

Long-lasting Insecticidal Nets: Market and Supply Update

UNICEF Supply Division

October 2022

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This update reports on UNICEF's historical and projected long-lasting insecticidal nets supply, demand, and market developments. In 2021, UNICEF reviewed and extended its long-term arrangements for prequalified products with ten suppliers until December 2023.

1. Summary

- UNICEF works to increase and reinforce sustainability aspects in its procurement of long-lasting insecticidal nets (LLINs) across ongoing and new initiatives and products. LLIN procurement volumes can vary substantially from year-to-year in accordance with country requirements.¹ In general, countries procure new and replacement LLINs for distribution in mass campaigns on a two- to three-year cycle. In 2020 and 2021, UNICEF procured just under 18 and 41 million nets respectively on behalf of approximately 30 countries. UNICEF anticipates procuring an estimated 28 million nets in 2022, and 32 million nets in 2023.
- Currently, the World Health Organization (WHO) lists 23 prequalified LLINs products from 13 manufacturers. The list includes eight products with increased efficacy against pyrethroid-resistant mosquitoes,² having increased by one product in this category since 2019.
- Overall global aggregate supply increased by 20 per cent over the past three years. UNICEF estimates current global LLIN production capacity at 480 million nets annually, compared to 400 million nets estimated in 2019. Global LLIN deliveries have increased by 16 per cent on average annually since 2018.
- UNICEF's steady reduction trend in weighted average price (WAP) for LLINs reached USD 1.87 in 2018. It reversed in 2019, reaching in 2021, a UNICEF WAP of USD 1.94 per net, representing an overall increase of four per cent compared to 2018. The increase in WAP was partly due to the growing share of more expensive Piperonyl Butoxide (PBO) and next generation nets through UNICEF's procurement. However, the increase is also due to the market effects from COVID-19 and its impact on global markets.
- UNICEF concluded its last LLIN tender in 2018 and issued ten qualified manufacturers long-term arrangements (LTAs) for 2019 and 2020, extending LTAs through to December 2022 on account of markets being affected by the pandemic. In 2021, UNICEF undertook a price review that introduced an updated price adjustment mechanism (PAM). This resulted in UNICEF extending its existing LTAs through to December 2023. UNICEF plans to launch its new tender during the 2nd or 3rd quarter in 2023.

2. Background

Malaria is a preventable and curable life-threatening parasitic disease transmitted to people through the bites of infected female *Anopheles* mosquitoes. There are more than 400 species of *Anopheles* mosquito, of which five are known to cause malaria in humans.^{3,4} In 2020, WHO reported that malaria parasites caused an estimated 241 million cases of the disease in 85 countries and estimated 627,000 deaths, of which 77 per cent were children under five years of age (approximately 480,000).⁵ Malaria deaths in 2020 increased compared to the previous year, of which two thirds have been attributed to the disruptions caused by the COVID-19 pandemic. Africa accounts for 95 per cent of the estimated disease burden globally. Six countries account globally for just over half of all malaria cases: Nigeria (27 per cent), the Democratic Republic of the Congo (12 per cent), Uganda (5 per cent), Mozambique (4 per cent), and Angola and Burkina Faso both have 3.4 per cent, respectively.

Sleeping under an insecticide-treated mosquito net (ITN) is one of the most effective measures that can reduce contact between mosquitoes and humans. It provides both a physical barrier and an insecticidal effect. As part of WHO's Global Malaria Technical Strategy 2016-2030 to reduce the burden of global malaria by 90 per cent by 2030,⁶ WHO recommends

1 UNICEF articulates supply trends as either number of nets procured, or number of nets delivered. Substantial differences in supply data can occur between annually reported LLIN procurement and LLIN deliveries due to long-lead delivery times for shipments by sea, which can be between two to eight weeks depending on the volume, and their subsequent transit to community distribution points.

² See end of page 3 for information on pyrethroids and pyrethroid resistance.

³ World Health Organization, [Malaria Fact Sheet](#), WHO, Geneva, April 2022.

⁴ Zoonotic Plasmodium causing malaria in humans: *P. falciparum*, *P. malariae*, *P. ovale*, *P. vivax*, and *P. knowlesi*, the latter normally infecting animals. There is no known human to human transmission.

⁵ World Health Organization, [World Malaria Report 2021](#), WHO, Geneva, December 2021, p. xv.

⁶ World Health Organization, [Global Technical Strategy for Malaria 2016-2030](#), WHO, Geneva, May 2015, p. 3.

universal coverage with effective vector control including the use of ITNs, particularly LLINs, as well as indoor residual spraying (IRS),⁷ as core interventions in all malaria-endemic settings.

LLINs are mosquito nets treated with WHO-recommended insecticides at the manufacturing unit. Insecticides bound within or around fibres of netting material used for LLINs results in greater durability compared with conventionally treated nets (nets dipped into liquid insecticide and/or re-treated). LLINs, properly cared for, can retain their efficacy against mosquito vectors for up to three years and do not require any re-impregnation (see 5.1 Durability).

Significant progress has been achieved to date since 2000 in malaria control, having reduced the number of global cases by 12 per cent and deaths from malaria by 45 per cent, largely credited to the scale-up of core vector control interventions, particularly the use of LLINs.⁸ Not least the new malaria vaccine and ongoing market shaping efforts to ensure the market will have sufficient malaria vaccine supply to meet all demand between 2026 and 2028.⁹

By 2020, 65 per cent of households in sub-Saharan Africa had at least one LLIN, an increase from only about five per cent in 2000. In the same period, the percentage of the population with access to an LLIN within their household increased from three per cent to 50 per cent. However, since 2017, indicators for LLIN access and use in sub-Saharan Africa have been declining, which is worrying trend that requires effective countermeasures.

UNICEF procures LLINs on behalf of countries and partners in support of malaria control and elimination programmes, using either programme funds or available country financing from domestic and donor sources. UNICEF only procures LLINs that are prequalified by WHO. WHO currently lists 23 prequalified LLINs from 13 manufacturers (Table 1). All vector control products that have been WHO prequalified, which includes IRS, insecticide treated net kits, larvicides, and space spray, can be accessed [here](#).¹⁰

Table 1 WHO Prequalified LLINs

Manufacturer	WHO PQ Code	WHO PQ Year	Product	Material	Active Ingredient / Synergist
A to Z Textile Mills (Tanzania)	009-001	2018	MiraNet®	Polyethylene	Alpha-cypermethrin
BASF (Germany)	002-001	2017	Interceptor®	Polyester	Alpha-cypermethrin
	002-002	2018	Interceptor G2®	Polyester	Alpha-cypermethrin / Chlorfenapyr
Disease Control Technologies (USA)	003-001	2017	Royal Sentry®	Polyethylene	Alpha-cypermethrin
	003-002	2019	Royal Sentry®2.0	Polyethylene	Alpha-cypermethrin
	003-003	2019	Royal Guard®	Polyethylene	Alpha-cypermethrin, Pyriproxyfen
Fujian Yamei Industry (China)	015-001	2018	Yahe LN®	Polyester	Deltamethrin
Life Ideas Biological Technology (China)	026-001	2018	Panda Net 2.0®	Polyethylene	Deltamethrin
Mainpol (Germany)	018-001	2018	SafeNet®	Polyester	Alpha-cypermethrin
Moon Netting FZCO (China)	028-001	2018	Tsara Boost®	Polyester	Deltamethrin, Piperonyl Butoxide (PBO)
	028-003	2020	Tsara Soft®	Polyethylene	Deltamethrin
	028-004	2018	Tsara Plus®	Polyester	Deltamethrin, Piperonyl Butoxide (PBO)
	028-002	2020	Tsara	Polyester	Deltamethrin
Real Relief Health (Denmark)	036-002	2021	Reliefnet Reverte	Polyethylene	Deltamethrin
Shobikaa Impex Private (India)	006-001	2017	Duranet LN®	Polyethylene	Alpha-cypermethrin
	006-003	2020	Duranet® Plus	Polyethylene	Alpha-cypermethrin, Piperonyl Butoxide (PBO)
Sumitomo Chemical (Japan)	001-004	2017	OLYSET Ne®	Polyethylene	Permethrin
	001-005	2018	OLYSET PLUS®	Polyethylene	Permethrin, Piperonyl Butoxide (PBO)
Tianjin Yorkool International (China)	021-001	2018	Yorkool LN®	Polyester	Deltamethrin
Vestergaard (Switzerland)	005-001	2017	PermaNet 2.0®	Polyester	Deltamethrin
	005-002	2018	PermaNet 3.0®	Polyester	Deltamethrin, Piperonyl Butoxide (PBO)
VKA Polymers (India)	014-001	2018	MAGNet®	Polyethylene	Alpha-cypermethrin
	014-002	2018	VEERALIN®	Polyethylene	Alpha-cypermethrin, Piperonyl Butoxide (PBO)

Source: World Health Organization

In 2020-2021 WHO prequalified and listed four new LLINs. In addition, several other vector control products that have been submitted to WHO for prequalification and accepted for assessment.¹¹ These include submissions for seven new LLINs from six different manufacturers.

The transition from the WHO Pesticide Evaluation Scheme (WHOPES) to prequalification for vector control products (PQT-VC), launched by WHO in 2015, was in response to the growing prominence and broader array of vector control

⁷ World Health Organization, [Guidelines for Malaria Vector Control](#), WHO, Geneva, February 2019, p. 34.

⁸ Bhatt, S., Weiss, D., Cameron, E. et al., [The Effect of Malaria Control on Plasmodium falciparum in Africa between 2000 and 2015](#), Nature, Berlin, September 2015, p. 207-211.

⁹ UNICEF, [Malaria Vaccine Questions and Answers](#), UNICEF, Copenhagen, August 2022.

¹⁰ World Health Organization, [Prequalified Vector Control Products](#), WHO, Geneva, 2022.

¹¹ World Health Organization, [Vector Control Products Pipeline](#), WHO, Geneva, August 2022.

interventions. There was also a need to cover a wider range of vector borne diseases.¹² The transition took three years and was concluded in January 2017. WHO's PQT-VC seeks to:

- Ensure an accurate and current list of prequalified vector control products.
- Provide a baseline of information on the safety, efficacy, and quality of converted products to inform future activities to be undertaken to ensure products are supported by a modern database of evidence and a lifecycle approach.
- Link products claiming equivalence to an innovator product to an appropriate and relevant database of evidence.

3. Innovation

There is a wide range of innovative tools, technologies, and approaches under development for vector control. The Vector Control Advisory Group (VCAG) assists WHO to assess the public health value of innovative interventions and provides guidance on developing a necessary evidence base for any evaluations.¹³

VCAG evaluates and publishes updates on tools, technologies, and approaches for vector control that are categorized under 8 different types of intervention.¹⁴ These include insecticide-treated nets, spatial repellents, toxic sugar baits, traps, as well as genetic manipulation and insect sterilizing techniques, amongst others. With reference to insecticide-treated nets specifically, VCAG is currently reviewing two innovative products that are designed to provide superior protection over and above the standard pyrethroid-only nets due to the addition of a second, non-pyrethroid active ingredient.¹⁵

- A pyrethroid plus chlorfenapyr ITN from BASF (Germany) is under assessment and review of public health value. Currently, the manufacturer is in the third-year follow-up of the trial in the United Republic of Tanzania and continues the trial in Benin. The product was prequalified by WHO in 2018 and is currently available on the market.
- A pyrethroid plus pyriproxyfen, which acts as an insect growth regulator, ITN from Disease Control Technologies (DCT) (USA) is under assessment and review of public health value. The manufacturer has completed 24-month trial in the United Republic of Tanzania and entered the third-year follow-up of the trial, also completed experimental hut studies in Côte d'Ivoire. The product was prequalified by WHO in 2019 and is currently available on the market.

Pyrethrum is one of the oldest known insecticides, derived from the dried and crushed flower heads of Asters. However, as it is expensive and in limited natural supply, **pyrethroids** were adapted and synthesized from Pyrethrum. Developed in 1973, synthetic pyrethroids are more stable to light, more toxic and last longer in the environment than natural Pyrethrum.¹⁶

Synthetic pyrethroids - such as alpha-cypermethrin, deltamethrin and permethrin - which were in use since the 1970s, are most commonly used in the production of ITNs, including LLINs. Due to the wide-spread use of synthetic pyrethroids in vector control programmes and agriculture, WHO has been reporting an increasing emergence of insecticidal resistance to insecticides, including pyrethroids, among *Anopheles* mosquitoes.¹⁷ Pyrethroid-resistant mosquitoes greatly reduce the efficacy and efficiency of wide-spread LLIN coverage as they are no longer killed by the insecticide, thus reducing progress towards malaria-transmission reduction.

An expansion of the current market to include new LLINs with increased efficacy against pyrethroid-resistant mosquitoes has become a specific priority within malaria vector control. Manufacturers are expanding the range of a novel class of bed nets using piperonyl butoxide (PBO),¹⁸ a chemical synergist. PBO-pyrethroid-treated LLINs appear to have similar or better efficacy against resistant mosquitoes under controlled household conditions than standard LLINs that do not have PBO.¹⁹

On a different innovation frontier, manufacturers are developing next-generation nets with active ingredients other than, or in addition to, pyrethroids. Two products containing non-pyrethroids, in addition to alpha-cypermethrin (pyrethroid) are prequalified by WHO. One more product with the use of a non-pyrethroid (chlorfenapyr) is currently in WHO's prequalification pipeline. A recent study showed that next-generation nets, nets treated with chlorfenapyr, provided significantly better protection in areas with pyrethroid-resistant mosquitoes. However, it also acknowledged that robust insecticide-resistance management strategies are needed to preserve effectiveness of next-generation nets.²⁰

12 World Health Organization, [Welcome to Vector Control Product Prequalification](#), WHO, Geneva, 2022.

13 World Health Organization, [Vector Control Advisory Group \(VCAG\) \(who.int\)](#), WHO, Geneva, 2019.

14 WHO, [Vector Control Advisory Group](#).

15 World Health Organization, [Fifteenth meeting of the Vector Control Advisory Group](#), WHO, Geneva, December 2021.

16 World Health Organization, [Safety of Pyrethroids for Public Health Use](#), WHO, Geneva, 2005, p. 5.

17 World Health Organization, [Insecticide Resistance](#), WHO, Geneva, 2019.

18 World Health Organization, [Conditions for Deployment of Mosquito Nets Treated with a Pyrethroid and Piperonyl Butoxide](#), WHO, Geneva, December 2017.

19 Protopopoff, Natacha, et al., [Effectiveness of a Long-lasting Piperonyl Butoxide-treated Insecticidal Net and Indoor Residual Spray Interventions, Separately and Together, Against Malaria Transmitted by Pyrethroid-resistant Mosquitoes: A Cluster, Randomised Controlled, Two-by-two Factorial Design Trial](#), National Center for Biotechnology Information, U.S. National Library of Medicine, Bethesda, April 2021.

20 Moshia, Jacklin F, Manisha A Kulkarni, Eliud Lukole, et al., [Effectiveness and Cost-effectiveness against Malaria of Three Types of Dual-active-ingredient Long-lasting Insecticidal Nets \(LLINs\) Compared with Pyrethroid-only LLINs in Tanzania: a Four-arm, Cluster-randomised Trial](#), The Lancet, Volume 399: 1,227-41, London, March 2022.

4. Current Market Situation

According to the World Malaria Report 2021, the percentage of the population sleeping under an ITN increased considerably between 2000 and 2020 from two per cent to 43 per cent, and for children aged under five years from three per cent to 49 per cent, and for pregnant women from three per cent to 49 per cent. Even though this represents a significant increase, it still leaves more than half of the population at risk uncovered.²¹

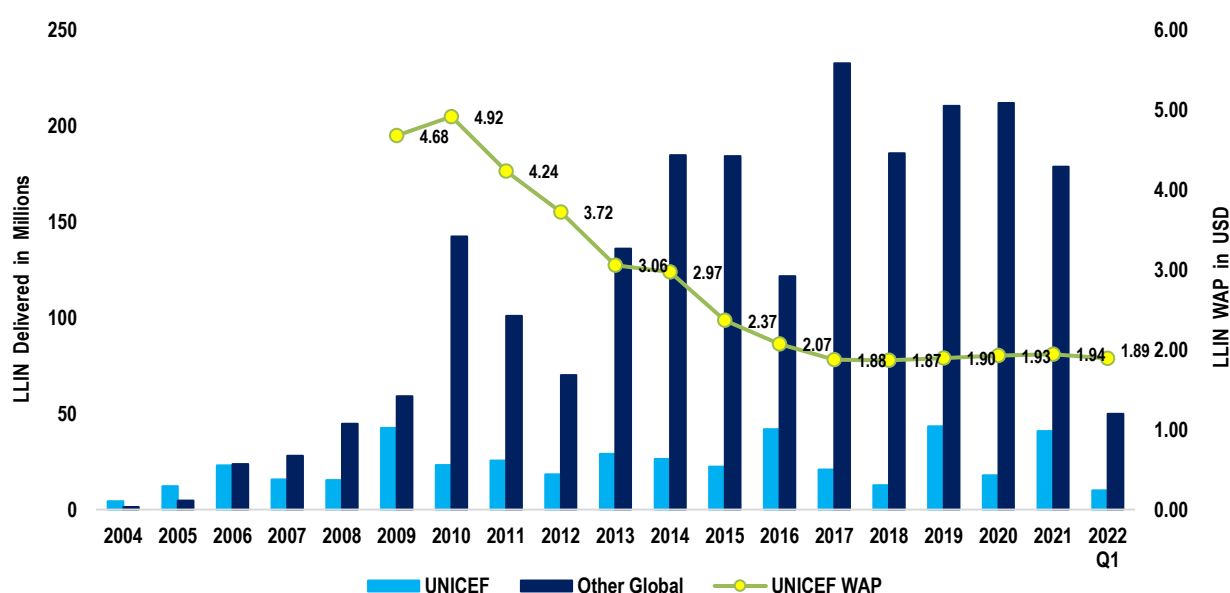
The use of LLINs remains the most efficient approach for malaria vector control and prevention, and efforts to sustain the gains achieved to date depend on funding availability as a key driver of demand. Total funding for malaria control and elimination in 2020 was estimated at USD 3.3 billion, compared with USD 3.0 billion in 2019 and USD 2.7 billion in 2018. The amount invested in 2020 fell short of the USD 6.8 billion estimated to be required. The funding gap between the amount invested and the resources needed has widened dramatically over recent years, increasing from USD 2.3 billion in 2018 to USD 2.6 billion in 2019 and USD 3.5 billion in 2020.

Country demand forecasts and procurement plans are directly linked to and dependent on the timeliness and availability of funding. Funding uncertainty and change affect and alter a country's procurement commitment, and as such affect the accuracy of country forecasts, which remain a challenge. It also undermines a country's opportunity to secure greater procurement and transport cost-efficiencies and effectiveness that could be achieved.

The Global Fund to Fight AIDS, Tuberculosis and Malaria (The Global Fund) remains the single largest investment channel for malaria programmes, accounting for 42 per cent of all funds disbursed in 2020, followed by the US President's Malaria Initiative (PMI). On the other hand, governments of endemic countries contributed almost a third of total funding in 2020, with domestic investments nearing USD 1.1 billion.

4.1 Demand

Figure 1 Global LLIN Deliveries 2004-Q1 2022



Source: UNICEF Supply Division, AMP

Malaria programmes and replenishment cycles in large malaria endemic countries are big drivers for LLIN requirements and deliveries, which can significantly fluctuate year to year (Figure 1). The total global deliveries of LLIN have been gradually increasing since 2012, reaching over 250 million nets in 2017 and 2019. Replenishment cycles (which normally occur on a three-year cycle) for major donors such as the Global Fund drive major funding availability to meet LLIN requirements and in-country deliveries.

Between eighty to ninety per cent of LLINs are delivered to countries in sub-Saharan Africa, of which Côte d'Ivoire, the Democratic Republic of the Congo, Nigeria, and Uganda account for around 50 per cent of total annual volumes. India represents the largest recipient country outside of sub-Saharan Africa.²² Year-to-year demand can vary significantly for

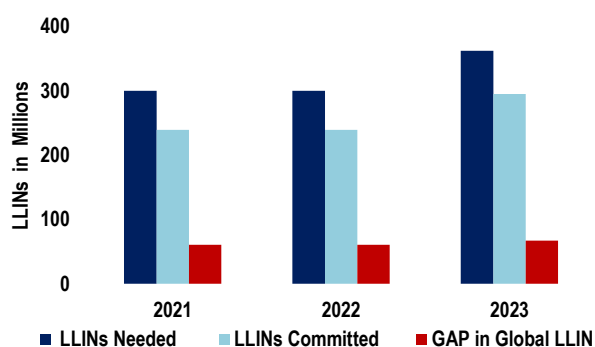
²¹ World Health Organization, *World Malaria Report 2021*, WHO, Geneva, December 2021, p. xx.

²² The Alliance for Malaria Prevention, *Net Mapping Project*, AMP, Geneva, August 2022.

each country due to some large-scale mass distribution campaigns that require countries to renew and procure LLINs on a two- to three-year cycle. The Alliance for Malaria Prevention (AMP) has been monitoring the delivery of WHO prequalified nets from manufacturers since 2004,²³ detailing deliveries per quarter, per year, per country and by donor.²⁴

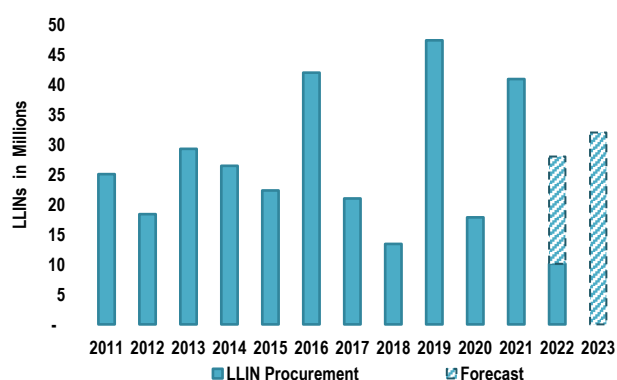
UNICEF first procured LLINs in 2000 with the purchase of 53,000 nets, and through to 2009 was the largest procurer of LLINs. Starting in 2010, other major partners, notably the Global Fund and PMI, started playing bigger roles and UNICEF's share in global LLIN procurement has ranged between 6 and 25 per cent. Over past 10 years, 2012-2021, UNICEF procured over 275 million nets, of which 38 per cent were just in the last three years: 47.4 million LLINs in 2019, followed by 17.8 million in 2020, and 40.9 million in 2021 (Figure 1, preceding page). The majority of UNICEF's LLIN procurement is delivered to countries in sub-Saharan Africa.

Figure 2 LLIN Needs and Gaps in 2021-2023



Funding availability is another critical driver of demand. Since 2014, funding has been fairly steady and predictable, with around 80 per cent of the needs covered year to year. UNICEF does not expect the funding gap will be closed over the next two years, and that between 61 to 67 million nets will remain unfunded in 2022 and 2023 according to ALMA's analysis (Figure 2).²⁵ The Roll Back Malaria Partnership's Country and Regional Support Partner Committee (CRSPC) also regularly monitors country needs, financing, and gaps, publishing the data as part of its resources [here](#).²⁶ Source: Roll Back Malaria, ALMA

Figure 3 UNICEF LLIN Procurement and Forecast



To improve access and affordability, and to ensure supply security, UNICEF promotes demand flexibility and supports countries, partnerships, and initiatives to increase the number of registered products from different manufacturers in countries. As a result, in 2021 yet another large, malaria endemic country expanded their number of nationally registered LLINs from two to four, diversifying the supply for future mass campaigns in the coming years. From a procurement standpoint, such diversification brings flexibility, improves availability, and eliminates supply dependency and associated risks.

Source: UNICEF Supply Division

Based on UNICEF's annual forecast exercise in 2022, UNICEF estimated the need for 60 million LLINs over 2022-2023. It includes the procurement of 60 million LLINs for mass campaigns in 2022-2023 for Afghanistan, Burundi, Chad, Côte d'Ivoire, South Sudan, and Sudan. UNICEF expects to procure 28 million nets in 2022 and 32 million nets in 2023 (Figure 3).

4.2 Supply

UNICEF estimates the LLIN industry production capacity to be approximately 480 million nets, from which manufacturers globally supply approximately 240-270 million nets a year.

As of mid-2022, UNICEF has ten LTAs with LLIN manufacturers for products prequalified by WHO. The list of valid LTAs is presented in Table 2.

23 The Alliance for Malaria Prevention (AMP), established in 2004, is a multi-sectoral partnership within Roll Back Malaria Partnership to End Malaria, which is itself the largest global platform of 500 partners coordinating efforts to eliminate malaria.

24 AMP, [Net Mapping Project](#).

25 Roll Back Malaria, [Programmatic and Financial Gap Analysis](#), UNOPS, Copenhagen, August 2022.

26 Roll Back Malaria, [Country/Regional Support Partner Committee \(CRSPC\)](#), UNOPS, Copenhagen, August 2022.

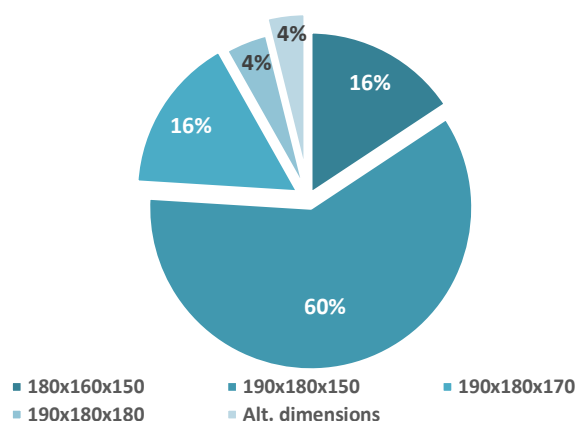
Table 2 UNICEF LTAs with Manufacturers 2019-2023

Manufacturers	Product	Material	Active Ingredient / Synergist	LTA Duration	Start Date	End Date
BASF (Germany)	Interceptor G2	Polyester	Pyrethroid + Chlorfenapyr	31 months	01.06.2021	31/12/2023
Disease Control Technologies (USA)	Royal Sentry®	Polyethylene	Pyrethroid	60 months	01/01/2019	31/12/2023
	Royal Sentry®2.0	Polyethylene	Pyrethroid	60 months	01/01/2019	31/12/2023
Guangdong / Life Ideas Biological Technology (China)	Panda Net 2.0®	Polyethylene	Pyrethroid	60 months	01/01/2019	31/12/2023
Mainpol (Germany)	SafeNet®	Polyester	Pyrethroid	60 months	01/01/2019	31/12/2023
Net Health (A to Z Textile Mills) (Tanzania)	MiraNet®	Polyethylene	Pyrethroid	60 months	01/01/2019	31/12/2023
	OLYSET Net®	Polyethylene	Pyrethroid	60 months	01/01/2019	31/12/2023
Shobikaa Impex Private (India)	DuraneNet®	Polyethylene	Pyrethroid	60 months	01/01/2019	31/12/2023
	DuraneNet® Plus	Polyethylene	PBO	24 months	01/01/2022	31/12/2023
Sumitomo Chemical (Japan)	OLYSET Net®	Polyethylene	Pyrethroid	54 months	01/01/2019	30/06/2023
	OLYSET PLUS®	Polyethylene	PBO	54 months	01/01/2019	30/06/2023
Tijanjin Yorkool International (China)	Yorkool LN®	Polyester	Pyrethroid	60 months	01/01/2019	31/12/2023
Vestergaard (Switzerland)	PermaNet 2.0®	Polyester	Pyrethroid	54 months	01/01/2019	31/06/2023
	PermaNet 3.0®	Polyester	PBO	54 months	01/01/2019	31/06/2023
VKA Polymers (India)	MAGNet®	Polyethylene	Pyrethroid	60 months	01/01/2019	31/12/2023
	VEERALIN®	Polyethylene	PBO	60 months	01/01/2019	31/12/2023

Source: UNICEF Supply Division

Multiple LLIN variations in net size, colour, mesh, shape, packaging, and labelling options exist. The most procured are rectangular nets with sizes (L)190 x (W)180 x (H)150 cm, (L)180 x (W)160 x (H)150 cm; and (L)190 x (W)180 x (H)170 cm, all in standard colours: white, blue, and green, with a minimum of 100 denier.²⁷ Sixty per cent of the procurement of LLINs through UNICEF is for the 190x180x150 size net from 2019 to 2021 (Figure 4).

Figure 4 UNICEF LLIN Procurement by Sizes 2019-2021

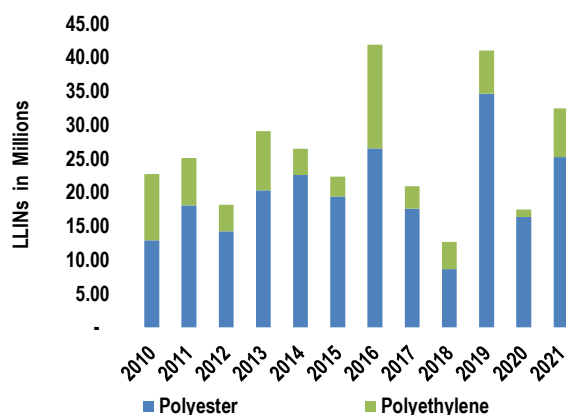


Source: UNICEF Supply Division

Four LLIN manufacturers with LTAs with UNICEF provide nets made with polyester netting material; while the other six use polyethylene. While both polyester and polyethylene nets provide the same level of protection, several end-user factors other than LLIN material seem to drive nets use. Polyester nets are lighter and softer compared to polyethylene (Figure 5). Polyester nets account for approximately 60 to 80 per cent of UNICEF’s procurement year to year. As per anecdotal feedback, the preference for polyester over polyethylene derives from a perception that lighter and softer material alleviates “airlessness” and “heat”. However, such an imbalance presents risks to supply security and undermines the optimal use of available supply. UNICEF seeks to encourage countries to adopt a more balanced adoption of polyester and polyethylene LLINs, while respecting end-user/country preferences. Nevertheless, the requirements for polyester nets increased to the unprecedented high of 93 per cent in 2020 and then reduced to a more typical 78 per cent in 2021.

UNICEF has procured novel PBO nets since 2016. From an initial 7,000 nets, over the next five years, UNICEF procurement of PBO nets has been increasing to reach over two million nets in 2018 and 2019, and over five million in 2021. The COVID-19 pandemic negatively affected UNICEF’s procurement of PBO nets, which reached less than 400,000 in 2020.

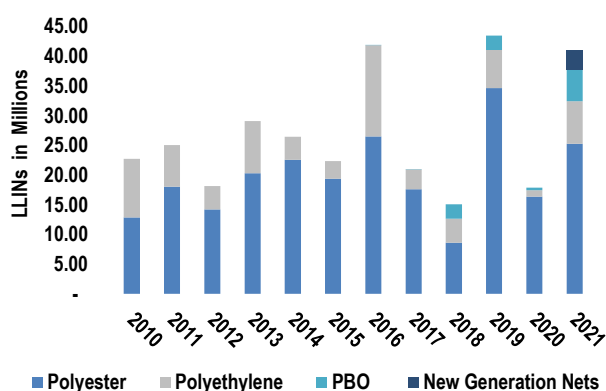
Figure 5 UNICEF LLIN Procurement by Material 2010-2021



²⁷ A denier is a unit of measurement used to determine the thickness of fibre and individual threads or filaments used in textiles and fabrics.

In 2021, UNICEF procured for the first time an order for over 3.2 million next generation nets (Figure 6). These nets have a non-pyrethroid as well as a pyrethroid active ingredient, which provide significantly better protection in areas with pyrethroid-resistant mosquitoes.

Figure 6 UNICEF Procurement of LLINs by Net Type, 2010-2021



In 2021, UNICEF placed an order for over 3.2 million next generation nets that contain a pyrethroid and non-pyrethroid as active ingredients. As countries are progressively developing comprehensive insecticide resistance management strategies using PBO and next generation nets, complementing regular pyrethroid-treated nets, UNICEF expects to see a shift in procurement towards a larger share of novel LLINs over the next three-five years.

Source: UNICEF Supply Division

4.3 COVID-19 Impact on LLINs Deliveries

Lockdowns and quarantine requirements due to COVID-19, and restrictions on power usage in China in 2021, temporarily reduced global LLINs production. The reduced workforce and global shortages and access to 40-foot containers, which are those most commonly used for shipping LLINs at all free carrier ports, increased delivery timelines and freight costs, ultimately pushing up the landed costs higher and causing a number of other supply, logistic, and programmatic uncertainties.

Shippers continue to cancel and omit vessels with no or short advance notification, and they are not making hard commitments on transit times due to the congestion at transshipment hubs. Also, the high level of bookings from China is reducing India's capacity on connected services. UNICEF's Covid-19 Impact Assessment on Global Logistics and Supplies is available [here](#).²⁸

4.4 Pricing. Price Adjustment Mechanism

UNICEF pursues price transparency as one of the ways to influence and shape the market. UNICEF publishes LLIN prices, accessible here: [Long-lasting insecticidal net \(LLIN\) price data | UNICEF Supply Division](#).^{29, 30} Published prices are indicative and do not reflect volume discounts, price decreases, nor increased costs due to incurred customization during the LTA period.

The WAP per LLIN secured by UNICEF has been steadily decreasing since 2010. From USD 4.92 in 2010, it reached USD 1.87 in 2018, reflecting a decrease of 62 per cent (Figure 1, page 4). However, since 2019, the WAP has gradually increased to reach USD 1.94 in 2021, reflecting a four per cent increase compared to 2018.

The increase in WAP has been partly due to UNICEF's growing share of procurement for more expensive PBO and next generation nets. The price increase also reflects the impact COVID-19 has had on global markets such as increased energy and labour costs, inflation, foreign currency exchange rate fluctuations, high international transport, shipping and handling freight rates, costs of storage, and increases in the price for raw materials, all of which has been pushing up the prices of material-intensive finished products, such as LLINs. The cost of raw materials alone for LLINs makes up on average approximately 45 per cent of the final product price and is the main driver behind any LLIN price increase.

To mitigate LLIN price volatility and to develop a more structured price management mechanism, in December 2021, UNICEF engaged with its LLIN LTA holders to undertake a price review exercise, which included an updated price adjustment mechanism (PAM) as a measure to mitigate the volatility in the LLIN market. PAM uses a dynamic adjustment formula, triggered by changes in an agreed common reference raw material index prices above a minimum ten per cent increase or decrease threshold as a structured pathway for raw material cost volatility management. PAM works both on

28 UNICEF, [COVID-19 Impact Assessment on Global Logistics and Supplies](#), UNICEF, Copenhagen, September 2021.

29 LLIN price based on LLINs: 190 x 180 x 150 cm; minimum 100 denier; colour white.

30 UNICEF, [Long-lasting Insecticidal Net \(LLIN\) Price Data](#), UNICEF, Copenhagen, May 2022.

a negative and positive trend, enabling an increase or decrease in LLIN price following the raw material index. UNICEF LTA holders overwhelmingly recognized benefits of PAM and adopted it as part of the LTA arrangements, covering over ninety-five per cent of UNICEF's procurement.

Through the application of PAM, UNICEF expects suppliers to remove raw material risk premiums in their LTA prices. Applying the PAM gives participating suppliers the certainty that any changes to the cost of raw materials will be adjusted proportionally in the price of LLINs. It thus reduces or neutralizes the suppliers' largest risk factor and allows them to focus on optimizing other operational aspects during the course of their LTA. In turn, participating suppliers understand UNICEF's need to ensure that any price reductions in the cost of raw materials are also captured in the price of the product.

5. UNICEF LLIN Procurement Considerations

5.1 Durability

LLIN durability depends on it retaining its physical integrity (i.e. the number and size of holes and tears a net acquires while still in use), as well as encompassing net attrition (i.e. the complete loss of the net). WHO's laboratory testing guidelines require LLINs to retain biological activity for a minimum number of 20 standard washes under laboratory conditions, and a three-year minimum period of use under field conditions.³¹ An LLIN's serviceable life depends on various factors in addition to textile durability and insecticide efficacy, the damage it acquires depending on the way households use it, which governs a net's attrition rate and the need for a replacement.

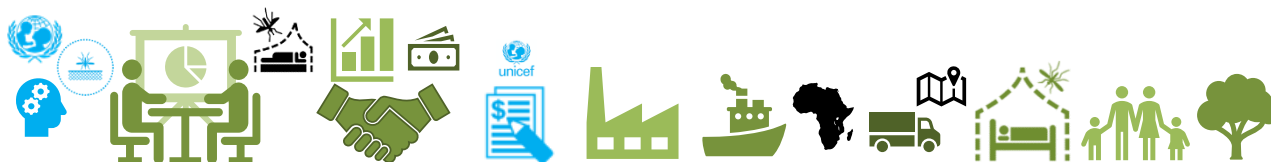
Field durability has proved to be difficult to measure and can be country- and culture-specific.³² As a result, there is to date insufficient robust evidence and durability data gathered on products to inform procurement decisions in UNICEF's recent tenders.

In the absence of clear comparative results from the available studies, UNICEF supports the work of global partners to develop durability indicators and encourages manufacturers to engage in these endeavours. UNICEF also advocates for the responsible ownership and appropriate use and maintenance of nets to ensure a prolonged life of use, as well as access to new or replacement needs at critical junctures (e.g. for women during pregnancy). In addition, UNICEF's quality control teams verify that manufacturers follow WHO recommendations and if the nets can resist local climate conditions and damage.

In order to help prolong the life and effective use of LLNs, UNICEF has improved a nets traceability through the use of barcoding. The use of scannable barcodes can help field monitoring and enable field staff and partners track and trace a nets durability. In collaboration with GS1,³³ UNICEF, global partners and manufacturers of WHO prequalified LLINs have adopted global standards on the labelling and identification of nets.³⁴

5.2 Sustainable Procurement

In February 2018, UNICEF released its procedure on sustainable procurement ([SUPPLY/PROCEDURE/2018/001](#)). The procedure constitutes UNICEF's policy sustainable procurement and is applicable across all UNICEF offices engaged in supply planning and procurement, wherever feasible and applicable, whether for goods or services, or for programmes or office assets, read more [here](#).³⁵



31 World Health Organization, *Guidelines for Laboratory and Field-Testing of Long-lasting Insecticidal Nets*, WHO, Geneva, 2013, p. 2.

32 A. Kilian, et al., *Field Durability of the Same Type of Long-lasting Insecticidal Net Varies Between Regions in Nigeria Due to Differences in Household Behaviour and Living Conditions*, Malaria Journal, Liverpool, 2015.

33 GS1 is a private, not-for-profit, international organization developing and maintaining its own barcode standards to ensure products can be identified, tracked, and traced.

34 GS1, *What We Do*, GS1, Copenhagen, Denmark, August 2022.

35 UNICEF, *Sustainable Procurement*, UNICEF, Copenhagen, September 2018.

Sustainable Procurement Considerations

In implementing sustainable procurement, UNICEF seeks to include green manufacturing quality management systems and social considerations, sustainable procurement criteria in tender evaluations and specific supply targets to develop local industry capacity in programme countries.

In applying sustainable procurement, many UNICEF procurement decisions will face trade-offs between sustainable procurement's three (economic, social, and environmental) pillars, and present key operational challenges, especially between environmental and social considerations, with the latter often being more difficult to quantify. The absence of evidence to make any informed trade-off decisions will be part of the challenge. The other challenge will be the difficulty to make value judgments to prioritize one pillar over the other. However, solutions will be situation specific, and priorities based on readiness, market influence, and targeted objectives.

Some sustainable procurement elements, notably under the social pillar, may put some pressure on short-term costs that generate longer-term savings, such as investments in fairer employment working conditions, or health and safety, which would be offset by increased motivation, productivity, and reductions in work-related injury and absenteeism. To achieve higher tangible economic benefits and VFM, UNICEF and industry will strive to manage procurement decisions based on longer-term perspectives, considering the advantages of environmentally, socially sound products and services, and better performing staff, bring in the long-term.

Source: UNICEF Supply Division

For LLINs, UNICEF focuses on several sustainable procurement aspects:

- **Supply chain elements:** UNICEF considers supply chain elements, notably on optimized container loading that have an impact not only on freight and container costs but also on carbon footprints associated with freight, as evaluation criteria in UNICEF tenders (under sustainable procurement's economic and environmental pillars).
- **Eco-friendly packaging:** UNICEF promotes bulk packaging (without individual wrappings per unit) as standard and considers the use of individual bio-degradable bags as the next best option (under sustainable procurement's economic and environmental pillars).
- **Local procurement:** UNICEF pursues opportunities to support and expand sources of local production and the procurement of prequalified products from qualified manufacturers (under sustainable procurement's economic and social pillars).
- **Sustainability:** UNICEF recognizes the circular economy as a viable model for most industries. It includes LLIN production as a way of supporting the Sustainable Development Goals 12: Responsible Consumption and Production; 13: Climate Action; 14: Life Below Water; and 15: Life on Land. UNICEF is actively supporting initiatives, approaches, and products, including with LLINs, that contribute to waste reduction and recycling. Meeting quality standards is an integral part of a circular economy. As WHO's PQT-VC processes do not yet consider issues with regards to sustainability and sustainable procurement, UNICEF will be conducting onsite visit inspections to determine if manufacturers adhere to any social responsibility and environmental impact considerations in accordance with international social accountability standards, [ISO 14001 and SA8000](#).³⁶

6 Issues and Challenges

- WHO prequalified manufacturers currently estimate their total global production capacity of recommended standard sized LLINs to reach 480 million nets a year. However, global procurement only uses just above half of this capacity as the lack of funding contributes to unmet country needs.
- An imbalance in demand structure, with a preference for LLINs made from polyester, at the expense of LLINs made from polyethylene, persists, leading to increased risks to global supply security and results in the inefficient use of resources.
- A specific priority for malaria-endemic countries is to have access to quality-assured, affordable LLINs with increased efficacy against pyrethroid-resistant mosquitoes, such as PBOs and next generation nets. However, the range of such products remains limited, and their prices are higher compared to regular pyrethroid-treated nets. Since 2019, WHO has only prequalified one new PBO net, and no new next generation nets have been added to WHO's prequalification list. As of the 2nd quarter of 2022, WHO is in the process of prequalifying two new PBO nets and one next generation net. With the arrival of new LLINs, UNICEF recommends countries to review and develop robust insecticide resistance strategies to preserve their effectiveness.
- Product registration requirements in certain countries continue to limit product range availability, which limits a country's ability and flexibility to access all the available products on the market. It also heightens product supply dependency and insecurity. LLIN manufacturers need to pursue a wider selection of product registration in countries to ensure that they increase their supplier base, and that countries can access more than one WHO prequalified LLIN product.

³⁶ Social Accountability International, [SA800 Standard](#), SAI, New York, 2022.

- Inaccurate country forecasts remain a challenge and are related to issues of funding availability and timelines. Changes in funding availability and ensuing ad-hoc requests reduce procurement opportunities for greater cost-efficiency and effectiveness, which could be achieved with more robust and timely procurement and logistics.
- The price volatility of raw materials undermines and drives price uncertainty for LLINs. Manufacturers tend to offset these uncertainties by adding a risk premium to the prices offered on LTA. UNICEF is promoting the adoption of PAM to allow manufacturers to reduce or neutralize this risk, as well as remove their risk premiums in their LTA pricing.
- LLINs is a product category that offers an excellent opportunity to apply sustainable procurement considerations, initiatives, and practices that can be implemented through intentional and coordinated efforts by manufacturers, procurers, donors, and end-users. UNICEF actively supports the sustainable procurement considerations. UNICEF will be performing onsite visits to verify of the compliance with social and environmental considerations in accordance with ISO standards.
- UNICEF advocates for the responsible ownership and appropriate use and maintenance of nets to ensure their prolonged use of life. While there are standards for LLIN durability under laboratory conditions, there is little evidence to inform of field durability and is difficult to measure. The improved traceability of LLINs through the use of scannable codes could enable and facilitate the field monitoring of durability. Global partners and the manufacturers of WHO prequalified LLINs have adopted global standards on the labelling and identification of nets in collaboration with GS1.

7 Steps Forward

- UNICEF will continue to collaborate with partners to optimize interventions, approaches, and the availability of new products and tools to improve the effectiveness of malaria vector control.
- UNICEF will collaborate with partners and governments to improve and diversify the number of LLIN products registered in countries, to mitigate risks to supply insecurity.
- UNICEF will continue to advocate and target efforts to reduce the imbalance in the uptake of polyester and polyethylene nets.
- UNICEF's will continue to foster collaboration with global partners, including the Global Fund and PMI, to improve aggregate country forecasts, monitor implementation, and align policy and practices to stabilize and determine accurate LLIN demand and increase market efficiency.
- UNICEF will implement PAM as a standard approach of its LLIN LTAs with those manufacturers that have adopted the tool. UNICEF will continue to engage suppliers and industry to consider the universal adoption of PAM as a means to mitigate the price volatility of raw materials and promote a structured pathway for overall price management.
- In collaboration with partners and manufacturers, UNICEF will support the adoption and use of scannable individual barcoding for LLINs.
- In collaboration with partners, manufactures, and end-users, UNICEF will continue to pursue its sustainable procurement considerations for LLINs, as well as to identify and support new, viable opportunities, approaches, to ensure sustainable procurement's advancement.

For further questions or additional information, please contact:

Abdallah Makhlof
Chief, Health and Technology Centre
UNICEF Supply Division
+45 45 33 55 18
amakhlof@unicef.org

Tatsiana Ptashnik
Contracts Manager
UNICEF Supply Division
+45 45 33 56 96
tptashnik@unicef.org

Aadrian Sullivan
Information Management
UNICEF Supply Division
+45 45 33 57 68
asullivan@unicef.org

Other UNICEF information notes can be found at: <https://www.unicef.org/supply/market-notes-and-updates>

UNICEF issues market and information notes on products and supplies that are essential for the needs of children, and by extension their families. While some products are easily available and affordable, the availability of others can be limited, or in some instances, non-existent in the quality and price required. UNICEF places a strategic focus on these supplies to shape healthy markets. UNICEF seeks to influence the market to achieve greater coverage, affordable prices, diversified supplier bases, competitive market landscapes, and product quality that is fit for purpose and in the right form for children.