Nets	Active
Data in use (see 'Country selection' tab): Overall	
Deaths averted per protected child under 5 (summary effect from Lengeler 2004 meta-analysis) [1]	0.00553
Under-5 all-cause mortality from trials included in Lengeler 2004 (per 1,000 child-years) [2]	34.8
Under-5 all-cause mortality in 2016 in AMF countries (per 1,000 child-years) [3]	13.8
Mortality in AMF contexts relative to study contexts	40%
Portion of mortality difference attributed to ITNs [4]	25%
Mortality in AMF contexts relative to study contexts (effect of ITNs stripped out) [5]	55%
Deaths averted per child protected after adjusting for lower mortality in today's settings	0.00303
Net use adjustment [6]	90%
Internal validity adjustment — Nets [7]	95%
Proportion of mortality attributed to malaria in areas AMF works vs. the contexts of trials in Lengeler 2004 [8]	100%
Efficacy reduction due to insecticide resistance [9]	25%
Adjusted deaths averted per child under 5 targeted by a distribution	0.00195
Pre-existing nets	
Percent of all individuals owning nets (in absence of a distribution) [10]	20%
Proportion of "extra" nets distributed that are eventually used [11]	50%
Final adjustment for pre-existing nets	90%
Reduction in prevalence from net distributions	
Reduction in malaria incidence for children under 5 (from Lengeler 2004 meta-analysis) [12]	50%
Expected reduction in malaria prevalence in current day distributions [13]	29%
Malaria prevalence in AMF context (Age <5)	14%
Malaria prevalence in AMF context (Age 5-14)	18%
Expected increase in malaria prevalence in the absence of an LLIN distribution [14]	20%
Adjusted malaria prevalence in AMF context (Age <5)	17%
Adjusted malaria prevalence in AMF context (Ages 5-14)	22%
Percentage point reduction in the point-in-time probability of a covered child being infected with malaria (Age <5)	5%
Percentage point reduction in the point-in-time probability of a covered child being infected with malaria (Age 5-14)	6%

Nets	Active
Cost per year of protection	
Arbitrary donation size [15]	$1,000,000
Pre-distribution wastage [16]	5%
Remaining dollars available for purchasing LLINs	$950,000
Cost per LLIN [17]	$4.53
Number of LLINs distributed per person in the community [18]	0.56
Cost per person covered in a universal distribution	$2.51
Number of people covered	377,822
Percent of population under 5 years old (used for mortality effects and development effects) [19]	17%
Percent of population ages 5-14 (used for development effects only) [20]	31%
Children under 5 covered	66,004
Children 5-14 covered	115,706
Lifespan of an LLIN [21]	2.22
Person-years of coverage for under 5's	146,528
Person-years of coverage for ages 5-14	256,868
Person-years of coverage for under 15's	403,397
Cost per person year of protection for under 15's	$2.48
Deaths averted — children under 5	
Under-5 deaths averted per $1,000,000 donated	257
Cost per under-5 death averted (before accounting for leverage and funging)	$3,897
Value assigned to averting the death of an individual under 5 — AMF	47
Units of value from under 5 deaths averted for each dollar donated (before accounting for leverage and funging)	0.0121
Deaths averted — individuals 5+ years old	
Ratio of 5 and over malaria deaths to under-5 malaria deaths [22]	0.38
Relative efficacy of LLINs for reducing mortality of individuals age 5 and older [23]	80%
Total number of age 5+ deaths averted per $1,000,000 donated	77
Cost per age 5+ death averted (before accounting for leverage and funging)	$12,980
Value assigned to averting the death of an individual 5 or older	85

Nets	Active
Units of value from 5 and over deaths averted per dollar donated (before adjusting for leverage and funging)	0.0066
Deaths averted — overall	
Total deaths averted per $1,000,000 donated	334
Income increases — ages 14 and under	
Reduction in the number of people infected with malaria at a single point of time in hypothetical cohort (Age<5) [24]	7,134
Reduction in the number of people infected with malaria at a single point of time in hypothetical cohort (Age 5-14) [25]	16,251
Increase in income from reducing point-in-time probability of malaria infection from 100% to 0% for an individual for one year between the ages of 0 and 14 [26]	2.30%
Additional replicability adjustment for relationship between malaria and income [27]	52%
Adjusted increase in ln(income) from reducing point-in-time probability of malaria infection from 100% to 0% for an individual for one year between the ages of 0 and 14	0.012
Average number of years between nets being distributed and the beginning of long term benefits [28]	10
Discount rate	4.2%
Benefit on one year's income (discounted back because of delay between distribution and working for income)	0.008
Duration of long term benefits of AMF (in years) [29]	40
Present value of lifetime benefits from reducing prevalence from 1 to 0 for an individual for one year between the ages of 0 and 14	0.16
Multiplier for resource sharing within households [30]	2
Present value of benefits from reducing point-in-time probability of malaria infection from 100% to 0% for an individual for one year between the ages of 0 and 14	0.32
Total units of increase in units of annual ln(income) (Age<5) — Present value	2,252
Total units of increase in units of annual ln(income) (Ages 5-14) — Present value	5,130
Value assigned to increasing ln(consumption) by one unit for one person for one year	1.44
Units of value from development benefits generated per $1,000,000 donated	10650
Adjusted long-term benefits per year of nets in terms of ln(consumption)	0.02
Units of value from development benefits per dollar donated (before accounting for leverage and funging)	0.0106
Results before accounting for leverage and funging	
Total units of value per $10,000 donated (before accounting for leverage and funging)	293
Cost per outcome as good as: averting the death of an individual under 5 — AMF	$1,609
Cost per death averted (before accounting for leverage and funging)	$2,997

Nets	Active
Results after accounting for leverage and funging	
Total additional expected value from leverage / funging — Nets	-15.89%
Total units of value per $10,000 donated (after accounting for leverage and funging)	246.79
Cost per outcome as good as: averting the death of an individual under 5 — AMF	$1,913
Cost per death averted (after accounting for leverage and funging)	$3,563
Cost per under-5 death averted (after accounting for leverage and funging) [31]	$4,633
Cost per age 5+ death averted (after accounting for leverage and funging) [32]	$15,432
Contribution of each outcome to overall cost-effectiveness	
Percent of nets' modeled benefits coming from development effects	36%
Percent of nets' modeled benefits coming from age 5 and over mortality reduction	22%
Percent of nets' modeled benefits coming from under 5 mortality reduction	41%
Intuition check	
Aggregate adjustment to Lengeler 2004 summary effect	35%
Summary calculations	
Median cost per death averted (before accounting for leverage and funging)	$2,997
Median cost per under-5 death averted (before accounting for leverage and funging)	$3,897
Median cost per death averted (after accounting for leverage and funging)	$3,563
Median cost per under-5 death averted (after accounting for leverage and funging)	$4,633

[1] "The summary rate difference, which expresses how many lives can be saved for every 1000 children protected, was 5.53 deaths averted per 1000 children protected per year (95% CI 3.39 to 7.67; Analysis 1.2). I performed a regression analysis of the natural logarithm of the rate difference on the entomological inoculation rate and could not find a trend (r 2 = 0.52, F = 3.2 on 1,3 degrees of freedom, P = 0.2). In contrast to protective efficacies, the risk differences seemed to have a tendency towards a higher effect with a higher entomological inoculation rate. This apparent paradox is because the baseline mortality rates are higher in areas with high entomological inoculation rates." Lengeler 2004, Pg 8. Author has confirmed that "protection" means "has received an ITN", not "has been confirmed to be using an ITN."

[2] The calculation behind the 34.8 figure can be seen in the section of our supplementary calculations labeled "All-cause mortality in Lengeler 2004" at https://docs.google.com/spreadsheets/d/1OM42oJzPYiPS34vedrxbgwxA-DLg7py-3J-c5pJ0HN4/.

[3] See the Against Malaria Foundation section of the "Country selection" tab for the calculation behind this figure.

[4] Funding for malaria prevention began to rapidly increase after 2004, thus some of the mortality decline after 2004 was probably due to bednets. (see http://files.givewell.org/files/DWDA%202009/Interventions/Nets/2012%20vet/Malaria%20case%20rate%20and%20death%20rate%20information%20edited.xls from http://blog.givewell.org/2012/10/18/revisiting-the-case-for-insecticide-treated-nets-itns/)

We have limited confidence in the default figure, but we believe 25% is a reasonable estimate. See Eisele et al. 2012 (https://malariajournal.biomedcentral.com/articles/10.1186/1475-2875-11-93) for more information about the role ITNs have played in mortality declines.

[5] We remove the effect of ITNs in order to estimate what the baseline mortality rate would be in the absence of a net distribution. This is higher than the actual baseline mortality rate in countries where AMF works, since nets that AMF distributes largely replace older nets, rather than being distributed to households that previously had no nets.

[6] This adjustment is used to account for reduced net efficacy due to poor net usage (i.e. people who receive nets not sleeping under them).

Net use was imperfect in trial contexts, but we guess that net use following AMF's distributions may still be lower than it was in trial contexts.

Some information about net use in bed net trials and AMF programs can be viewed at https://docs.google.com/a/givewell.org/document/d/1-wcSC2wz6Jn8uKALZvyAo9Um1ukhIB5GMaie8lQDmhU/edit?usp=sharing. Methods for collecting usage data vary, and we don't believe we can make a simple apples-to-apples comparison between AMF use data and use data from bed net trials. We have substantial uncertainty, but our best guess is that a value of 90% is appropriate for this parameter.
An excerpt from Lengeler 2004 (pgs. 10-11) details why net use may be a concern in large-scale distributions:

"The bulk of data in this review describe impact under ideal trial conditions (efficacy) rather than impact under large-scale programme conditions (effectiveness). While the difference between efficacy and effectiveness is likely to be small for certain medical interventions (such as vaccination or surgery), it can potentially be large for preventive interventions such as ITNs.

Some of the consequences of moving from a scientific trial towards a large-scale programme is illustrated by the results of the two mortality trials carried out in The Gambia. The first trial was carried out under well-controlled implementation conditions, with a high coverage rate in the target population (Gambia (Alonso)). Unfortunately it was not randomized and hence not included in the present analysis. The second one was the evaluation of a national impregnation programme carried out by primary health care personnel and which faced some operational problems...and a lower coverage rate (around 60%) of the target population (Gambia (D'Alessandro)).The difference of impact between the two studies is important: the first trial achieved a total reduction in mortality of 42%, while the protective efficacy in the second trial was 23%."
(Link to Lengeler 2004: https://www.ncbi.nlm.nih.gov/pubmed/15106149)

Additional discussion about net ownership and use is available at https://www.givewell.org/international/technical/programs/insecticide-treated-nets#How_have_larger-scale_distributions_compared_to_the_programs_addressed_in_these_studies.

[7] This adjustment is used to account for the possibility that the summary effect reported in Lengeler's 2004 meta-analysis might not have been the true effect ITNs had on the populations being studied. It's GiveWell's best guess that these trials captured something close to the true effect of nets in the study settings. Although we don't have specific, serious concerns about internal validity, we use a default value below 100% based on our expectation that published studies are more likely to overstate an intervention's efficacy than understate it.

(Link to Lengeler 2004: https://www.ncbi.nlm.nih.gov/pubmed/15106149)

[8] Our estimate of how effectively ITNs avert deaths is based on the summary effect from Lengeler 2004 (https://www.ncbi.nlm.nih.gov/pubmed/15106149), a meta-analysis of universal bed net or curtain distribution trials. We adjust the effect found in that meta-analysis based on differences in all-cause mortality rates in the contexts of the trials versus the contexts AMF works in today.

That adjustment should be sufficient if, absent nets, the portion of all-cause mortality coming from malaria mortality is constant across settings.

This parameter can be used to adjust for the possibility that the portion of all-cause mortality due to malaria is different in areas where AMF works than it was in trial settings.

The sensitivity checks at https://docs.google.com/spreadsheets/d/1OM42oJzPYiPS34vedrxbgwxA-DLg7py-3J-c5pJ0HN4/ suggest that, on average, the portion of all-cause mortality coming from malaria mortality is roughly consistent between trial settings and AMF settings. Accordingly, we set this value to 100% (implying no adjustment) in our default specification.

However, malaria burdens vary substantially between countries. A value other than 100% will be used if a specific country is selected on the "Country selection" tab.

We are uncertain about the appropriate value for this parameter and have limited confidence in the reliability of our sensitivity checks and country-specific values.

Some further discussion of how net efficacy could vary between settings with different transmission dynamics (one of the possible issues accounted for by this parameter) is available at https://www.givewell.org/international/technical/programs/insecticide-treated-nets#HowmighttheeffectivenessofITNsvaryacrosssettingswithdifferentmalariatransmissionpatterns.

[9] The default adjustment of 25% reflects our views on insecticide resistance as of September 2018. Details at https://www.givewell.org/international/technical/programs/insecticide-treated-nets/insecticide-resistance-malaria-control#How_does_insecticide_resistance_affect_the_expected_cost-effectiveness_of_donations_to_AMF.

A spreadsheet with the calculation that is used to arrive at the 25% value is at https://docs.google.com/spreadsheets/d/1Igt89pPBais7EP6sODpCj8JSulVJqLM2XSqbSxfa3NQ/edit#gid=0

[10] In many AMF distributions, the number of nets distributed to each household is based on the number of people in the household and the allocation does not take into account whether there are any non-worn-out nets already in the household. Our model assumes that some portion of people receive a new net when they had a non-worn-out net available. The value here is a guess and is based on the average lifespan of nets, the interval between campaigns (generally 3 or more years), and AMF data from Malawi where data on existing nets was collected.

[11] When a net is distributed to an individual who already has a usable net, the new net may eventually be used.

This input accounts for the average proportion of the lifespan of a LLIN that extra nets are eventually used for.

The value we use here is a guess; the true value of this input is highly uncertain.

[12] "The effect of ITNs on uncomplicated clinical episodes ofmalaria is shown by large effect estimates in all trials. Overall, thereduction in clinical episodes was around 50% for all subgroups(stable and unstable malaria; [compared with] no nets and untreated nets) and for both P. falciparumandP. vivax." Lengeler 2004, Pg 9.

We also considered using the relative reduction from analyses of (i) parasite prevalence (13%), and (ii) splenomegaly.

"In areas of stable malaria, impact on prevalence of infection(measured through cross-sectional surveys) was small: 13%reduction when the control group did not have any nets and 10% reduction when the control group had untreated nets." Lengeler 2004, Pg 9.

"Splenomegaly was significantly reduced for both types of controls:there is a 30% protective efficacy when controls were not using nets, and a 23% protective efficacy when the control group used untreated nets." Lengeler 2004, Pg 9.

We decided to use the estimate of reduction in incidence for two reasons:
(i) the largest number of trials in Lengeler 2004 collect this outcome
(ii) it is consistent with our approach for estimating prevalence reductions for seasonal malaria chemoprevention.

[13] We assume a reduction in incidence will have a similar effect on reduction in prevalence.

[14] In the absence of an LLIN distribution, net coverage would likely fall from current levels, leading to an increase in malaria prevalence.

This means the baseline prevalence (in the absence of a distribution) is likely to be higher than current prevalence.

We have attempted to quantify this consideration by calculating how much higher we would expect malaria incidence to be if net coverage dropped to 20% in a region (in line with our assumption of "Percent of all individuals owning nets (in absence of a distribution)"). We assume malaria incidence is roughly proportional to prevalence.

Our current estimate implies that, in the absence of a LLIN distribution, malaria incidence would revert to around 2013 levels.

Full calculations and sources behind this estimate can be found in this spreadsheet:
https://docs.google.com/spreadsheets/d/1fWIfaVaTKZX53mBrB9_EdT8EUsk1Q58h7XsuNj8YyJE/edit#gid=1052575435

[15] The value in this row is used for illustrative purposes only—changing this value will not affect the final cost-effectiveness estimates.

[16] Some procured nets may never make it to distribution. We have limited confidence in the default value for this input.

[17] The default value of $4.53 per net comes from GiveWell's 2018 analysis of AMF's cost per net.

See https://docs.google.com/spreadsheets/d/1AqmTkXS8CporZ0TIWPpCcesAgc9nxqYLg9GGITp66Ng for more details.

[18] "At the household level, the distribution of 1 LLIN for every 2 members of the household will entail rounding up in households with an odd number of members (e.g. 3 LLINs for a household with 5 members, etc.) Because of this rounding up, the achievement of 1 LLIN for every 2 people at household level requires an overall ratio, for procurement purposes, of 1 LLIN for every 1.8 people in the target population."
See http://www.givewell.org/international/technical/programs/insecticide-treated-nets#footnote8_zqhtlcm

[19] See the Against Malaria Foundation section of the "Country selection" tab for the calculation behind this figure.

[20] See the Against Malaria Foundation section of the "Country selection" tab for the calculation behind this figure.

[21] The default value of 2.22 is drawn from the decay model discussed at https://www.givewell.org/international/technical/programs/insecticide-treated-nets/decay-model

[22] See the Against Malaria Foundation section of the "Country selection" tab for the calculation behind this figure.

[23] AMF distributed long-lasting insecticide treated nets (LLINs), which are a type of insecticide-treated net (ITN).

The link between ITN coverage and age 5 and over mortality is not well-established by empirical research. GiveWell has spoken with malaria experts who agreed that there is a solid theoretical basis for believing that ITNs should avert adult deaths. Additional details are available in our writeup at https://www.givewell.org/international/technical/programs/insecticide-treated-nets/malaria-mortality-over-five.

In our model, we consider the ratio of adult malaria deaths to child malaria deaths in countries where AMF works (using estimates from the Global Burden of Disease Project). A value of 100% for this parameter would imply that ITNs avert deaths directly in accordance with that ratio.

For example: Imagine that data suggest there are two under-5 malaria deaths for every age 5+ malaria death in a given setting. An input of 100% for this parameter would suggest that for every two under-5 deaths averted, one age 5+ death is averted. Similarly, in the same situation an input of 50% would indicate that one age 5+ death is averted for every four under-5 deaths averted.

Note that one might choose a low value for this parameter if he or she believes that Global Burden of Disease estimates overstate malaria mortality in individuals age 5 and older.

We use a suggested value of 80%, but have limited confidence about the appropriate value for this parameter. Our value of 80% is based on the following:

1) Two reasons why bed nets may reduce proportionally less death in adults than children are:

(a) Later sleeping times: ~15% adjustment. Older individuals may go to sleep later in the day than young children. As a result, 5-and-overs may be less likely to be under bed nets during the hours when mosquitoes are most likely to bite. We do not have data on this; the only malaria researcher we spoke to who commented on this said, "We investigated mosquito biting times and the times people are under a bed net, and generally did not find large differences between adults and children, though it did vary substantially from site to site." (See link to notes in above report.) We have very roughly guessed that perhaps children are asleep during ~10 critical hours of mosquito biting time. If older individuals are not under bed nets for ~1.5 of those hours, then we roughly assume the nets are ~15% less effective for them.

(b) Lower net use: ~15% adjustment. Maybe older individuals use nets less than young children. We have not yet investigated this in-depth. The only malaria researcher we spoke to who commented on this said, "Bed net usage rates among adults are quite good overall; they mostly share a sleeping place with young children. Again, there is very little research out there and quite a lot of variability. For example, one study found the lowest usage is often among teenagers as, unlike young children, adolescents often don’t share sleeping spaces with their parents." (See link to notes in above report.) We have adjusted by ~15% for this factor very arbitrarily.
2) One factor going in the other direction is that we'd guess that a substantial portion of bednets' effects are community-level effects that come about from generally killing mosquitoes in a region; since these effects are not based on bed net usage practices for any given individual, we expect them to be similar for children and adults. We add ~10% to the adjustment account for this factor.
3) Final discount: 100% - 15% - 15% + 10% = 80%

[24] How many less children under the age of 5 do we expect to be infected with malaria at a given point in time for the arbitrary donation size given above?

[25] How many less children between the ages of 5 and 14 do we expect to be infected with malaria at a given point in time for the arbitrary donation size given above?

[26] This figure represents a midpoint between the findings of two natural experiments (Bleakley 2010, Cutler et al. 2010)

It should be interpreted as the expected increase in lifetime income from reducing the point in time probability of having malaria from 1 to 0 for one year.

We are uncertain at what age range children would get long term benefits from malaria reduction. We chose ages 0-14 fairly arbitrarily, but do not believe the results are highly sensitive to this assumption. We normalized the results of the studies we relied on to an annual figure by dividing by 15, and then applied this to children aged between 0 and 14. If we had chosen a lower age than 14, the increase in the estimate of the annual effect would have been cancelled out by applying it to a lower proportion of the population.

We have not yet published the full rationale for choosing this figure.

Bleakley 2010: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3810960/

Cutler et al. 2010: https://scholar.harvard.edu/files/kremer/files/malaria_aej_applied_2010.04_sunday_two.pdf

[27] We apply a downward adjustment to the headline results of the studies for two reasons:

1) The two natural experiments we use to calculate the expected increase in income from reducing malaria have a number of weaknesses and uncertainties. In particular, they study different malaria interventions that operated in different places and time periods and generated larger reductions in malaria prevalence than the programs we are currently modelling. While they support the idea that suffering from malaria can have substantial impacts on long-term income, we are unsure if extrapolating the effect sizes they estimate is externally valid for our model.

They are also retrospective, quasi-experimental studies, and we cannot entirely rule out the possibility that the observed results are affected by unknown other factor(s) or data quality issues.

We therefore apply a subjective downward adjustment (70%) to the headline results of the studies.

2) The studies primarily report outcomes for males. We would guess that there would also be effects on income for females, but that these would be lower due to females having lower rates of labor force participation. We apply a further discount of 75% to account for this consideration.

70% x 75% gives a replicability adjustment of 52%.

We have not yet published the full rationale for choosing this figure.

Bleakley 2010: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3810960/

Cutler et al. 2010: https://scholar.harvard.edu/files/kremer/files/malaria_aej_applied_2010.04_sunday_two.pdf

[28] Our best guess is that children are roughly 17 years of age when they begin substantive work (see our justification for the equivalent parameter in our deworming cost-effectiveness analysis https://docs.google.com/document/d/1NxN6SO8GNv1AhpHMy1-IGu-tStT7py29W8AFU0u_bLw/edit?ts=599b4840)

We assume children between the ages of 0 and 14 benefit from the long run effects of reduced childhood exposure to malaria. Taking a simple average, we expect the average beneficiary is ~7 years of age.

Our best guess is therefore that there are ~10 years between receiving nets and starting work.

[29] For consistency, we use the same figure here as we do for our deworming CEA. This is our estimate of the length of an adult's career.

[30] For consistency, we use the same figure here as for deworming. We repeat the cell note from our deworming cost-effectiveness analysis:

"If a person treated for worms earns additional income and supports a family, then multiple people may benefit—not just the person who was dewormed.

In a multi-person household with one wage earner, a 10% increase in wages could enable every member of the household to consume 10% more. However, many households will have multiple wage earners, and household size may change overtime.

A rough model for estimating a value for this parameter is available at https://docs.google.com/spreadsheets/d/112uuyYt6QLRZuJojwz6fHv4JQ-GHNeIpiT-SauY3kmM/edit#gid=0. The appropriate value for this parameter will depend on many uncertain factors (e.g. household composition and how household composition changes overtime). We currently use a default value of 2.0. Our rough model suggests values close to 2 under a range of reasonable assumptions."

[31] This parameter accounts for the entire cost of the program divided by the number of under-5 deaths averted. It does not take into account the age 5+ deaths averted in this cohort.

[32] This parameter accounts for the entire cost of the program divided by the number of age 5+ deaths averted. It does not take into account the under-5 deaths averted in this cohort.