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Malaria

Malaria was once a scourge across nearly the entire inhabited world. Thanks to medical advancements, insecticides, and development replacing the swampy environments where mosquitos breed, we have succeeded in eradicating the illness in many places. However, although we know how to get rid of it, malaria remains endemic in sub-Saharan Africa. Yet for a relatively small investment of $1.1 billion annually, we could avoid 200,000 deaths each year, delivering $48 of benefits for each dollar spent.

An illness that shaped history

While today the burden of malaria largely falls on the poorest countries in Africa, it was for a very long time prevalent across the world. The illness has taken human lives at least since the Neolithic era and was once so prominent that it was mentioned in Homer's *Iliad* as well as the works of Aristotle, Sophocles, and early Chinese writers. Indian authors in 1500 BC dubbed it the "king of diseases," and, indeed, malaria is blamed in part for the fall of Rome and for southern China developing more slowly than the north.

Spreading with human movement between Africa, Europe, Asia, and the Americas, malaria flourished wherever there was still water and crowded communities. Female mosquitos carry the protozoan parasite and transmit it from person to person with their bite. Once the parasite enters a person's blood system, it travels into his liver to reproduce. This causes high fever, shaking, chills, and pain. Without the right treatment, malaria infection can recur. In the worst cases, it leads to coma and death.

Although malaria infected hundreds of millions of people, it took generations before we discovered how the illness spread. Early on, humanity realized that malaria was linked to swamps, which inspired the name *mal'aria* ("bad air"), but it was only at the turn of the 20th century that scientists managed to identify the malaria parasite and discern that it was being spread by mosquitos. In 1902, Ronald Ross of the British Indian Medical Service received the Nobel Prize for Medicine for discovering the mosquito stages of malaria.

Today, we think of malaria as an illness found in humid, hot countries. However, it once thrived as far north as Siberia and the Arctic Circle. In Finland, malaria was endemic throughout the 1800s. In Kiev, during the mid-to-late 1800s, malaria epidemics repeatedly accounted for 80% of all recorded illnesses. In 1924, the Soviet authorities estimated that there were more than 5.5 million cases annually, and independent sources suggested the yearly caseload could be as high as 13 million. In parts of Moscow, even until the mid-1940s, 20% of the population was infected with malaria yearly.

Malaria was also pervasive in the USA. In California, the State Board of Health noted in 1875 that "malarial fevers and consumption constitute the most prevalent forms of disease." In 1920, almost 2% of the American population had malaria each year, and by the mid-1930s, the USA still experienced more than 400,000 cases each year. Up to the 1940s, it was endemic in 36 states, including Michigan, New York, Oregon, Washington, and Wisconsin.

Globally, in the first 30 years of the 1900s, malaria killed around 90 million people, more than all the deaths across the entirety of World War II. And yet today, malaria is unheard of in most of the world—a marvel of human ingenuity and what economic growth can do for our physical well-being.

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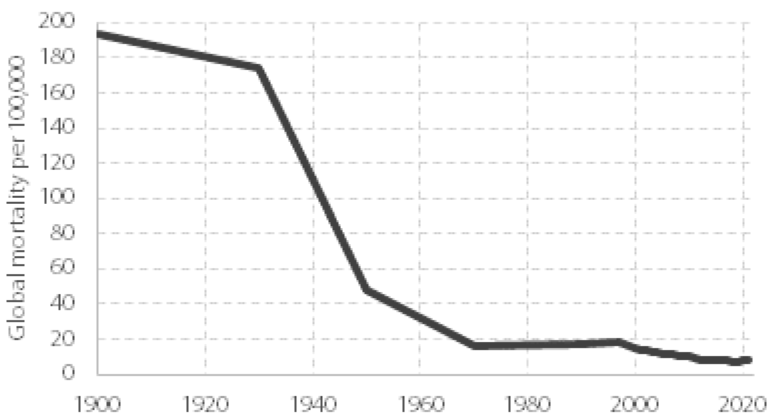
How humanity cleared out the 'bad air'—for the most part

By the early 20th century, malaria was diminishing in Europe and North America because of two intertwined causes: Increasing prosperity and medication.

With rising prosperity came more development. Marshes in the United Kingdom and elsewhere were drained, reducing mosquito breeding grounds. The increased number of livestock diverted mosquitos from biting humans, disrupting malaria transmission. Better nutrition improved people's health and reduced their vulnerability to malaria. Increased incomes meant better homes and better-maintained insect screens, which kept out mosquitos. It also, crucially, meant better access to healthcare, which was improving too.

At the same time that Europe and the USA were growing in prosperity, there was a remarkable breakthrough in malaria treatment—but not a medical one. Malaria medicine had already been discovered back in the 1600s when the Spanish brought powder made from the cinchona tree back from the New World. The problem was that it remained prohibitively expensive. The cinchona tree's slow growth and the difficulty of growing it elsewhere led the Spanish to have a virtual monopoly on quinine for almost 300 years. They kept supplies low and prices high, meaning most people couldn't benefit.

This changed when cinchona was successfully grown in Java; it grew so well that by the early 1900s, it supplied nearly all of the global consumption. While prices were still fairly high, most developed-world citizens could afford treatment. With the discovery of how to synthetically manufacture chloroquine, worldwide treatment became a real possibility.



Source: https://www.who.int/whr/1999/en/, https://www.who.int/teams/global-malaria-programme/reports/world-malaria-report-2022.

Figure 8.1 Global malaria death rate 1900–2021.

Development continued to play an important role alongside affordable malaria medicine—as an analysis of malaria in Mississippi from 1945 shows. Malaria deaths generally declined over the first part of the 20th century, but ups and downs were strongly dependent on cotton prices, which were highly correlated with income. When prices—and therefore income—were high, malaria deaths were low, and vice versa. Higher incomes meant people were better fed, and homes were kept in better repair, including insect screens. Moreover, in high-income years, there were many more malaria cases for each death, meaning more people could afford treatment.

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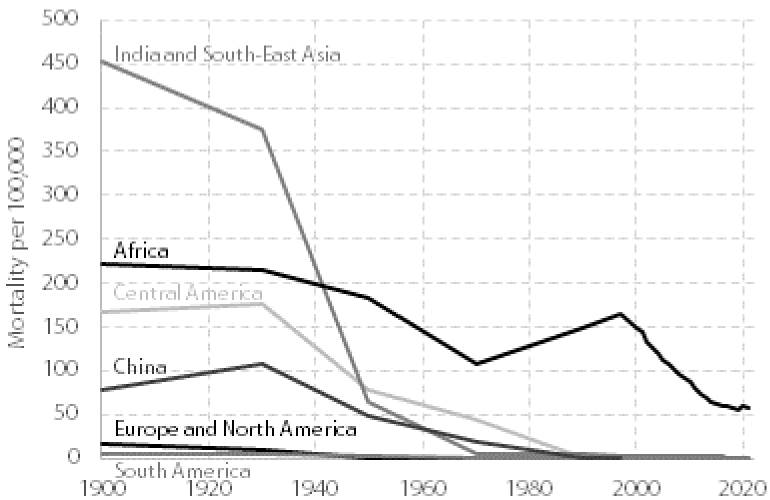
Together, economic growth and improved treatment caused malaria death rates to fall 25-fold over the past 121 years, from almost 200 deaths per 100,000 people to less than 8, as Figure 8.1 shows.

The invention of the insecticide DDT [i] was also crucial to the precipitous drop in deaths. The ability to spray it indoors and use insecticide to control mosquito breeding grounds effectively eradicated malaria in many developed countries. In the USA, for instance, the government ensured that more than 4.5 million homes were sprayed with DDT between 1947 and 1949, and in 1951 malaria was considered eradicated in America.

As malaria was eradicated in Europe and North America, the bulk of the deaths came to weigh on Africa and Asia (Figure 8.2). This shift was already taking place as early as 1900. Malaria still killed about 80,000 Europeans and North Americans each year, but about one-third of global malaria mortalities occurred in sub-Saharan Africa.



Sources: 1900–1997, 2000–21. Central America includes the Caribbean, and China includes North-East Asia. Middle East, South Asia, and Western Pacific are here denoted as India and South Asia.

Figure 8.2 Regional malaria death rates 1900–2021.

An even larger burden of mortalities fell on Asia, where about three million people died from malaria each year in the early 20th century—about one-in-ten of all deaths on the continent. Most of the deaths took place in India and South Asia, along with the Middle East and Western Pacific.

In many Indian provinces, it's likely that malaria caused more than half of all deaths, with death rates in entire provinces above 1,500 per 100,000. Because of the highly uneven distribution of malaria across the subcontinent, many localities would have surpassed even these rates, so much so that malaria made some areas essentially uninhabitable.

As prosperity increased across Asia, a huge transformation took place. Economic development and the availability of DDT, quinine, and chloroquine—as well as the cessation of World War II—finally made it possible to combat malaria. Malaria death quickly reduced. Although many Asian nations didn't quite reach eradication because of increased mosquito resistance to DDT, cases and deaths dropped dramatically. In China, deaths dropped from almost 300,000 per year in 1950 to a few thousand annually in the 1990s and then to zero in 2016 and onward. In 2021, China was declared malaria-free.

Outside of sub-Saharan Africa, annual deaths have plummeted by more than 99% since 1930, dropping from more than three million in 1930 to less than 30,000 today.

Yet malaria remains a stubborn problem in Africa. While deaths declined somewhat after the 1940s, when medications and DDT spraying became more widespread, it didn't work nearly as well. This is because malaria transmission in Africa is an order of magnitude more intense than in other continents. This means that even if campaigns manage to reduce malaria transmission, lots of mosquitos still get to bite lots of humans, keeping the infections going.

Malaria is harder to control in Africa for many reasons, but two stand out. First, the malaria-spreading parasite found in Africa is the deadliest variety. Second, while many malaria-carrying mosquitos prefer to bite animals rather than humans, the most common malaria mosquitos in Africa almost exclusively bite people. Livestock can't help to interrupt the spread of malaria in Africa as it did in other regions.

Because Africa didn't get the potent malaria reductions other regions saw, when the malaria parasite began developing resistance to chloroquine around 1978, it lead to a resurgence of malaria on the continent, as shown in Figure 8.2. Already by the 1980s, chloroquine was ineffective in many populations.

It took several decades for an alternative treatment to reach sub-Saharan Africa. The Chinese researcher Tu Youyou discovered a new drug called artemisinin in 1972, which comes from a traditional Chinese medicine extracted from the sweet wormwood herb. She was ultimately awarded the Nobel Prize for her work, but it was only after China's opening up to the West in the 1980s that the drug became well-known in the rest of the world. Successful large clinical trials were conducted in the mid-1990s, and in 2006, the WHO recommended it for first-line treatment. Because there is now early resistance to artemisinin, it is important to use artemisinin together with other drugs in so-called combination therapies.

Artemisinin has been an important driver of what progress Africa has made against malaria this century. Rapid diagnostic tests show if a fever actually is malaria and if it is, the patient can receive artemisinin-based combination therapies. Over the period from 2010–2021, 3.5 billion rapid tests were conducted, and 3.8 billion treatment courses were delivered.

The other important driver of the malaria decline in Africa has been the proliferation of long-lasting insecticide-treated nets (LLINs). Almost 220 million such nets were delivered to sub-Saharan Africa in 2021 alone. Sleeping under an LLIN is one of the best ways to prevent malaria, as they form both a physical and chemical barrier to mosquitoes. Not only are mosquitos blocked by the netting, but also killed by the insecticide coating.

The parasite that spreads the illness takes about 11 to 14 days to mature inside the mosquito, so if the carrier dies before that point, malaria's spread is interrupted. Even making a small dent in the insects' lifespans can dramatically reduce transmission. This is part of what makes LLINs the most efficient way to control malaria in places where malaria is endemic.

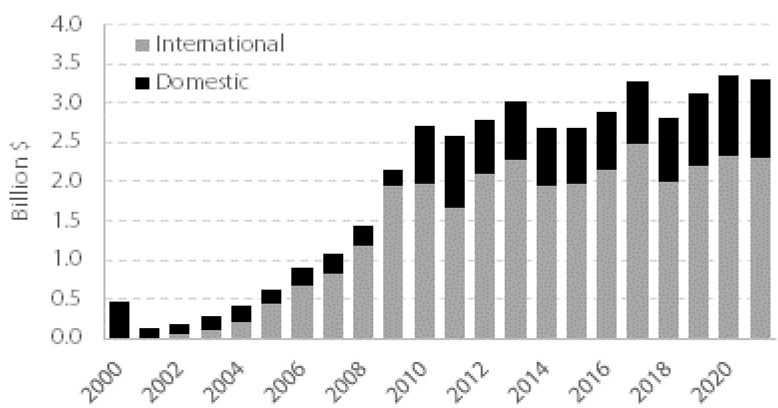
The slight uptick you can see in 2020 and 2021 in Figure 8.2 is due to the disruption of essential medical services treating malaria during the Covid pandemic, which caused an estimated additional 63,000 deaths.

MDGs and SDGs on malaria: Impetus lost?

There was a flurry of activity on malaria at the start of this century. As a key disease afflicting people in poverty, malaria was singled out for special attention in the Millennium Development Goals. The Rollback Malaria partnership—a global campaign that includes African governments, donor countries, foundations, researchers, businesses, and international organizations—aimed to achieve a 75% reduction in global malaria incidence by 2015.

In 2000, African heads of state signed the Abuja Declaration, which set out to "halve the malaria mortality for Africa's people by 2010. These targets led to a significant increase in investment: The Global Fund to Fight AIDS, Tuberculosis, and Malaria drove an expansion in international spending on malaria from virtually nothing in 2000 to more than $2 billion per year in the late 2010s (see Figure 8.3).

In the same period, domestic spending on malaria increased from about $200 million in the 2000s to almost $800 million in the 2010s. This helped to scale up control programs, such as the distribution of LLINs. By 2011, over a third of children exposed to malaria slept under LLINs, up from 5% in 2000.



Sources: https://www.who.int/teams/global-malaria-programme/reports/world-malaria-report-2022, p. 57, http://ihmeuw.org/5rim. Nearly all international funding comes from the Global Fund and US bilateral aid.

Figure 8.3 Malaria spending in low- and lower–middle–income countries, from domestic and international sources. Households also spend almost $700 million per year out-of-pocket.

The overall impact of this campaign was marked: Between 2000 and 2015, an estimated 6.2 million malaria deaths were averted.[ii] Malaria incidence decreased by 37% globally, and malaria mortality rates decreased by 58%.

Yet, these efforts didn't quite meet the stated goals. Malaria incidence did not decrease by 75% by 2015—indeed, in a reevaluation of the data, the WHO now estimates that the reduction was a modest 27%. Likewise, African mortality fell more modestly, by 42% in 2010 and 62% even in 2019, as seen in Figure 8.2.

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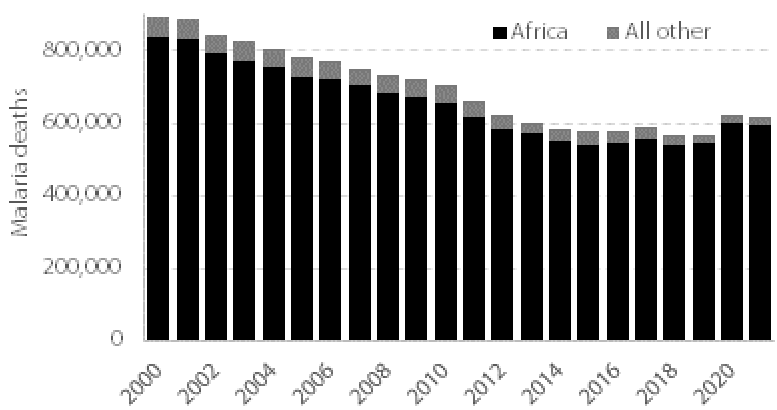
There was a renewed effort on malaria in the Sustainable Development Goals set in 2015. The illness is a focal point in target 3.3:

> By 2030, end the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis, water-borne diseases and other communicable diseases.

The wording of the goal is inappropriate for malaria. It is endemic to sub-Saharan Africa specifically, not an *epidemic,* which implies it affects a large swathe of the world. Yet, it's clear that the SDG target is to substantially reduce malaria. Likewise, the WHO's Global Technical Strategy for Malaria 2016–2030 suggested trying to reduce global malaria incidence and deaths by at least 90% by 2030 compared to 2015.

Sadly, the data shows we are nowhere near achieving these goals. By 2021, malaria mortality rates were supposed to drop by 36% compared to 2015,[iii] but they fell by just over 1%. This failure was in part due to Covid, but even up until 2019, there was only a mortality reduction of about 7%—far below the 24% reduction that was promised. Progress on the incidence of malaria was slightly worse.

On the world's 2015–21 trajectory, malaria mortality would fall by less than 4% in 2030 compared to 2015. At this rate, it would take almost 400 years for the world to hit a 90% reduction.[iv] Even if you discount Covid's effect by only looking at the trend from 2015–19, the reduction in 2030 would still be a mere 17%, and we'd only hit 90% by 2065. Really, as Figure 8.4 shows, progress has been arrested since 2015, with almost all malaria deaths being concentrated in sub-Saharan Africa.



Source: https://www.who.int/teams/global-malaria-programme/reports/world-malaria-report-2022

Figure 8.4 Malaria deaths 2000–21 for Africa and all other regions.

The WHO puts the malaria issue bluntly: "Progress has clearly stalled since 2015, and funding has plateaued." That might slightly overstate the problem—as Figure 8.2 shows, mortality has slightly declined in Africa, and as Figure 8.3 outlines, funding has slightly increased for low- and lower-middle-income countries. But the overall point is true: The world isn't working on malaria nearly as much as it should be.

Substantially reducing malaria would require a huge boost in funding, according to the 2022 *World Malaria Report* estimates. Global funding in 2021 was around $3.8 billion (slightly higher than shown in Figure 8.3 because of extra spending in upper-middle-income countries). The SDGs and the Global Technical Strategy elimination would require spending more than twice as much: $7.9 billion. To meet the goals, the global malaria budget should have hit $10 billion by 2025, and it would need to increase even further to reach the goal by 2030.

Such an enormous increase in funding is unlikely based on current trends, but we can do better. The paper on which this chapter is based outlines how the world can substantially reduce malaria deaths and cases in sub-Saharan Africa with a highly efficient policy, the benefits of which far outweigh the costs.

How to save lives from an endemic killer at little cost

it is well-known that there are two very effective ways to limit malaria: Spraying or nets. However, indoor residual spraying, as was done, for instance, in the USA after the war, turns out to be logistically demanding. It is easy to do badly, which can make the policy ineffective.

In comparison, handing out insecticide-treated bednets is less logistically challenging, and the coverage is easier to sustain. As discussed above, the benefits are two-fold: LLINs block mosquitos and cull their population.

This chapter's study shows how the number of LLINs can be scaled up by ten percentage points in the 29 highest-burden countries in Africa (with a cap of 90% coverage)[1] from 2023–30. When the phase-in starts, the additional cost will be $480 million, as Figure 8.5 shows. By the end of the decade, the extra cost will be almost $1.6 billion. The total—discounted appropriately—would come to $6.6 billion.

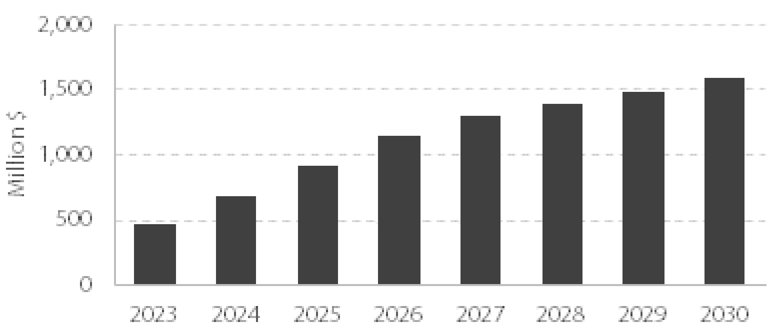


Figure 8.5 Incremental costs of increasing the coverage of LLINs and SBCC from 2023–30.

Most of this cost is the bed nets themselves, but a small portion also comes from a necessary awareness campaign. Although more straightforward than spraying insecticide indoors, bed nets can be used incorrectly, which undercuts their benefits. The added cost of educating the public and encouraging proper use of LLINs comes to about $0.10 per bed net. The information can be delivered through almost any format, including TV, radio, radio drama, billboards, or

[1] The 29 highest-burden countries are Nigeria, Democratic Republic of Congo, Tanzania, Mozambique, Uganda, Burkina Faso, Mali, Niger, Angola, Cote d'Ivoire, Cameroon, Chad, Kenya, Ghana, Benin, Guinea, Ethiopia, Madagascar, Zambia, Sierra Leone, South Sudan, Sudan, Malawi, Burundi, Central African Republic, Liberia, Senegal, Togo and Rwanda. Among the countries on this list, more than half of all malaria deaths happen in just four countries: Nigeria (31%), the Democratic Republic of the Congo (13%), Niger (4%), and Tanzania (4%).

promotional gift items like caps or bags. The one exception is sending representatives in person to help families hang up nets correctly. It does help with sustained use, but it's expensive and, therefore, not very cost-effective. That is why it's not included in the study's proposal.

Mosquitos are also becoming resistant to the standard insecticide on the nets in some places. So, the researchers assume that only 70% of the LLINs distributed will be standard nets at a distributed cost of $3. The rest will include a new pesticide (Chlorfenapyr), to which mosquitos have low resistance. It does, however, cost more at $4.50. The study assumes that all LLINs will last three years, so each year, a third the existing stock of nets will have to be replaced.

This relatively small additional cost can generate incredible benefits.

By far, the biggest benefit is the vast number of lives saved from malaria. As Figure 8.6 shows, under current trends, the death toll from malaria will actually slightly increase between now and the SDG deadline of 2030. The baseline assumes that up to 2030, the world will maintain the level of malaria control activities of 2019, just before Covid. This means malaria mortality will grow from 550,000 per year to 641,000, mainly because of increasing populations.

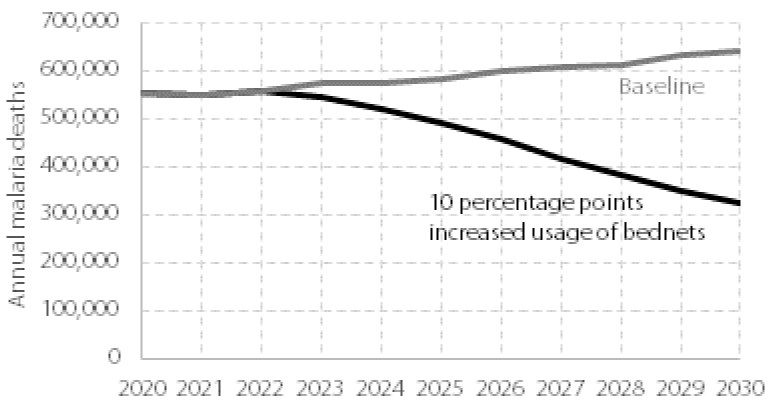


Figure 8.6 Annual malaria deaths for 29 highest-burden countries in Africa, on the baseline and with ten percentage points more use of LLINs. Simulations without Covid impacts.

If, instead, the world follows the policy outlined in the paper, malaria deaths will decline fairly rapidly. Even in the first year the policy is implemented, 2023, the increase in LLINs will save 30,000 lives. By the end of the decade, the number of dead will be halved, saving 1.3 million lives over the period. Translated into economic terms and discounted back to today, this would represent a social value worth $259 billion.

The policy's benefits exceed its costs even before considering the lives it saves. In the baseline scenario, by the end of the decade, sub-Saharan Africa would suffer 560 million cases of malaria a year. With this policy, however, the researchers' simulation shows we can achieve a more than 40% reduction, knocking annual cases down to only 318 million.

This means 242 million fewer people will get sick in 2030, drastically reducing healthcare costs. That results in lower costs for society as well as lower costs for the people who would've otherwise gotten malaria—not only for medicine but also for the costs associated with reaching healthcare facilities, such as bus tickets.

Amazingly, these cost savings quickly become bigger than the costs of scaling up bed-net use, as Figure 8.7 outlines. The savings start at almost $350 million (just somwhat lower than the cost of $480 million) and already outweigh the total annual costs of the policy come 2025 By 2030, healthcare savings will reach $2.9 billion, about twice the cost of the increase in LLINs.

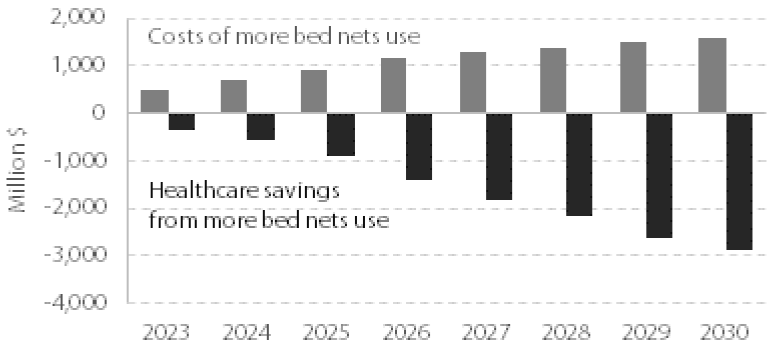


Figure 8.7 Costs for more bed net use and savings for less healthcare needed.

The total healthcare savings, discounted back to today, amount to $8.9 billion—well above the total policy cost of $6.6 billion.

In addition to the lives and healthcare costs saved, the fact that 242 million people won't be infected with malaria delivers a significant productivity boost. Some 95% percent of malaria cases are handled as outpatient treatment, and here it is estimated that adults typically lose out on five days they could have been working. Because it is a debilitating illness, the study assumes that one more adult caregiver will have to be present to look after a sick child or adult, meaning this second person also loses five days of productivity. The remaining 5% of malaria cases are so serious that treatment has to be done within the healthcare system, and these last an average of almost nine days. Here the study assumes caregivers spend half that time visiting the hospital.

In addition to losing entire days of work recovering from the illness, malaria patients often return to work before they're fully healthy, and so, it is estimated that during the first three days they're back, they deliver only half the productivity they normally would.

In total, the policy will avoid a productivity loss of an estimated $17 billion in 2030. Across the current decade—and discounted back to today—it averts a loss of almost $48 billion.

Table 8.1 Benefits, costs in billion dollars for more bed nets use 2023–30 along with the benefit-cost ratio.

Benefits		
	Avoided healthcare costs	8.9
	Avoided productivity loss	47.9
	Avoided death	259.3
Total benefits		**316.0**
Costs		
	Nets and campaign	6.6
Benefit-cost ratio		**48.0**

Together, these benefits come to a total value of $316 billion, which outweighs the costs of $6.6 billion at a ratio of 48 to 1.

An incredible investment in saving lives

While malaria no longer wreaks destruction across the entire globe, it is still a terrible illness in the places where it remains endemic. Malaria can be a debilitating disease, draining adults and youths of their vitality and diverting resources to their care, even in the majority of cases when it does not claim lives. The progress that we have made against malaria elsewhere urgently needs to be replicated across sub-Saharan Africa.

We have a remarkable opportunity in distributing additional long-lasting insecticide-treated nets to substantially lighten the burden of this painful and often deadly disease. Not only can it save hundreds of thousands of lives per year, but it can also ensure more productive societies. Bed nets against malaria are among the world's best investments this decade.

The academic paper is entitled "Benefits and Costs of Scaling up Coverage and Use of Insecticide Treated Nets: An Investment Case for the Scale up of Insecticide Treated Nets and the use of all nets, halfway into the SDG targets" It is authored by

Rima Shretta, University of Oxford
Randolph Ngwafor, University of Oxford

Reviewers and advisors include

Catherine Pitt of the London School of Hygiene and Tropical Medicine

Lesong Conteh of the London School of Economics

Jessica Cohen of Harvard University

Joshua Yukich of Tulane University

Obinna Onwujekwe of the University of Nigeria

The paper is published in Cambridge University Press' *Journal of Benefit-Cost Analysis*, vol. 13, S1, 2023. You can access it here: https://copenhagenconsensus.com/halftime

[i] Although DDT has negative environmental impacts like thinning eggshells of birds, it is surprisingly safe for humans and much better than dying from malaria.
[ii] This assumes that mortality rates remained constant from 2000, https://idpjournal.biomedcentral.com/articles/10.1186/s40249-016-0151-8
[iii] This assumes a linear reduction in mortality rate each year. If it is a relative reduction (perhaps more plausible), we should have seen a 60% reduction already in 2021.
[iv] Assuming linear reduction. With a relative reduction, it would take thousands of years.