



U.S. PRESIDENT'S MALARIA INITIATIVE



THE PMI VECTORLINK PROJECT

2020 SCHOOL AND COMMUNITY-BASED ITN DISTRIBUTION COST STUDY REPORT

Recommended Citation: Yukich, Joshua, Eleanore Sternberg, and Jane Miller. September 2022. *2020 School and Community-Based ITN Distribution Cost Study Report*. Rockville, MD. The PMI VectorLink Project, Abt Associates Inc.

Contract: AID-OAA-I-17-00008

Task Order: AID-OAA-TO-17-00027

Submitted to: United States Agency for International Development/PMI

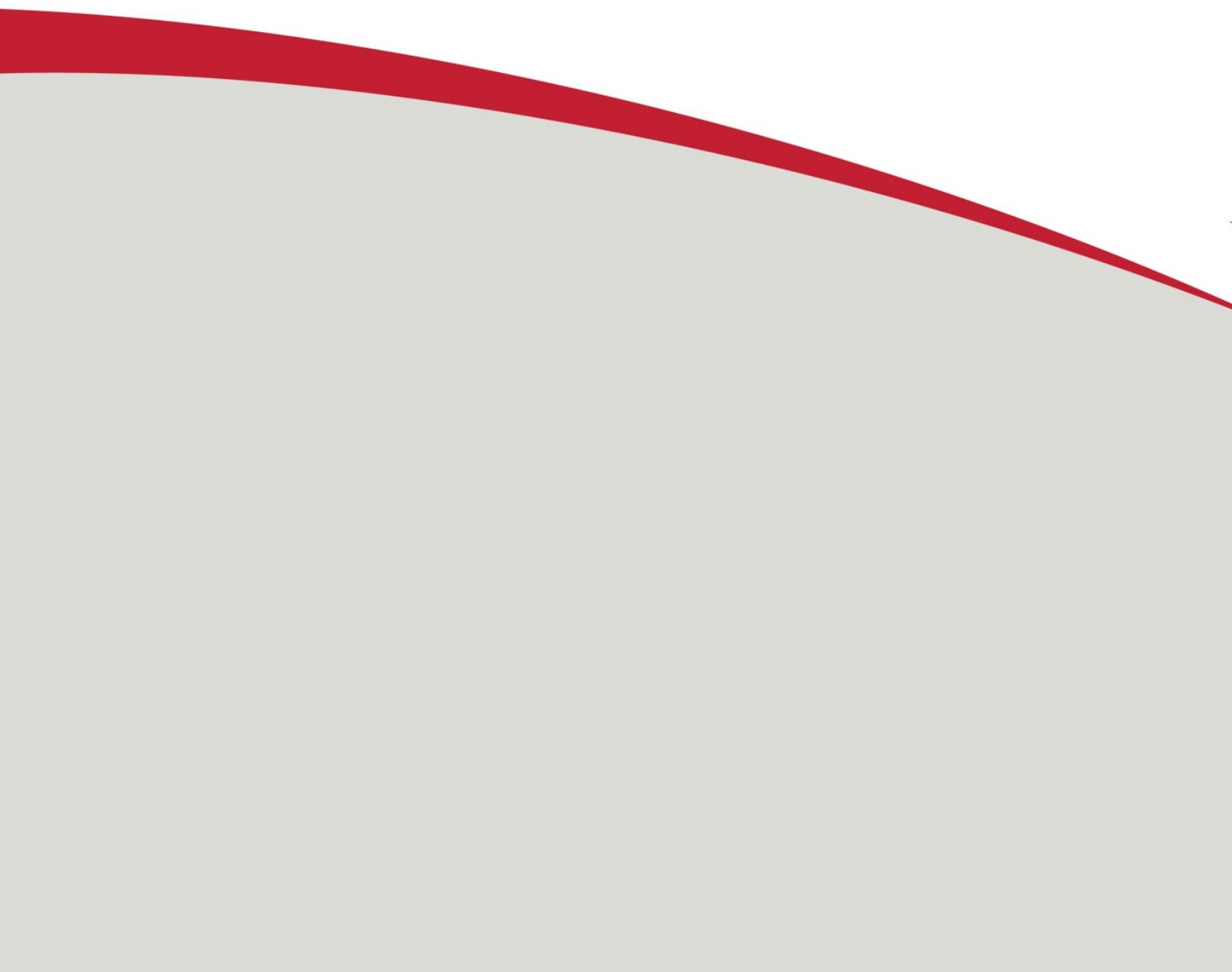
Submitted on: September 30, 2022

Approved on: January 11, 2023



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ACRONYMS

3PL	Third Party Logistics
ANC	Antenatal Care
CCD	Continuous Community Distribution
CMS	Central Medical Stores
DMFP	District Malaria Focal Persons
EPI	Expanded Program on Immunization
GES	Ghana Education Service
GHS	Ghana Health Service
GHSC-PSM	USAID Global Health Supply Chain-Procurement and Supply Management
ITN	Insecticide Treated Net
LGA	Local Government Authorities
MOE	Ministry of Education
MOH	Ministry of Health
MoHCDGEC	Ministry of Health and Community Development, Gender, Elderly and Children
PMI	U.S. President's Malaria Initiative
PO-RALG	President's Office – Regional Administration and Local Government
NMCP	National Malaria Control Program
RMFP	Regional Malaria Focal Persons
SBC	Social and Behavior Change
SBD	School Based Distribution
SHEP	School Health Education Program
SISO	School Improvement Support Officers
SLES	Simba Logistic Equipment Supply
SNP	School Net Program
ZAMEP	Zanzibar Malaria Elimination Program

I. BACKGROUND

Insecticide-treated nets (ITNs) are known to be among the most cost-effective measures for reducing malaria morbidity and mortality (White et al 2011; Conteh et al 2021). Mass distribution campaigns and continuous distributions are both recommended by the World Health Organization as part of a strategy to achieve and sustain access to ITNs.

ITN distribution systems have evolved over the past two decades in sub-Saharan Africa. Most countries in the region now implement a combination of mass ITN distribution campaigns and continuous “routine” distribution during ante-natal care and/or immunization health system contacts to distribute nets to the general population and to targeted biologically vulnerable groups in order to achieve vector control coverage goals. Additional ITN distribution mechanisms also exist, including variations on school-based and community-based distributions. School based distribution has been shown to be effective and cost-effective¹ in maintaining universal coverage of ITNs and community-based channels have also been shown to be effective in some settings (Killian et al 2017; Stuck et al 2017; Stuck et al 2022; Yukich et al 2020). Existing research has shown that the costs of ITN distribution may vary depending on context, the mechanism of distribution, and the perspective of costing (e.g., provider, societal, recipient). The evidence base for the costs of continuous distribution systems is more limited than the evidence base for the more widespread mass campaign distribution approach (Wisnewski et al 2020; Scates et al 2020; Conteh et al 2021).

This study seeks to expand the evidence base on the cost of ITN distribution through community and school mechanisms by estimating, comparing, and contrasting the cost of ITN distribution in four programs, two community-based, Zanzibar and Madagascar, and two school-based, Ghana and mainland Tanzania, during the year 2020 in the context of the COVID-19 pandemic. The U.S. President’s Malaria Initiative (PMI) supports ITN distribution in a number of partner countries through the PMI VectorLink project as well as bilateral projects. The purpose of this study is to expand the evidence base and improve decision making around continuous distribution of ITNs in sub-Saharan Africa.

¹ Effectiveness is a measure of whether the intervention of interest produces a given outcome. Cost-effectiveness is generally calculated by dividing a cost measure by an effectiveness measure to give a measure of how much it costs to produce a given health outcome using a specified intervention. It is a metric used to inform resource allocation decisions and to measure efficiency in producing the outcome.

2. METHODS

This study is a case series of cost estimates of ITN distribution programs. Four programs were compared:

1. Zanzibar Community Based Net Distribution 2020
2. Madagascar Community Based Net Distribution 2020
3. Ghana School Nets Distribution 2020
4. Tanzania School Net Distribution 2020

The study used the provider perspective² and covered a period of one (12-month) year for each program. Costs and/or cost savings to intervention recipients were not included.

All programs were assumed to be ‘mature’ programs operating at running levels, whereby annual costs may fluctuate, but no ‘start-up’ costs are incurred or captured. Economic cost (opportunity cost or the value of the resource in its next most productive use) has been estimated where possible. Financial cost (costs incurred on financial ledgers) was produced as a secondary option, if the data were not available to produce accurate economic cost estimates (*i.e.*, if we were unable to value significant donated contributions). We have attempted to include all financial and economic costs from the provider perspective, meaning both those resources contributed through international donor agencies and their implementing partners, as well as those provided by the domestic health systems. The study has estimated gross costs and does not include potential cost savings to providers from reduced malaria treatments.

Data was collected through document review and key informant interviews. Documents reviewed included budgets and expenditure reports from distribution systems, invoices for ITNs operational and monitoring and evaluation reports on the systems, and gray and published literature. Documents were sourced by VectorLink and PSI from their own records and from other partners. Key informant interviews were conducted remotely via phone, Zoom, or similar. Key informants included program managers of implementing partners of the distribution systems, national malaria control program managers and other Ministry of Health employees involved with administering the program. Interviews were used to understand the content of documents obtained or to identify and value resource inputs which were otherwise not documented. A maximum of four-five interviews per program were conducted by the Tropical Health study team, with support from PSI representatives in-country, where deemed necessary/feasible. Additional data from previous costs assessments of the government contributions to these specific distribution systems was also used to calculate unit costs of government inputs where possible and where such information was not available during the current period.

Where detailed data of sufficient quality was available for non-PSI costs, we integrated these data into cost estimates, but where such data is not available/acquirable with study resources, we made budget/expenditure estimates from the more limited provider perspective, including PSI-only (and ITN) costs. For the case study in Madagascar no estimate of government resource use or financial contribution was available and cost estimates are therefore composed of only ITN and PSI costs. For the Ghana and Zanzibar case studies, previous studies collected information on the contribution of domestic sources (government resources). These data were used by estimating the additional per net cost of government contribution by line item and scaling

² Provider perspective is generally considered to include resources used from all the entities/persons involved in the delivery of the intervention and to exclude those used by beneficiaries and indirect costs.

these to the number of nets distributed in the 2020 session. In all case studies the price of an ITN was assumed to be USD 2.50 in base-case analysis³.

Data analysis was primarily descriptive. We estimated the total financial and economic costs of each program as well as per ITN cost (unit cost) for each program. Costs were disaggregated into line items and/or activity groups/cost-centers to the extent possible. Costs were also disaggregated by financing arrangement where possible. Finally, costs were presented both including costs of the ITN products, with only one year of ITN cost included and with the cost of ITNs excluded (in sensitivity analysis). Cost data was compared across the four programs studied, as well as between each of the community-based distributions and each school-based distribution. Cost data is presented in 2020 USD. ITNs were assumed to have a three-year lifetime and were annuitized for analysis considering this lifetime. Where government unit costs were estimated using historical cost estimates these costs were adjusted to 2020 USD using the U.S. Gross Domestic Product Implicit Price Deflator (US BEA 2022). Where applicable, a discount rate of 3% was used for base case analysis⁴. Assumptions made during the costing were examined in one-way sensitivity analysis.

The rest of this report starts with a description of each of the four programs costed. This is followed by the costing results first by program and then across programs. These results are discussed in the next section before concluding remarks. The report ends with the list of the literature used as reference for the study.

³ A unit price of USD 2.5 was applied for two reasons: 1) to use a uniform value in order not to bias comparisons between systems based solely on procurement prices of ITN; and 2) since prices for nets/invoices were not shared by GHSC-PSM, we used a number that should provide a general comparability to previous studies as it is in the normative range of ITN prices over a relatively long historical period. It is intended to represent a typical delivery duty paid (DDP) value in the main port/location of delivery nationally, noting that intra-country logistics are being valued separately in these cost estimates.

⁴The Discount Rate is a measure of the time-value of money and is used as part of the annuitization process for capital goods (here mainly ITNs) which are used only partial during a project. The discount rate is applied to account explicitly for the cost of capital.

3. DESCRIPTION OF COSTED PROGRAMS (2020)

3.1 ZANZIBAR CONTINUOUS COMMUNITY DISTRIBUTION (2020)

The community distribution system in Zanzibar is integrated with reproductive and child health distribution of ITN. Health facilities serve as decentralized points for storage and issuing ITNs, as well as a nexus of reporting and management of voucher/coupon supply. For this reason, the community distribution system is considered as a component of the larger continuous distribution system in Zanzibar and requires health facility resources to function. This intervention description refers to distribution of nets under this system, with costs information for the period July 2020 to February 2021 as per the study scope. The system is led and implemented by Zanzibar Malaria Elimination Program (ZAMEP) in collaboration with other parts of the health system. It is supported by the PMI VectorLink project, which principally assists ZAMEP in their planning and supervision functions whilst ITNs procurement and transport and social and behavior change (SBC) support for ITNs are provided by other PMI funded projects, as described further below.

PMI VectorLink support for the continuous distribution strategy was largely with health facilities, rather than at the community level. Staff from PMI VectorLink, ZAMEP, district pharmacists, and Central Medical Stores (CMS) conducted planning meetings and reviewed resupply orders from health facilities in the Phase III design phase.

These teams developed an ITN distribution plan for all health facilities on Unguja and Pemba islands (179 health facilities identified). This plan was reviewed and approved by relevant local government authorities (LGAs). Implementation of the distribution plan was done by Simba Logistic Equipment Supply (SLES).

PMI VectorLink organized pre-alert meetings with LGAs to coordinate the timing of deliveries to each facility. USAID Global Health Supply Chain-Procurement and Supply Management (GHSC-PSM) procured ITN and coordinated their delivery to CMS in Zanzibar. CMS created an invoicing system used to validate deliveries of ITNs to health facilities, and ITNs were then moved to health facilities by SLES according to the validated delivery plan. Standard CMS logistics management took responsibility for nets at the health facility stores. Aside from the initial push of nets to facilities, resupply orders were prepared by CMS and the logistics of health facility resupply was handled by SLES.

Nets were issued through three channels: (1) at a pregnant women's first antenatal care (ANC) visit at a health facility, (2) to a child attending a health facility to receive their first measles-rubella vaccination (approximately nine months of age), or (3) when a community member presented with an issued coupon/voucher for an ITN. The issuing of vouchers for nets were handled through community systems managed at the shehia level by sheha (community leaders) or assistant sheha. Sheha received coupons in volume from health facilities, typically travelling to retrieve the coupons from facilities and returning the coupon stubs to the health facilities using their own resources. Sheha or their representatives then issued these coupons to community members who met eligibility criteria, and the community member could redeem the coupon at a health facility for an ITN. Eligibility criteria evolved over the course of the community distribution system, but in 2020 they were: uncovered sleeping spaces, ITNs torn beyond repair, households identified through reactive case detection, or households that have been struck by disasters (such as flooding and fire).

Reporting on ITN distribution, from health facilities to district and finally to national levels, occurred through the Chandarua Kliniki dashboard, an accountability information system hosted under DHIS2 as a standard commodity reporting system of the Ministry of Health. The Chandarua Kliniki dashboard captured and provided data on ANC and the expanded program on immunization (EPI), as well as ITNs distributed through

those channels and through community coupons. Supportive supervision was provided by PMI VectorLink in collaboration with the Ministry of Health/ZAMEP and supportive supervision visits were conducted at all health facilities during Phase III. During Phase III, 251,960 nets were distributed through the combination of the community channel, ANC and EPI. SBC for ITNs was supported by the PMI Tulonge Afya project.

3.2 MADAGASCAR CONTINUOUS COMMUNITY DISTRIBUTION (2020)

Continuous community distribution (CCD) of ITNs in Madagascar was carried out in specific targeted districts. The system leveraged existing community structures and organizations to distribute ITNs to households in communities in the targeted districts. The overall strategy for CCD consisted of three main domains: 1) coordination, planning and advocacy, 2) logistics, and 3) communication. Within these domains, the partnership consisting of the PMI IMPACT project (a consortium of PSI, MSH, PATH, Banyan Global and Telma Foundation), the Ministry of Health (MOH) (*Ministère de la Santé Publique*), the NMCP, and the Ministry of Education (MOE) (*Ministère de l'Éducation Nationale et de l'Enseignement Technique et Professionnel*) all shared responsibility for activities across domains.

Coordination of activities was managed at each level (national, regional, district, commune, and community site) by a coordinating committee composed of stakeholders from Madagascar, MOH, MOE LGAs, PSI, and others. PSI largely undertook the role of issuing payment through direct means or mobile money for personnel operating in the delivery of nets and providing technical supervision in collaboration with MOH, and MOE personnel at all levels above the community sites of distribution.

Financing was provided by USAID/PMI and by the Government of Madagascar. ITNs for distribution were procured internationally for the 2020 distribution by GHSC-PSM, cleared from customs and delivered to the PSI national warehouse storage depot in Antananarivo. Planning and quantification for the implementation of this activity across all selected districts had previously been conducted at the national level by the national coordinating committee with an expected requirement of approximately one million ITNs. However, only around 786,281 ITNs were eventually distributed to the district level, nearly all of which (~99%) reached households. PSI and its logistic contractors moved ITNs through district stores and eventually to commune stores managed by PSI. Nets were then retrieved from commune level stores by community agents and distributed through community sites.

Community agent mobilisers surveyed their local communities for households with sleeping spaces uncovered by ITN and issued coupons to these households. Households could then bring the coupon to a community distribution site on designated distribution days, where a community distribution agent would redeem the coupon for an ITN. This activity is generally integrated with the routine activities of the mobilizers (e.g., vaccinations) and therefore is already financed by these other programs.

Communication and advocacy were conducted⁵ through a combination of mechanisms, including through schools, radio spots for local radio broadcasts, targeted SMS messaging and various communications products including job aids, posters, bracelets, stickers, and other items. Interpersonal communication activities were carried out in three phases, with one contact being during the sweep of the community to identify uncovered sleeping spaces, a second when the community members come to redeem coupons for ITNs and a final visit by community agents to the home after the nets were obtained.

Information and reporting were provided through an electronic system based in DHIS2 software. Paper reporting was conducted from community sites through the commune and to the district level where data was entered into the DHIS2 system.

During the 2020 (January – December) CCD, a total of 786,281 ITNs were distributed in 12 districts.

⁵ We could not clarify from the program who funded these communication and advocacy activities.

3.3 GHANA SCHOOL BASED DISTRIBUTION (2020)

The seventh school-based distribution (SBD) in Ghana was delayed in the year 2020 by school closures due to the COVID-19 pandemic. It was originally planned for May 2020 but was delayed until November/December 2020. Distribution targeted primary school class 6 and junior high school class 2; this was also a “covid adaptation” as in previous years only primary school classes 2 and 6 were targeted.

A “macro” plan was developed at the national level by the national ITN committee which included quantification, planning, logistics and other factors necessary for distribution of nets to districts and schools. This plan served as a foundation for regions, districts, and other administrative levels to adapt to specific local circumstances. Coordination of ITN distribution was carried out by a partnership between the Ghana Health Service (GHS) and the National Malaria Control Program (NMCP), the Ghana Education Service (GES) and School Health Education Program (SHEP), PMI Ghana, PMI VectorLink and GHSC-PSM. Quantification of net requirements was undertaken by the ITN committee using school enrollment data from the Education Management Information System in 2019.

Micro-planning sessions were held in each targeted district. These sessions produced district level micro plans, including information on local logistics, training, and communication with head teachers/principles of schools, and planning for appropriate distribution including COVID-19 mitigation strategies within schools.

Trainings for distribution were conducted both virtually and in person. A one day, in-person training was used for School Improvement Support Officers (SISOs) and a virtual training was used for district and regional level supervisors. In previous SBD, school premises had often been used for training however distancing for COVID-19 prevention required the use of conference centers and hotels for many of these trainings. 50 in-person training sessions were conducted in October. In total 2,364 people from 235 distinct districts attended trainings. Participants included District Directors of Education, Deputy/Assistant Directors of Supervision, District SHEP Coordinators, Private School Coordinators, SISOs from GES, District Directors of Health Services, and District Malaria Focal (DMFP) Persons from GHS. Regional level participants included regional SHEP coordinators and the Regional Malaria Focal Persons (RMFP). Of the attendees 1,665 SISOs were trained in the in-person sessions while 699 district and regional level officers participated in virtual trainings.

Approximately 1.4 million ITN were procured internationally by GHSC-PSM in 2020 for SBD. All logistics were managed by GHSC-PSM through third party logistics contracts. GHSC-PSM or their designated agents were responsible for delivery of the ITNs, clearing customs, and transportation to national warehouses. Nets for school distribution arrived in Ghana in April and were stored at the national level until October, when they were moved to the district level stores of the education ministry in preparation for delivery to schools in November.

Distribution itself was supervised by a combination of representatives from the PMI VectorLink Project, SHEP national officers, NMCP, GHS and GES regional and district staff, and SISOs. For junior high school classes, class teachers handled distribution and nets were generally delivered directly after receipt, to minimize storage and security risks at schools. For primary school classes, the schools were closed during the time of distribution and therefore additional outreach by local education authorities was used to encourage pupils, parents, or relatives to retrieve the ITNs at the local schools. This necessitated school level storage for several weeks and resulted in some ITN remaining at schools at the end of the eligibility period. Approximately 68,000 ITN were returned to GHS stores to be distributed at health facilities. Inter-school redistribution of nets, where necessary, was conducted by SISOs.

Trained SISOs were responsible for record keeping and data entry and used a Ghana NMCP bespoke mobile app (Net4Schs) on tablets provided by NMCP. Formal checklists were used for monitoring and supervision by GES and GHS national, regional, and district officers. SISOs were entrusted with the responsibility of reinforcing messages on ITN use and care in schools. Previously, School-based health coordinators and head teachers were trained and tasked to develop an ‘action plan’ for educating pupils in schools and parents during Parent Teacher Association (PTA) meetings.

In total 1,175,249 ITNs of an initially targeted 1,243,650 were distributed through 26,488 schools in 235 (out of 260) districts in 15 (out of 16) regions.

3.4 TANZANIA SCHOOL BASED DISTRIBUTION (2020)

The School Net Program (SNP) in Tanzania has operated in mainland Tanzania for nearly 10 years. The eighth round of SNP, SNP-8, was conducted during calendar year 2020 (planning and coordination began in June 2020 and distribution of nets occurred in August to November 2020). The plan for distribution in SNP-8 was developed by PMI VectorLink in collaboration with the Ministry of Health and Community Development, Gender, Elderly and Children (MoHCDEGEC), NMCP, MOE, and President's Office - Regional Administration and Local Government (PO-RALG).

Advocacy and microplanning meetings were coordinated by PMI VectorLink at the regional and council level. Participants included the Regional Medical Officers, Regional Education Officers, RMFP, District Medical Officers, DMFP, and Statistics and Logistics Officers. Meetings were facilitated by PMI VectorLink staff, PO-RALG staff, and MoHCDEGEC/NMCP staff. There were 43 meetings conducted during this phase of planning and coordination. PMI VectorLink followed advocacy and microplanning meetings with pre-alert meetings with all target councils to develop detailed distribution plans. PMI VectorLink worked with SNP coordination teams to determine ITN quantities per school, identify appropriate routes for distribution, develop plans for hard-to-reach locations, agree on ITN re-bundling/cross docking sites, and develop a distribution calendar that included supportive supervision by LGAs. There were also 43 pre-alert meetings conducted during SNP-8.

SNP-8 covered five of Tanzania's 31 administrative regions, all in the north-western part of the country (Geita, Kagera, Kigoma, Mara and Mwanza). There were an estimated 3.1 million enrolled pupils in primary school in these five targeted regions and approximately 2.3 million (75%) were considered eligible during SNP-8. Primary school pupils were eligible if enrolled in classes 1, 2, 5 & 7 (Geita), 1, 2, 3, 4 & 6 (Kagera), 1, 2, 4 & 6 (Kigoma), 1 – 7 (Mara) and 1 – 6 (Mwanza – though distribution/eligibility was not uniform in Mwanza and only two councils distributed to all six classes).

Net distribution through SNP was typically coordinated such that all nets at a given school were distributed on a single day (the same day that the nets were delivered to minimize the need for storage and security at the school level).

The nets were procured through two different mechanisms: the bulk of nets were procured through GHSC-PSM project, while other nets were procured by NMCP using Global Fund grant support. The GHSC-PSM nets were procured internationally, received at port in Dar es Salaam, cleared from customs by Kuhene and Nagel and then transferred to the VectorLink Project's third-party logistics contractor SLES, generally at regional level, using a cross-docking approach to minimize storage time and transportation costs. The NMCP procured ITNs were purchased from A-Z Textile in Arusha and transferred to VectorLink's custody directly from the manufacturer or their agent (in a similar cross-docking fashion). SLES also received these nets, and some were stored at a VectorLink rented warehouse in Mwanza after receipt from manufacturer.

SLES delivered nets directly to schools after breaking bales and re-bundling nets (reorganizing into target amounts for council and school distribution sites) at regional and district levels consistent with micro-planning quantities. PMI VectorLink used text messaging to notify head teachers about the upcoming deliveries of ITNs and to allow schools to plan for distribution. Nets were received by head teachers or principles of individual schools and documented with goods received notes as proof of delivery.

All SBC activities for the project were implemented separately by the PMI Tulonga Afya project. Supportive supervision was conducted by teams containing representatives from the national level (PO-RALG, NMCP and PMI VectorLink), and regional and council level (SNP coordination teams). USAID/PMI contributed to supportive supervision through virtual meetings with the VectorLink team. School level supervision utilized a checklist-based approach and was implemented at a total of 2,043 randomly selected schools (approximately 50% of issuing schools). Issuing data was then subsequently entered into the BEMIS system by council officials to document issuing of ITNs at school levels. SNP-8 resulted in the distribution of 2,253,149 ITNs through 4,065 schools in five districts.

4. COST ESTIMATES

4.1 ZANZIBAR COMMUNITY BASED DISTRIBUTION

Overall cost estimates for the Zanzibar community and ANC/EPI programs combined are shown in Table 1 below. ITNs (assuming a USD 2.50-unit price) and government management costs were estimated to be the largest contributors to line items, with the largest fraction of costs being used to support the delivery of nets at health facilities.

Table 1. Line-Item, Total Costs and Costs per ITN for the Zanzibar Program (2020 USD)

Total ITNs Delivered	25,1960
Detailed Costs with ITNs Full Costs	
Line Item	Cost 2020 USD
Donor Costs	
Contractual	\$53,488
Other	\$20,914
Travel	\$17,999
ITNs	\$661,395
Government Costs	
Personnel	\$69,201
Planning and coordination	\$5,536
Quantification	\$30,448
Microplanning and training	\$55,361
Supervision	\$5,536
Monitoring and evaluation	\$19,376
Health facility costs	\$1,098,909
Shehia costs	\$381,988
Total Costs with ITNs Full Costs	\$2,420,150
Total Cost Per Net Delivered with ITNs Full Costs	\$9.61
Detailed Costs of ITNs (One Year Only)	
Line Items (only variable ones)	Costs 2020 USD
Donor Costs	
ITNs	\$220,465
Total Costs, including ITNs (One Year Only)	\$1,979,220
Total Cost Per Net Delivered with ITNs One Year Costs Only	\$7.86
Total Costs without ITNs costs	\$1,758,755
Total Cost Per Net Delivered without ITNs costs	\$6.98

The types of costs included in various cost categories above are as follows:

- Donor costs:
 - Contractual: Consultants and system support costs, subcontract costs, costs for temporary hires, reclassification of costs, and other items.
 - Other: These include payments due to political violence, bank charges, boat hire, and other assorted payments.
 - Travel: This includes per diems, travel expenses, hotel hires, vehicle repairs, and other travel and local transportation related payments.
 - ITNs: cost of ITN calculated using assumed Delivered Duty Paid Price.
- Government costs: Unit cost (per net distributed estimates) based on prior study conducted under VectorWorks.⁶

Figure 1 shows the distribution of costs drivers in the Zanzibar program when a full three years of ITN costs are included versus when only one year of ITN value is included. In either case, health facility costs are the largest contributor though ITNs represent a larger proportion (27% of total costs) when a full three years of ITN value is included.

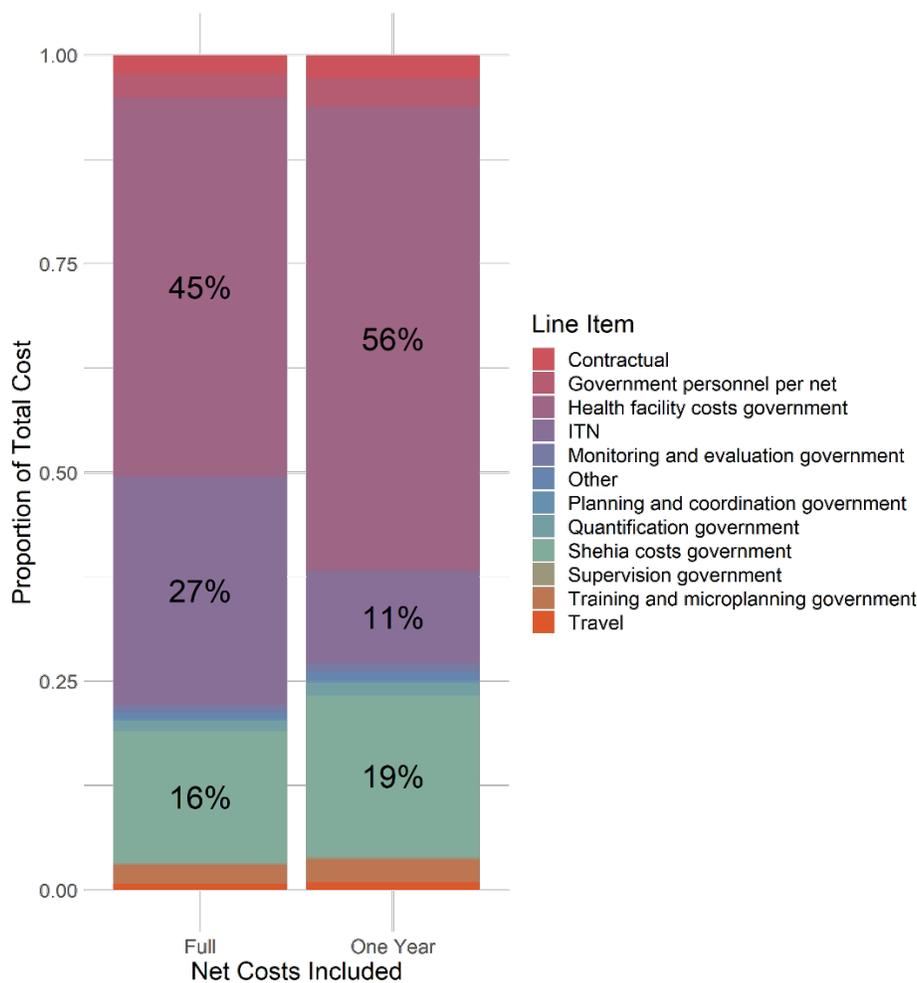


Figure I. Cost Drivers of Zanzibar Program (2020 USD)

⁶ This study was not funded to collect government costs at this level of detail. These costs were estimated using previously collected data. For more details, see study reference https://pdf.usaid.gov/pdf_docs/PA00TQMZ.pdf

Financing of ITN delivery (shown below in Figure 2) in the Zanzibar program is heavily weighted to the government, which provides approximately two thirds of all financing when all ITN costs are included.

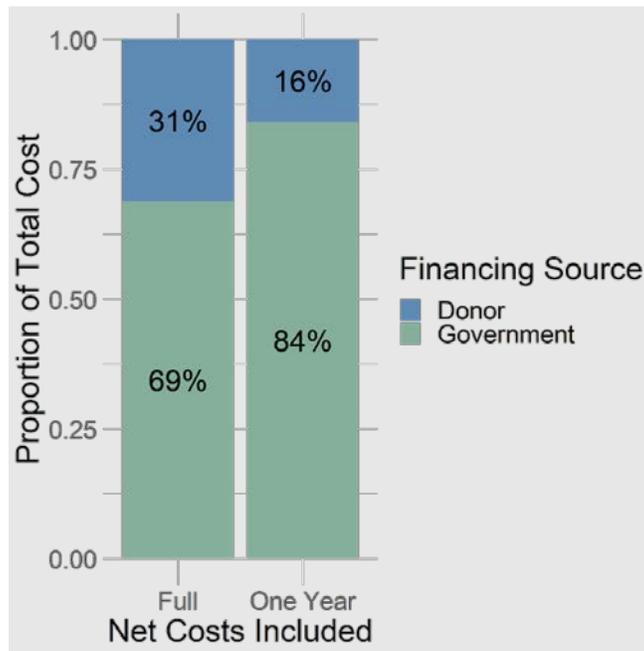


Figure 2. Financing of ITN Delivery in Zanzibar

4.2 MADAGASCAR COMMUNITY BASED DISTRIBUTION

Overall cost estimates for the Madagascar community ITN distribution program are shown in Table 2 below. PSI costs and government costs were reported as aggregate costs by line item by PSI.

Table 2. Total Costs and Cost per ITN of the Madagascar ITN Community Distribution System (USD)

Total ITNs Delivered	786,281
Detailed Costs with ITNs Full Costs	
Line Item	Cost USD
Donor Costs	
Coordination and planning	\$24,721
Local transport and storage	\$512,039
Supervision	\$86,729
Social Behavior Change Communication	\$936
Cascade trainings	\$53,811
Other travel	\$62,412
Consultants	\$147,127
RH and direct charge	\$142,596
Other Indirect	\$4,604
ITNs	\$2,063,988
Government Costs	
Personnel	\$192,077
Planning and coordination	\$779
Supervision	\$3,896
Total Costs with ITNs Full Costs	\$3,295,716
Total Cost Per Net Delivered with ITNs Full Costs	\$4.19
Detailed Costs of ITNs (One Year Only)	
Line Items (only variable ones)	Costs USD
Donor Costs	
ITNs	\$687,996
Total Costs, including ITNs (One Year Only)	\$1,919,724
Total Cost Per Net Delivered with ITNs One Year Costs Only	\$2.44
Total Costs without ITNs costs	\$1,231,728
Total Cost Per Net Delivered without ITNs costs	\$1.57

Figure 3 below shows the distribution of cost drivers in the Madagascar community program. ITNs are the main cost driver when the full three-year cost of ITN is included and when only one year of costs are included. Local transport and storage and government planning and coordination are the other main cost drivers.

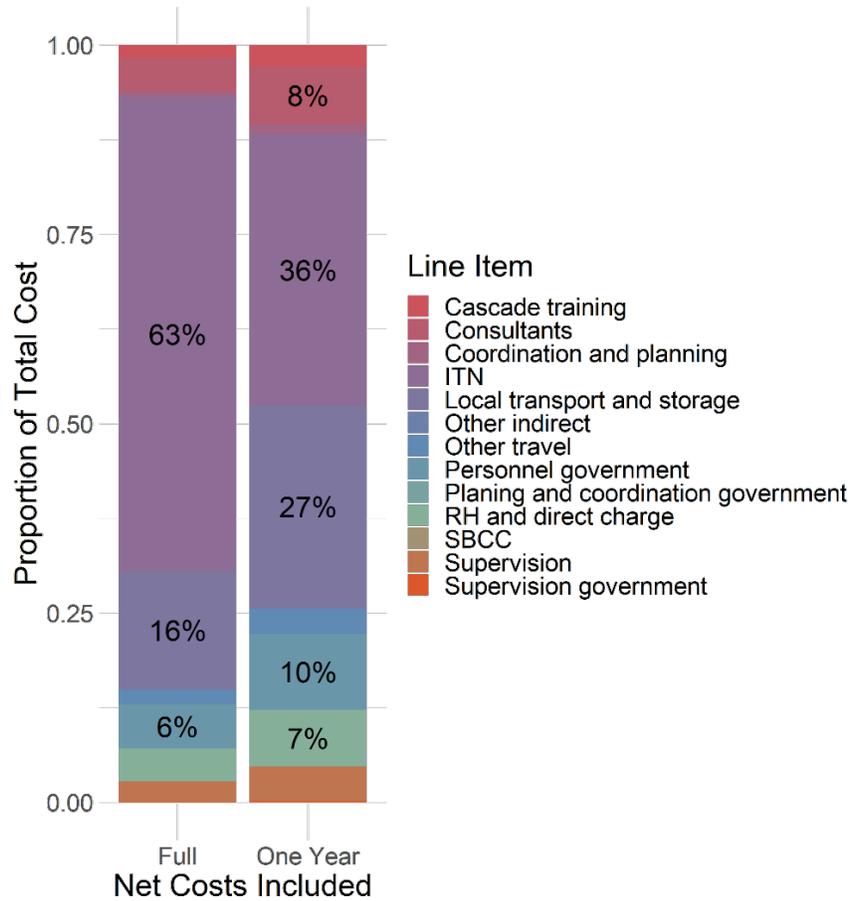


Figure 3. Cost Drivers in the Madagascar Community ITN Delivery Program

Financing of ITN delivery (shown below in Figure 24) in the Madagascar program is heavily weighted to the donors, more than 90% of costs when ITN costs are included.

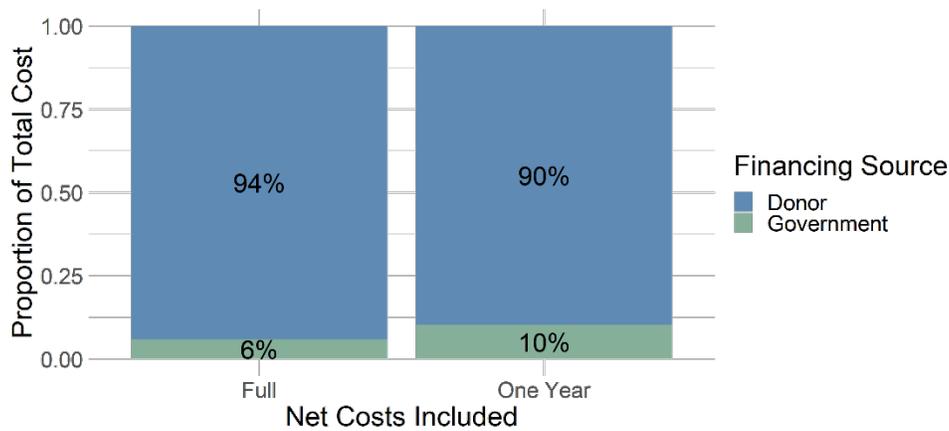


Figure 4. Financing of ITN Delivery in Zanzibar

4.3 GHANA SCHOOL BASED DISTRIBUTION

Table 3 below shows the total cost of the Ghana School Based ITN distribution program by line item. Third party logistics (3PL) and ITN costs were the two major cost drivers, with ITNs being a more substantial cost driver when all three years of ITN costs are included.

Table 3. Line-item, Total Costs and Cost Per ITN of the Ghana School Based ITN Distribution Program

Total ITNs Delivered	1,175,249
Detailed Costs with ITNs Full Costs	
Line Item	Cost 2020 USD
Donor Costs	
Contractual	\$136,523
Equipment	\$4,579
Fringe	\$87,160
Other	\$63,753
Personnel	\$142,299
Travel	\$89,340
ITNs	\$3,085,029
3PL	\$2,232,973
Government Costs	
Storage at HFs and schools	\$1,291
Distribution personnel	\$400,250
Trainings	\$25,823
Supervision	\$25,823
Communication	\$12,911
Total Costs with ITNs Full Costs	\$6,307,752
Total Cost Per Net Delivered with ITNs Full Costs	\$5.37
Detailed Costs of ITNs (One Year Only)	
Line Items (only variable ones)	Costs 2020 USD
Donor Costs	
ITNs	\$1,028,343
Total Costs, including ITNs (One Year Only)	\$4,251,067
Total Cost Per Net Delivered with ITNs One Year Costs Only	\$3.62
Total Costs without ITN Costs	\$3,222,723
Total Cost Per Net Delivered without ITNs Costs	\$2.74

General description of cost included in each cost category above include:

- Donor costs:
 - Contractual: These include contractual costs, subcontracts, temporary hires, consultant service fees, payments to individuals and other items.
 - Equipment: This includes computer equipment and payments to individuals.
 - Fringe: Includes payments of severance, leave, holidays, bonuses and other payments.
 - Other: Includes conferences, per diems, printing, bank charges and transfers, office supplies, meals, personal protection equipment, medical insurance and many other items.
 - Personnel: Includes salaries, holidays, leave time and other personnel related payments.
 - Travel: Includes airfare, car rentals, lodging, medical expenses, per diems.
 - ITNs: Cost of ITN calculated using assumed Delivered Duty Paid Price.
 - 3PL: Estimated cost of 3PL based on interview with GHSC-PSM.
- Government costs: Unit cost (per net distributed estimates) based on prior study conducted under VectorWorks.⁷

Figure 5 shows the distribution of cost by line item in the Ghana SBD program. This analysis shows that nearly half of all costs were contributed by ITNs themselves when the full three years of ITN value was included. 3PL costs for transportation of ITNs constituted a third or more of total costs.

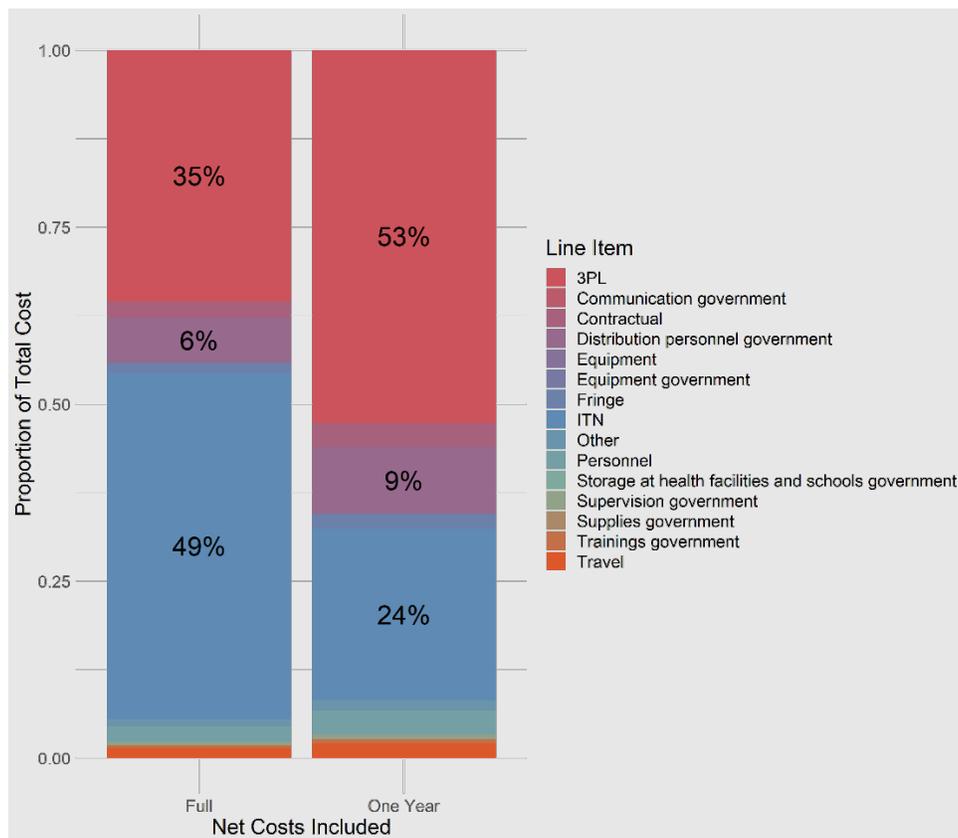


Figure 5. Cost Drivers in the Ghana SBD Program

⁷ https://pdf.usaid.gov/pdf_docs/PA00TQN7.pdf

Figure 6 shows the distribution of financing in the Ghana SBD program, with 89% or more of financing provided by donors while 7-11% was provided by the government of Ghana.

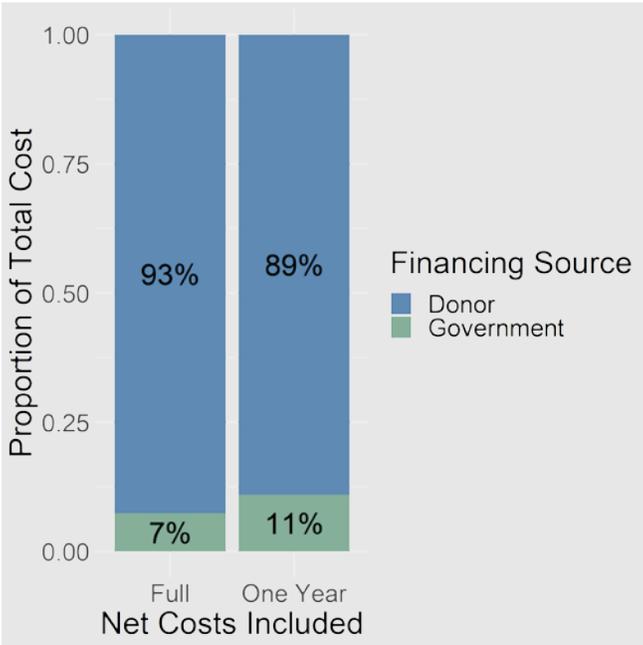


Figure 6. Distribution of Financing in the Ghana SBD Program

4.4 TANZANIA SCHOOL BASED DISTRIBUTION

Table 4 shows the distribution of costs by line item in the Tanzania school net program. Contractual costs (mainly for domestic logistics) and the ITNs themselves were the two major line items.

Table 4. Line-item, Total Costs and Cost Per ITN of the Tanzania School Net Program

Total ITNs Delivered	2,253,149
Detailed Costs with ITNs Full Costs	
Line Item	Cost 2020 USD
Donor Costs	
Contractual	\$5,740,905
Equipment	\$5,638
Fringe	\$236,548
Other	\$345,310
Personnel	\$588,345
Travel	\$200,836
ITNs	\$5,914,516
Government Costs	
Government costs	\$643,580
Total Costs with ITNs Full Costs	\$13,529,920
Total Cost Per Net Delivered with ITNs Full Costs	\$6.00
Detailed Costs of ITNs (One Year Only)	
Line Items (only variable ones)	Costs 2020 USD
Donor Costs	
ITNs	\$1,971,505
Total Costs, including ITNs (One Year Only)	\$9,586,910
Total Cost Per Net Delivered with ITNs One Year Costs Only	\$4.25
Total Costs without ITNs costs	\$7,615,404
Total Cost Per Net Delivered without ITNs costs	\$3.38

General description of cost included in each cost category above include:

- Donor costs:
 - Contractual: Includes, subcontracts, temporary hires, payments to individuals, and other items.
 - Equipment: Includes computer accessories, software licenses, and other items.
 - Fringe: Includes medical insurance, leave, holidays, pensions, and other payments.
 - Other: Includes payments to local government, boat and car hires, dues, fees, subscriptions, per diems, and other assorted payments.
 - Personnel: Includes salaries and associated expenses.
 - Travel: Includes vehicle hires, repair costs, fuel per diems, lodging, and other associated expenses.
 - ITNs: Cost of ITN calculated using assumed Delivered Duty Paid Price.
- Government costs: Unit cost (per net distributed estimates) based on prior study conducted under VectorWorks.⁸

Figure 7 shows the cost drivers in the Tanzania SNP program. As above, contractual costs represent approximately 40-60% of all costs, depending on the inclusion of all ITN costs, or only one year of value. The ITNs themselves represent approximately 20-45% of total costs.

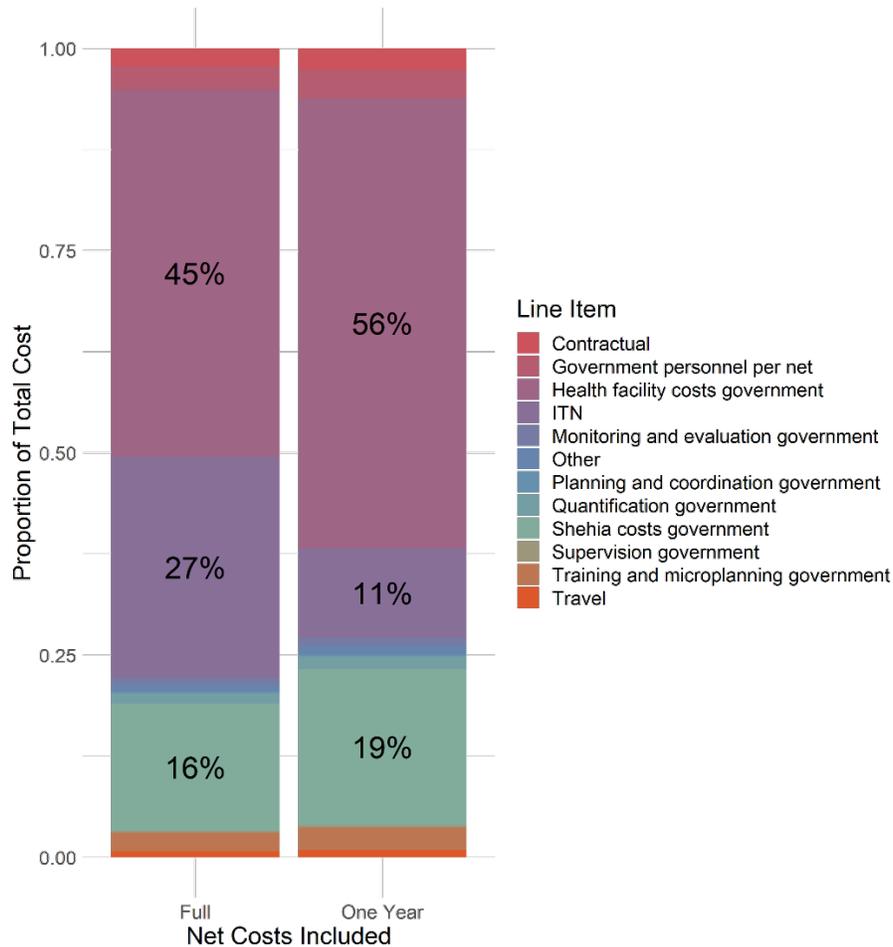


Figure 7. Cost Drivers in the Tanzania SNP Program

⁸ https://pdf.usaid.gov/pdf_docs/PA00TQN9.pdf

Figure 8 shows the distribution of financing in the Tanzania SNP program. The majority of financing is provided by international donors with 5-7% of the total financing provided by the government of Tanzania.

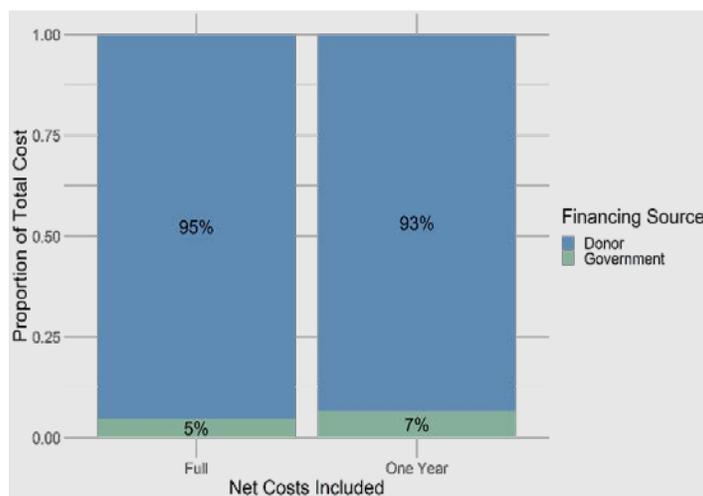


Figure 8. Financing the Tanzania SNP

4.5 COUNTRY COMPARISON

Figure 9 shows the cost per net distributed in each program, both with full ITN costs and with only one year of ITN costs included. With full ITN costs included, costs varied from USD 4.19 in Madagascar to USD 9.61 in Zanzibar for community-based distribution and from USD 5.37 in Ghana to USD 6.00 in Tanzania for school-based distribution. Costs were lower when only one year of ITN costs were included but this did not affect the ordering of the costs of programs. In general, the costs of the two school net programs were similar and fell between the cost estimates for the two community-based net programs. The community distribution programs varied widely in estimated unit cost in this study partly because the estimate of government contributions in Zanzibar was very high. When government contributions were excluded from all programs, the Zanzibar program had the lowest estimated unit cost. From the perspective of the donor, community-based systems may be some of the most efficient distribution systems, since resource contributions from government and local groups will not be considered costs. The high level of variance between the Zanzibar and Madagascar estimates also indicate the importance of accurately estimating the government contribution to programs when the full resource use of a program is the primary question of interest.

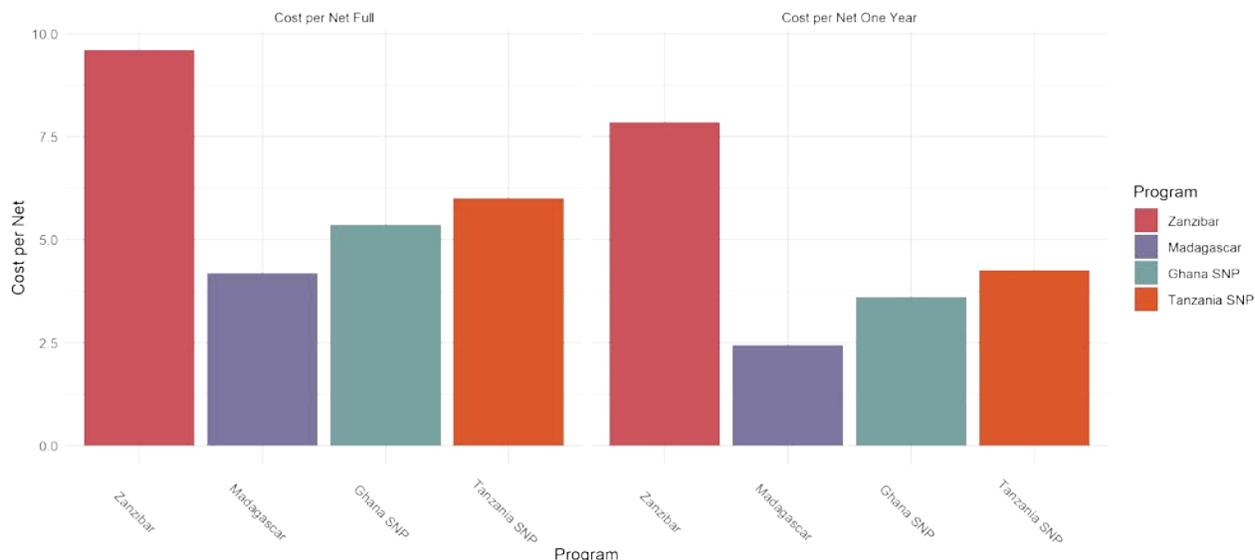


Figure 9. Cost Per Net Distributed by Program

Figure 10 below shows the distribution of cost drivers across the four compared programs with a) all costs included in, and b) and donor financed costs only. Notably, aside from ITNs, comparisons are difficult because classification of costs was not consistent across programs. ITNs were a major cost driver across all programs, while contractual costs (largely for logistics) and 3PL costs were important cost drivers in the other programs. Costs structures between the two school net programs were broadly similar.

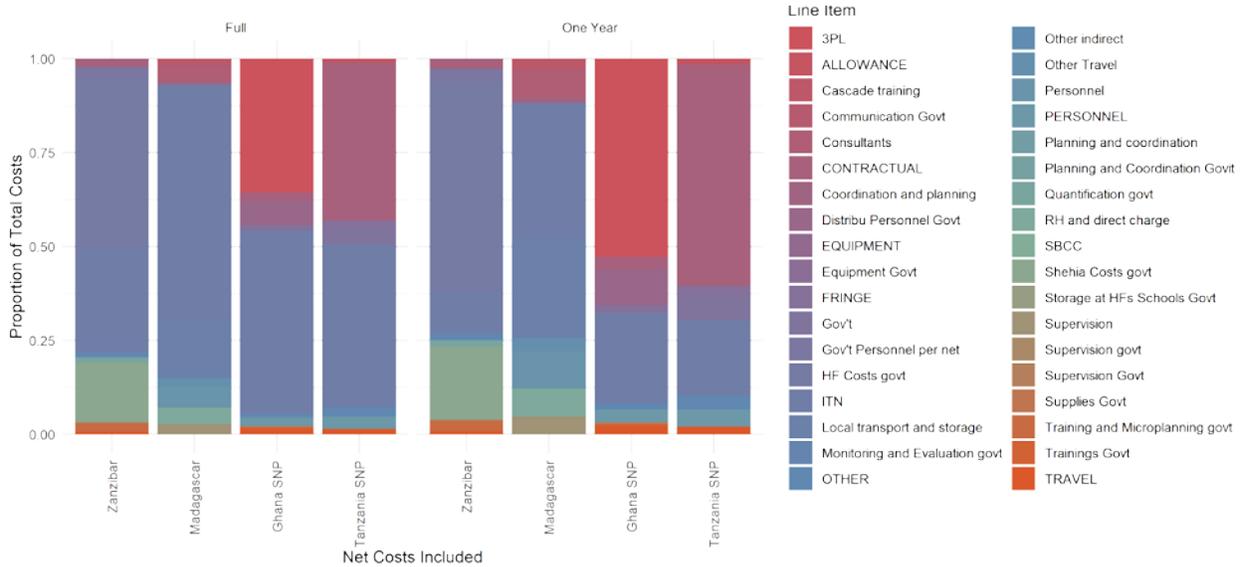


Figure 10a. Distribution of Cost Drivers Across Programs (All Costs Included)

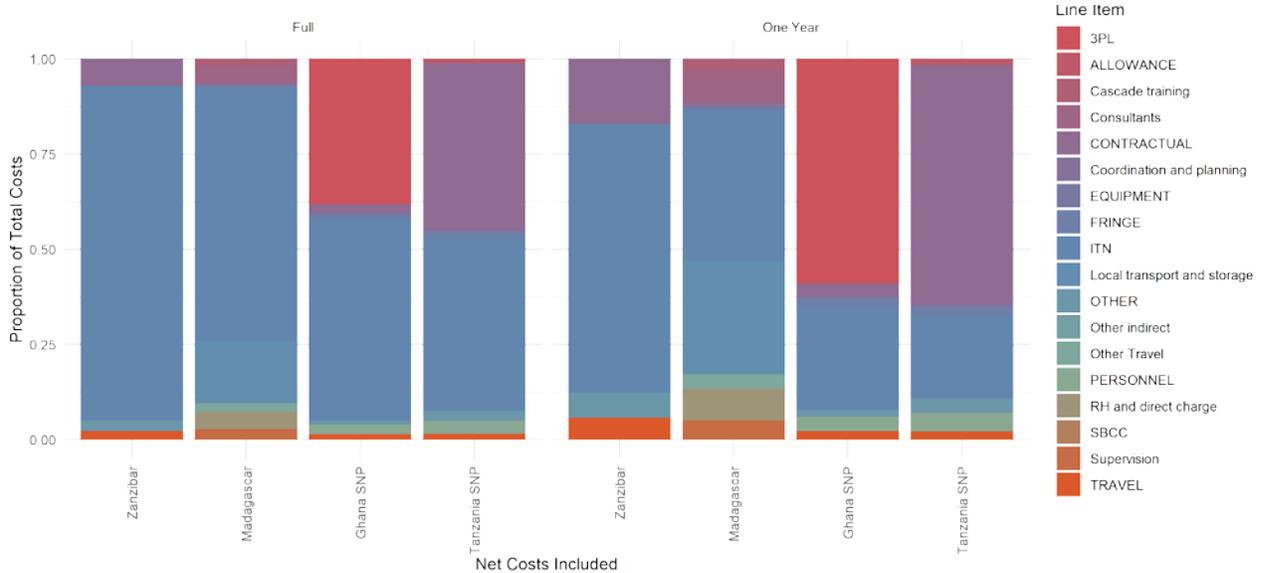


Figure 10b. Distribution of Cost Drivers Across Programs (Donor-Financed Costs Only)

Figure 11 below shows the distribution of financing across all programs. While Zanzibar was the most expensive program overall per net, most of this financing was provided by the government of Zanzibar through the government facilities used in the distribution of nets.

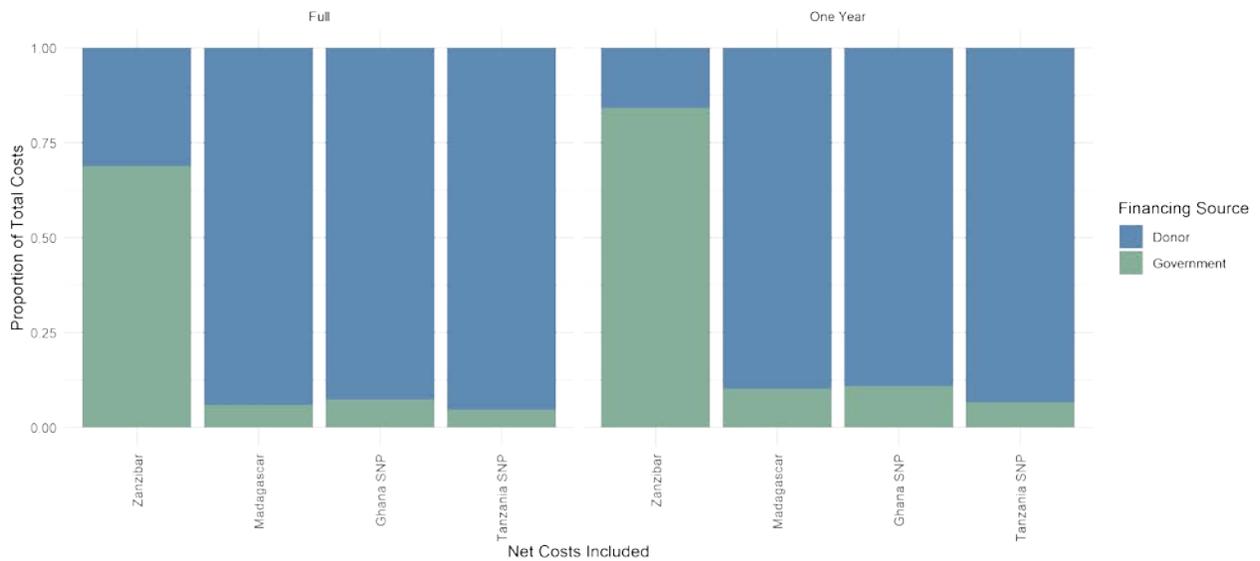


Figure 11. Distribution of Financing Across All Programs

4.6 SENSITIVITY ANALYSIS

Results of a one-way sensitivity analysis are shown in Table 5. While important, net price has only a small impact when varied up to up to USD 3.00 per net and does not affect the ordering of programs since the costs of nets impact each program identically. Similarly, the discount rate⁹ and the attribution of full cost of the net or only one year of use does not affect the ordering of programs. However, the estimation of government costs and the inclusion of costs not financed through VectorLink, PSI or others such as logistics contractors do have substantial impacts on both cost estimates and the ordering of the costs of the programs. While the base case scenario resulted in cost estimates of USD 3.56 to USD 9.01 per net, the cost of the PSI-only financed contributions varied from USD 0.37 to USD 3.16 per net. The overall most expensive program (Zanzibar) in base case analysis became the least expensive in PSI-only financed costs. Excluding government financed costs similarly led the estimate of the Zanzibar program to be the least expensive program.

Table 5. One Way Sensitivity Analysis of All Four Programs

Parameter	Base Value	Sensitivity Value	Impact Zanzibar	Impact Madagascar	Impact Ghana	Impact Tanzania	Justification
Price of ITN	2.50 USD	3.00 USD	↑ 0.52 USD per net (from \$9.61 to \$10.13)	↑ 0.53 USD per net (from \$4.19 to \$4.72)	↑ 0.52 USD per net (from \$5.37 to \$5.89)	↑ 0.53 USD per net (from \$6.00 to \$6.53)	Net prices uncertain and vary from program to program
Price of ITN	2.50 USD	0.00 USD	↓ 2.63 USD per net (from \$9.61 to \$6.98)	↓ 2.62 USD per net (from \$4.19 to \$1.57)	↓ 2.63 USD per net (from \$5.37 to \$2.74)	↓ 2.62 USD per net (from \$6.00 to \$3.38)	Net prices vary/ estimate of delivery cost only
Discount rate	3%	10%	↑ 0.37 USD per net (from \$9.61 to \$9.98)	↑ 0.38 USD per net (from \$4.19 to \$4.57)	↑ 0.37 USD per net (from \$5.37 to \$5.74)	↑ 0.38 USD per net (from \$6.00 to \$6.38)	Discount rate varies with prevailing risk-free rate of return
Discount rate	3%	0%	↓ 0.15 USD per net (from \$9.61 to \$9.46)	↓ 0.15 USD per net (from \$4.19 to \$4.04)	↓ 0.15 USD per net (from \$5.37 to \$5.22)	↓ 0.15 USD per net (from \$6.00 to \$5.85)	Discount rate varies with prevailing risk-free rate of return
Non-PSI costs	Included	Excluded	↓ 9.24 USD per net (from \$9.61 to \$0.37)	↓ 2.87 USD per net (from \$4.19 to \$1.32)	↓ 4.92 USD per net (from \$5.37 to \$0.45)	↓ 2.84 USD per net (from \$6.00 to \$3.16)	Analysis of only PSI financial contributions
Gov't costs	Included	Excluded	↓ 6.62 USD per net (from \$9.61 to \$2.99)	↓ 0.25 USD per net (from \$4.19 to \$3.94)	↓ 0.40 USD per net (from \$5.37 to \$4.97)	↓ 0.22 USD per net (from \$6.00 to \$5.78)	Gov't costs uncertain and not available for all programs.
Gov't costs Zanzibar	Included	Exclude HF costs	↓ 5.84 USD per net (from \$9.61 to \$3.77)	N/A	N/A	N/A	HF costs estimated in Zanzibar using different methods than other locations

⁹ Discount rate represents the time value of money and is used to value capital investments (those lasting longer than one year) and to calculate equivalent annual costs.

5. DISCUSSION

The cost estimates for four distribution programs made in this case series show that community-based and school based continuous distribution systems can deliver substantial numbers of nets for costs which are comparable to other programs. For example, earlier rounds of SNP distribution in Tanzania have been estimated to have similar costs or higher to the costs found in this study (~USD 10.33 [2020 USD] in 2014 and ~USD 3.97 [2020 USD] in 2016) (Yukich et al 2020; Scates et al 2020). Prior school-based distributions in Ghana also have been estimated to have an economic cost similar to those found here (~USD 4.70 2020 USD) (Scates et al 2020). Community based distribution systems have been subjected to a relative paucity of costing studies, but cost estimates are available for systems in DRC, Kenya, and Mozambique. Worrall et al (2020) found that the costs of distribution of ITN by community health volunteers in Kenya had a unit cost of ~USD 7.60 (2020 USD) per ITN distributed, as part of a trial in western Kenya. A study in Mozambique found distribution only financial costs at the district level and below for varied community distribution of ~USD 0.83 - 0.87 (2020 USD), which are similar to the PSI-only financial costs of distribution in the two community-based distribution systems examined here (Zanzibar and Madagascar) (Arroz et al 2019). While mass campaigns may typically have lower unit costs than CD strategies, they tend to have higher total costs, because their scale in a campaign year is generally much larger than that of a CD system.

The results indicate the importance of considering and accurately estimating domestically financed contributions. In the case of the four programs examined here, our estimates of government financed contributions ranged from 0 to 90% of the total costs of distribution. While this wide range is partly due to our lack of estimates for government contributions to the Madagascar program - hence the lower end estimate of 0% contribution- excluding Madagascar still produces a range of contribution from 7%-90%. Government contributions may be critical to evaluating the resource needs of ITN distribution programs. Unfortunately, while most donor-financed and nongovernment organization-implemented programs have mechanisms for explicit financial and operational tracking, most government contributions come through systems integrated into existing health systems and financing arrangements. This arrangement makes the estimates of resource used in domestic systems much more time-consuming and expensive, and more uncertain since it must often be estimated by survey and interview methods rather than directly through document review and tracking of financial or other records. Nevertheless, this case series shows that the estimates of government contributions can change conclusions about the most expensive/least expensive systems for ITN distribution. The ordering in cost of our four programs was particularly sensitive to this problem in the case of the Zanzibar system which, when estimates of government contributions were included was the highest unit cost program, but when government costs were excluded became the lowest unit cost system. Additionally, because domestic contributions to resource use were estimated from secondary sources it was not possible to standardize line-item designations across programs for these contributions making it more challenging to understand the reasons for differential contributions of domestic resources across programs.

The full supply chain for nets is complex and often involves highly varied combinations of containerized ocean shipping, containerized road or rail shipping, un-containerized and bundled shipment by various modalities including road, water and air, and unbundled transport by road, foot path or water, including via truck, motorcycle, pack animal, bicycle, boat and foot for last mile distributions depending on context, as well as potentially requiring storage and security at all stages. The relationships between distance traveled and cost of shipment are likely complex, and probably depend more on the details of the supply chain than the simple distances nets travel which are dominated by highly consolidated and efficient shipping modalities.

ITN distribution is one of the most cost-effective tools for malaria control in sub-Saharan Africa. The unit (per net) costs of these four community and school-based distribution systems may be somewhat higher (mean ~ USD 6.29 per net and USD 4.54 per net when the costs of the net are excluded) than those of mass campaigns

(Wisniewski *et al* 2020). Wisniewski *et al* showed that mass campaigns had a median economic cost of net delivery of USD 3.87 per net (S.E. USD 0.55) whereas continuous and routine systems had a median economic cost of USD 4.69 per net (S.E. USD 0.70), though this difference did not remain statistically significant in multivariable analysis controlling for country and program characteristics (Wisniewski *et al* 2020). Nevertheless, the costs are such that, if the ITNs distributed in these systems are expected to be similarly effective as in other distributions, these distribution approaches should remain cost-effective by accepted international standards. In other words, as long as the ITNs used in these systems have a similar effectiveness to those used in mass distributions, the extra cost of continuous distribution systems doesn't appear to be high enough that they would be considered to be cost-ineffective by generalized cost-effectiveness analysis norms, noting though that full cost-effectiveness assessment is outside the scope of this study.

We have not attempted to adjust for price levels from country to country, because such comparisons require a disaggregation of traded and non-traded goods which was not feasible to conduct for all programs. Price levels of salaries and wages, transportation and building rental, and many other domestically procured items are expected to vary between countries and these variations in price level can confound international comparisons of efficiency. In all cases, however, ITNs were the major cost driver of programs, and we used a uniform price for these nets across programs, helping to reduce price level specific variance in the programs. Prices of ITNs may vary based on a number of factors including specifications, country of destination and origin, procurement volumes, oil prices, and shipping cost variations. The price chosen here for base case analysis was elected to represent a typical price across countries and recent years for standard ITN and other nets currently on the market. Sensitivity analysis shows that net price is an important determinant of overall costs in most ITN distribution programs.

Economic costs derived using an ingredients approach are the preferred mode of comparison for program evaluation and efficiency comparisons. We have used economic costs in this analysis, but it should be noted that, we have relied on aggregated financial reports to estimate the economic costs of delivery through PSI systems that use and pay for 3PLs. This approach, which differs from a true ingredients approach for some line items, means that the ability to compare programs across settings is more limited due to price level differences than when a full ingredients approach can be used across all line items. The costs of ITNs represent full economic costs estimated using the ingredients approach while government contributions were generally estimated using unit costs derived from previous studies of the same systems. The use of financial data to produce economic costs estimates limits our ability to investigate potential changes to PSI-specific project structural choices. Further, the use of prior estimates of government contributions for Ghana, Zanzibar and Tanzania means that changes to the government functions and approaches for the 2020 program distributions are not captured here. The year 2020 includes the start of lockdowns and disruptions due to the COVID-19 pandemic and may have affected the costs of the campaigns and other net distribution programs conducted in that year. We were not able to specifically identify and adjust for COVID-19 related costs in the course of this case series, and as such our cost estimates may be biased in comparisons to net distribution costs collected out of the context of COVID-19. Other research has suggested that COVID-19 mitigation (procurement of personal protective equipment, extended storage, changes to training and distribution programs) could increase the unit costs of ITN mass distribution campaigns at the national scale by ~10% (Santiago E unpublished). While this might affect comparisons to cost estimates prior to the COVID-19 pandemic, it is less likely to affect the internal validity of comparisons within this case series since all the programs studied occurred in the context of COVID-19. However, national responses to COVID-19 differed dramatically, including between the countries studied in this case series, so there is still a possibility that comparisons are confounded by COVID-19. Furthermore, we utilized prior literature and data on government contributions in some cases to estimate government contributions. All of these estimates came from distributions prior to the COVID-19 pandemic and thus would not reflect COVID-19 adaptations.

Nevertheless, we believe that the cost-estimates presented here provide accurate estimates of the total economic costs of the distribution of ITNs through school and community based continuous distribution systems in mature programs in these settings.

6. CONCLUSIONS

ITN costs through community distribution systems vary widely by location but remain within historic ranges of ITN programs. ITNs delivered through school-based distribution in this case series were more similar in unit cost, than those through community mechanisms. ITNs remain the major cost driver in these systems despite historically relatively low prices for standard ITNs being used in the analysis. Government contributions to the financing of these systems vary greatly and appear largest where extensive use of government health facilities is involved and where program scale is small. Decisions between schools and community-based programs should consider the implications of domestic contributions in terms of both capacity and integration when planning ITN distribution strategies, as well as which are the most appropriate systems to give the necessary impact on coverage needed for that country. Systems which are heavily reliant on domestic health system resources will need to ensure that capacity and resources are available within local systems to support this, even when the budget impact of using local health system resources may only be reflected in lower requirements for international financing. Community and school-based distribution systems can deliver ITNs in sub-Saharan African settings at reasonable costs to donors and governments.

ANNEX C: REFERENCES

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