonia control strategies should be financed as part of national efforts to achieve Universal Health Coverage (UHC). Where some LMIC governments require external support to help finance pneumonia control, the major international health and development agencies should assist, with Gavi providing vaccine support, and the Global Fund, Unitaid, the World Bank and the Global Financing Facility (GFF) helping with improved access to diagnostic and treatment services. United Nations agencies, including the WHO, UNICEF, the United Nations Environment Program (UNEP), and the World Food Programme (WFP) should continue to provide assistance to countries to improve access to nutritious food and clean air, reduce tobacco smoking, and mitigate climate-related temperature extremes.

There are promising developments. Prior to the pandemic, the Government of Nigeria released the world's first **National Integrated Pneumonia Control Strategy & Implementation Plan** as part of its national child survival agenda and its pioneering effort to increase access to pulse oximetry and oxygen. Many more LMICs committed to developing national pneumonia control strategies by signing the G**lobal Forum on Childhood Pneumonia Declaration**. And the COVID-19 pandemic has required that all governments develop pandemic response plans that address many of the actions needed for effective pneumonia control. After the pandemic, these strategies and plans could be expanded to address longer-term pneumonia control for all populations. The Government of Ethiopia has already released a plan to redeploy the pulse oximetry and oxygen therapies received for COVID-19 patients throughout the healthcare system—**Leveraging COVID-19 Equipment Investments for Longterm Improvements**.

Now that COVID-19 has underscored what is needed to protect populations from respiratory infections and reduce case-fatality rates, governments and global health agencies are well-positioned and highly-motivated to develop and implement pneumonia control strategies. There needs to be a global effort to reshape national COVID-19 response plans into long-term pneumonia control strategies that both reduce all-cause pneumonia mortality across all populations and reduce the risk of another respiratory pandemic in the countdown to 2030.

LEARN MORE:

Declaration of the Global Forum on Childhood Pneumonia Barcelona: Spain, 2020. Available at: https://stoppneumonia.org/latest/global-forum/.

Ethiopia Ministry of Health. Leveraging COVID-19 equipment investments for longterm improvements, 2020. Available at: https://stoppneumonia.org/wp-content/uploads/2020/10/Leveraging-COVID-19-Eqmnt-investment_CHAI-Ethiopia-experience_Final-28Se....pdf.

Federal Republic of Nigeria, National Integrated Pneumonia Control Strategy & Implementation Plan, Federal Ministry of Health, 2019 and National Strategy for the Scale-Up of Medical Oxygen in Health Facilities 2017-2022. Federal Ministry of Health. Available at: https://stoppneumonia.org/wp-con-tent/uploads/2020/02/National_Integrated_Pneumonia_Control_Strategy_Implementation_Plan.pdf and https://www.health.gov.ng/doc/National%20Startegy%20for%20Scale-up%20of%20Medical%20Oxygen.pdf.

CALL TO ACTION

COVID-19 AND THE QUEST FOR PNEUMONIA CONTROL

Pneumonia control is achievable and essential if the world is to recover from the pandemic and reduce the risk of another in the decade remaining to achieve the Sustainable Development Goals (SDG) promise of, "ensuring healthy lives and promoting well-being for all at all ages." Ushering in a new era of pneumonia control will require major changes in the way governments, companies, United Nations and multilateral agencies, academic institutions, civil society and all stakeholders committed to achieving the SDGs for health set priorities and work together.

But what specifically must be done to achieve pneumonia mortality targets and reduce the risk of future respiratory pandemics in the next decade?

Five critical changes are required:

1. CONTROL

National governments with the highest burdens of pneumonia deaths, including from COVID-19, should develop pneumonia control strategies by 2022. These strategies should set annual national pneumonia mortality reduction targets for children and adults, and outline a plan for how to achieve these targets by 2030, modeled on a new Global Action Plan for Pneumonia endorsed by the World Health Assembly. The plans would set target coverage rates for the major prevention, diagnosis, and treatment services and also target reduction rates for the major risk factors associated with pneumonia deaths. Pneumonia control strategies would be part of overall national health and pandemic preparedness plans, nested within child survival and adult communicable and non-communicable disease plans. What does success look like? The World Health Assembly adopts a new Global Action Plan for Pneumonia Control in 2022 with new mortality targets across the life course, and all 20 high-burden pneumonia countries have launched pneumonia control strategies incorporating the lessons of the pandemic by 2022 and are publishing progress annually.

2. SUPPORT

National governments should at least fully cover the costs of the pneumonia-fighting vaccines and pneumonia diagnosis and treatment services for the most vulnerable populations of children and adults as part of Universal Health Coverage (UHC). Domestic financing to reduce the major risk factors for pneumonia death—air pollution, child wasting and smoking—should also be increased. Where domestic efforts cannot fully cover the cost of protecting vulnerable populations, external financing from international development agencies should support national efforts, including by targeting the most vulnerable populations. What does success look like? All of the high-burden countries that have UHC by 2030 provide full financial protection for pneumonia prevention, diagnosis, and treatment services for vulnerable populations and international development assistance for pneumonia-related activities is at least 10% of Official Development Assistance (ODA) for health and fully aligned with national pneumonia control efforts by 2025.

3. INNOVATE

National governments, donor governments, and non-government actors should increase investments in pneumonia research by targeting potential breakthroughs in the areas where cost-effective new technologies could prevent the most pneumonia deaths, including rapid diagnostic tests, pulse oximetry and oxygen delivery, and new technologies to reduce air pollution, child wasting, and low birth weight. Organizations fostering innovation in pneumonia should be supported and expanded as part of the overall effort to accelerate the pace and uptake of technological development. What does success look like? At least 20% of infectious disease research is allocated to pneumonia by 2025, with the majority targeted to researchers and institutions based in the high-burden countries and in countries where the emergence of another respiratory pandemic is highest.

4. PARTNER

Governments and non-government actors should work together to achieve pneumonia control as part of overall national efforts to achieve the SDGs and reduce the risk of another respiratory pandemic. National governments should mobilize coalitions from the public and private sectors to drive progress on pneumonia control within their own borders, and the international health and development community should coordinate transnational efforts. These efforts should ensure that pneumonia control is nested within broader child survival, communicable and non-communicable disease, and pandemic preparedness efforts, and aligned with the newborn, nutrition, air pollution, and UHC agendas at national and global levels. What does success look like? Every high-burden country has a network of government and non-government actors working together to achieve pneumonia control as part of broader national efforts to achieve the SDGs and reduce the risk of respiratory infection pandemics.

5. CHAMPION

Pneumonia has been called "a global cause without champions" which "barely registers on the radar of global health priorities."[73] New champions at the local, national, regional, and international levels must emerge, especially from governments, business, and civil society in the high-burden countries. Regular pneumonia summits, led by these new champions, should bring together the prevention, diagnosis, and treatment communities to shine a bright light onto progress (or lack of) to achievement of the agreed pneumonia mortality targets by 2030, to share learnings from the various national pneumonia control and pandemic preparedness efforts underway, and to discuss the latest research findings and breakthrough innovations. What does success look like? Pneumonia summits are held at least bi-annually with strong representation from the high-burden countries, donor governments, United Nations and multilateral agencies, companies, academic institutions, and civil society and from the national and international agencies responsible for pandemic preparedness and response.

73 Watkins, K. & Sridhar, D., 2018. Pneumonia: a global cause without champions. The Lancet, 392(10149), pp.718–719. Available at: http://dx.doi.org/10.1016/s0140-6736(18)31666-0.

Notes A

Global Burden of Disease methodology

The Global Burden of Disease Study (GBD) 2019 uses clinician-diagnosed pneumonia or bronchiolitis as the case definition for lower respiratory infections (LRI). Etiologies include influenza, respiratory syncytial virus (RSV), Haemophilus influenzae type b (Hib), and Streptococcus pneumoniae (pneumococcal pneumonia). In the GBD 2019, the incidence, mortality, and etiologic causes of LRIs are estimated independently.

Estimates of incident episodes of LRI are informed by incidence and prevalence data from a systematic literature review, hospital inpatient and outpatient data, claims data from the USA, and population-representative surveys. These data are modeled in a compartmental, mixed-effects, meta-regression model that enforces consistency between incidence, prevalence, recovery, and mortality.

LRI mortality was estimated in the Cause of Death Ensemble model (CODEm) platform. CODEm is a Bayesian statistical model and uses spatial priors from a hierarchical structure to inform the mortality models. CODEm is based on five general principles: identifying all available data, maximizing the comparability and quality of the dataset, developing a diverse set of plausible models, assessing the predictive validity of each plausible individual model and of ensemble models, and choosing the model or ensemble model with the best performance in out-of-sample predictive analysis.

LRI mortality is estimated for 23 age groups, 204 countries and territories locations, both sexes, and every year from 1980 to 2019. LRI mortality is estimated separately for males and females and for children under five years and older than five years due to expected underlying differences in the risk of mortality and predictive covariates between these age groups.

The etiologic causes of LRIs in the GBD 2019 are estimated using a counterfactual approach called a population attributable fraction. Influenza and RSV population attributable fractions were informed by a systematic literature review of the proportion of LRI cases that are positive for each pathogen and the odds that the pathogen was responsible for LRI. Hib and Streptococcus pneumoniae (pneumococcal pneumonia) are informed by a systematic review of vaccine efficacy and effectiveness studies. The population attributable fraction for the bacterial pathogens follows a vaccine probe approach to defining the counterfactual of disease burden in the absence of the vaccines.

The GBD study updates its results semi-annually. There were no substantive changes from GBD 2017. The primary updates to the estimation for LRI in GBD 2019 were the addition of new cause of death data, recently published population representative surveys and peer-reviewed publications, and inclusion of several additional covariates in the fatal model.

Notes B
World Bank regions

Latin America and the Caribbean (42)

Antigua and Barbuda
Argentina
Aruba
Bahamas
Barbados
Belize
Bolivia
Brazil
British Virgin Islands
Cayman Islands
Chile
Colombia
Costa Rica
Cuba
Curacao
Dominica
Dominican Republic
Ecuador
El Salvador
Grenada
Guatemala
Guyana
Haiti
Honduras
Jamaica
Mexico
Nicaragua
Panama
Paraguay
Peru
Puerto Rico
Saint Maarten (Dutch)
St. Kitts and Nevis
St. Lucia
St. Martin (French)
St. Vincent and the Grenadines
Suriname
Trinidad and Tobago
Turks and Caicos Islands
Uruguay
Venezuela
Virgin Islands (USA)

North America (3)

Bermuda
Canada
United States of America

South Asia (8)

Afghanistan
Bangladesh
Bhutan
India
Maldives
Nepal
Pakistan
Sri Lanka

The Middle East and North Africa (21)

Algeria
Jordan
Qatar
Bahrain
Kuwait
Saudi Arabia
Djibouti
Lebanon
Syrian Arab Republic
Egypt
Libya
Tunisia
Iran
Malta
United Arab Emirates
Iraq
Morocco
West Bank and Gaza
Israel
Oman
Yemen

East Asia and the Pacific (38)

American Samoa
Australia
Brunei Darussalam
Cambodia
China
Democratic People's Republic of Korea
Fiji
French Polynesia
Guam
Hong Kong SAR
Indonesia
Japan
Kiribati
Korea
Lao PDR
Macao SAR
Malaysia
Marshall Islands
Micronesia
Mongolia
Myanmar
Nauru
New Caledonia
New Zealand
Northern Mariana Islands
Palau
Papua New Guinea
Philippines
Samoa
Singapore
Solomon Islands
Taiwan
Thailand
Timor-Leste
Tonga
Tuvalu
Vanuatu
Vietnam

Sub-Saharan Africa (48)

Angola
Benin
Botswana
Burkina Faso
Burundi
Cabo Verde
Cameroon
Central African Republic
Chad
Comoros
Congo
Côte d'Ivoire
Democratic Republic of Congo
Equatorial Guinea
Eritrea
Eswatini
Ethiopia
Gabon
Ghana
Guinea
Guinea-Bissau
Kenya
Lesotho
Liberia
Madagascar
Malawi
Mali
Mauritania
Mauritius
Mozambique
Namibia
Niger
Nigeria
Rwanda
São Tomé and Principe
Senegal
Seychelles
Sierra Leone
Somalia
South Africa
South Sudan
Sudan
Tanzania
The Gambia
Togo
Uganda
Zambia
Zimbabwe

Source: World Bank 2020

Notes C

Development Initiatives Methodology

To determine spending levels of pneumonia-related Official Development Assistance (ODA and private sector (Bill & Melinda Gates Foundation) funding to pneumonia, Development Initiatives used expenditure reported to the OECD Development Assistance Committee (DAC) Creditor Reporting System (CRS) and applied the methodology used by the Institute for Health Metrics and Evaluation (IHME) and published in "Pushing the Pace: Progress and Challenges in Fighting Childhood Pneumonia", 2014.

As there are no pneumonia-specific fields (e.g., sub-sectors) in the OECD DAC reporting directives, Development Initiatives applied IHME methodology to capture donor activities on ODA and private funding to pneumonia by applying a pneumonia-relevant key word-search on CRS descriptive fields: project title, short description, and long description. Positive returns were classified into: "vaccine" (vaccine related ODA or private funding to pneumonia), "full" (other activities focused fully on pneumonia), "partial" (ODA partially-related to pneumonia), and "reject" based on a review undertaken on all returned activities.

(1) Vaccine related pneumonia ODA

Vaccine-related ODA included activities holding project titles or descriptions that indicated the disbursement was for vaccines relevant to pneumonia, specifically those including pneumococcal vaccine, Haemophilus influenzae type b (Hib) vaccine, pentavalent vaccine, and tetravalent vaccine (with Hib component), and other vaccines with Hib component. Relevant activities could encompass a focus across multiple areas within the descriptive fields including vaccine supply, support, procurement, immunization, pilot studies, support for country decision making, and vaccine research and development. The Hib component of funding for pentavalent vaccines and tetravalent (DTP-Hib) vaccines was calculated using UNICEF vaccine price data applied to the total value of the relevant disbursements. This is based on IHME methodology with component fractions updated for recent years.

(2) Full non-vaccine related pneumonia ODA

Full (non-vaccine) activities included projects with titles or descriptions that indicated the entire project was focused on pneumonia. Examples of these activities include pneumonia control, treatment, prevention, and research (non-vaccine related).

(3) Partial non-vaccine related pneumonia ODA

Partial (non-vaccine) activities included projects with titles and descriptions indicating that the project was partially directed towards pneumonia. Specifically, these were activities noting an element of focus towards pneumonia in descriptions that also included other areas of focus such as diarrhea, tuberculosis, HIV/AIDS or malaria. For these activities a proportion was applied on the disbursement marked as "partial" based on a subjective review of the project title and description. Proportions were decided based on the number of areas of focus around which pneumonia was mentioned. For example, a project which contained a focus on diarrhea and pneumonia had a share of 50% applied to the disbursement.

(4) Reject

A decision was taken not to include certain activities returned from the word-search in the analysis. These were generally multi-sector activities which mentioned a pneumonia related key-word in the description whilst being reported at a split component level to a sector not relevant to pneumonia (e.g., malaria control). Examples of such activities include a malaria control sector project description which states "pneumonia" as contextual background to a country setting or an activity undertaken on research relating to "Contagious Bovine Pleuropneumonia".

Note this analysis does not include bilateral development cooperation data from providers not reporting to the OECD DAC system. This includes Brazil, India, China, and South Africa. As such, the estimates may underestimate total concessional international development financing to pneumonia depending on the extent of the activities relevant to pneumonia from these providers. Further, ODA from certain non-DAC donors reported on the OECD DAC system can at times hold less detail compared to DAC donors, increasing the likelihood that any relevant ODA from these providers will be omitted from the word-search based methodology.

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