Controlling Urban Malaria in Africa:
Operational Guidance for Program Managers

By

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Abstract

Background: Malaria remains a significant global public health challenge. In 2010, out of an estimated 216 million episodes of malaria, the disease killed 655,000 people. While most malaria cases in Africa occur in rural settings, urban malaria is a unique public health problem that requires specific consideration. With Africa's rapid pace of urbanization, coupled with specific dynamics of urban settings that facilitate transmission, it is expected that malaria will remain an important public health concern for urban populations. Reduced amounts of international funding, waning international and domestic political commitment, and emerging insecticide resistance among the *anopheles* mosquitoes, are all factors that in combination require malaria experts to develop a customized urban malaria control program for the 21st century that is smarter, more cost effective, with targeted interventions.

Methods: This paper reports on an extensive literature search using the PubMed database to identify contemporary urban malaria studies, research past urban malaria control programs, and analyze currently available control interventions. The data gathered were used to determine the malaria risk factors associated with urban settings and identify essential components of successful urban malaria control programs.

Results: Urban settings experience a high level of heterogeneity in malaria transmission. Successful programs in these settings should have multiple, complementary interventions that can be adapted in response to context-specific dynamics of malaria incidence.

Conclusions: Urban malaria control programs should use the five-step tool developed and presented in this paper to: a) identify and map the disease burden, b) identify the appropriate strategy, goal and objective; c) select the appropriate interventions; d) expand partnerships to include (among others) the private sector; and e) continue monitoring program progress to ensure that it remains responsive to the urban epidemiological profile.

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Introduction

In Africa, malaria is not simply a disease in rural communities, it can thrive anywhere there is a conducive environment that allows the *anopheles* mosquito to breed and transmit the *Plasmodium* parasite to humans. With Africa's urbanization rates increasing, malaria infection risks will become a growing public health concern for urban populations. In 2004, there was a large push to examine urban malaria dynamics. Several conferences were held and many studies published that discussed the predicted needs and impact of malaria in urban areas as Africa's population urbanizes. The studies' findings were published and the conferences adjourned just as an unprecedented investment in malaria control efforts (including both prevention and treatment services) began.

Over the past eight years, the global malaria control effort has seen a significant scale up of malaria control funding, development of new and effective technologies, and a resurgence of political commitments from national and international bodies. Malaria is now at the forefront of public health initiatives, and has its strongest support since the original malaria eradication campaign ended (1955-1978). However, since the majority of the malaria disease burden occurs in rural settings, malaria control efforts have largely been focused in this setting, and the unique transmission dynamics occurring in urban areas has not been rigorously monitored. The analysis in this paper intends to build on the work completed in 2004, and specifically identify how malaria control program managers should address urban malaria transmission given the advanced malaria control resources available today.

Urban malaria is a unique public health problem that requires deliberate consideration. While the approaches to urban and rural malaria control efforts will vary, malaria control programs in both settings should seek context-specific ways to establish prudent, reasonable and cost-effective programs. With international donor funding expected to decline over the next decade, a strategic rationalization of malaria prevention and control interventions will allow countries to achieve similar public health impacts in both settings while being flexible to allocate resources according to disease burden patterns.

This paper will examine what we know today about the factors that increase risk of malaria transmission in urban settings, analyze the available urban malaria control interventions, and review the urbanization trends that could exacerbate the disease burden. This paper will then recommend how to align current malaria prevention and control tools with the relevant risk factors in urban settings. It will conclude with a five-step decision tool to help malaria control programs develop effective measures in their cities. Given the geographic variation and vector behaviors, this paper is limiting its analysis scope to the sub-Saharan Africa region, in order to provide specific, context-relevant guidance.

Part 1:
100 Years of Urban Malaria Control: Lessons Learned

Malaria in Africa: Background

Malaria Disease Burden

Malaria is caused by one of five parasite species of the genus *Plasmodium* (*p. falciparum, p. vivax, p. ovale, p. malariae,* and *p. knowles*). These parasites are transmitted to humans through a vector, the female *anopheles* mosquito. There are about ten species of the *anopheles* mosquito that transmit malaria in Africa, three of which are common to urban settings: *an. gambiae*, *an. arabiensis*; and *an. funestus.*[1,2,3]

Malaria morbidity and mortality is not equally distributed amongst geographic regions, within population cohorts, or between urban and rural settings. While malaria is found in 106 countries and territories throughout the world, the greatest morbidity and mortality burden lies within the Africa continent, and primarily in sub-Saharan Africa.[2(p1)] In 2010, there was an estimated 216 million episodes of malaria, 81% of which (174 million cases) were in Africa region. Malaria caused an estimated 655,000 deaths globally in 2010, 91% of which occurred in Africa.[2(pVIII)]

Young children and pregnant women have particular biological vulnerabilities to malaria infection that causes these cohorts in particular to become symptomatic and develop severe malaria infections at a much higher rate than the general population. In 2010, 86% of the estimated total malaria deaths worldwide were children under five years of age.[2(pVIII)]

In Africa, the level of malaria transmission in urban sites, peri-urban areas and rural settings can vary quite significantly. A rural population typically experiences higher exposure and greater risk of infection than compared to its urban counterparts. A recent meta-analysis of malaria transmission confirmed that malaria transmission in urban settings is at a magnitude significantly lower as compared to rural settings.[1(p170)] Even so, a 2004 study estimated that anywhere from 7-20% of the total global estimated malaria disease burden occurs in urban settings.[4,5] While urban malaria is not the primary source of malaria morbidity, it continues to make a significant contribution to the overall disease burden.

Malaria Control Interventions

Malaria prevention and treatment technologies have had to constantly evolve over the years to keep pace with the adaptive *Plasmodium* parasite. These technologies are integrated into public health program interventions designed to target the specific geographic areas, vulnerable cohorts, and settings with the greatest disease burdens to maximize disease control outcomes.

Today, malaria control efforts focus on ensuring the wide scale uptake and use of proven and effective prevention and treatment options. Table 1, below, summarizes the primary prevention and treatment interventions that virtually all malaria control programs currently use in some combination. While these interventions (insecticide treated nets, indoor residual spraying, malaria diagnosis, and malaria treatment with artemisinin combination therapy drugs) require significant resources to purchase, distribute, and ensure sustained protection from and treatment of malaria, they are all well-tested and proven disease control methods. The strategies summarized in Table 1 that are used to distribute these interventions are particularly effective in rural settings.

Today's combined package of interventions is working. The global malaria incidence rate has declined by 17% since 2000. The World Health Organization estimates that malaria-specific mortality has been reduced by 26% over the past decade. However, despite the progress made to reduce the global malaria burden, approximately 3 billion people continue to live in malaria at-risk geographic areas—the largest ever in recorded history.[6] The gains made during this past decade are fragile and vulnerable to being lost if malaria control interventions falter.

Table 1: Summary of Key Malaria Prevention and Treatment Interventions

Intervention	Intervention Definition and Deployment Strategy
Insecticide Treated Nets	Provides a physical barrier between mosquitos and humans (through the netting material) and offers a repellant effect (with the embedded insecticide in the material). Using insecticide treated nets on a regular, widespread basis can reduce overall mortality by about a fifth in Africa. Full insecticide treated net coverage could prevent up to 370,000 child deaths per year.[7] The estimated cost of this intervention is $1.39 per person per year.[2(pIX)]
	Strategy: • Universal Coverage: The malaria community is now vigorously working to reach universal coverage of insecticide treated nets by providing every person living in a malarial area in Africa with access to a net. This is primarily achieved through mass distribution campaigns—a major logistical undertaking. Insecticide treated net ownership in sub-Saharan Africa rose from 3% in 2000 to 50% in 2011.[2(pVIII)] • Targeted Vulnerable Populations: Ensures coverage of population cohorts (children under the age of five, pregnant women, HIV-positive persons) at the highest risk of malaria morbidity and mortality. This distribution system provides insecticide treated nets through antenatal care clinics, immunization clinics and in care packages to ensure that these cohorts have access to nets when they need them. This is primarily achieved through routine distribution systems and is integrated into the public health service delivery system.
Indoor Residual Spraying	Walls of homes are sprayed with an insecticide because *anopheles* mosquitoes like to rest on indoor walls after they have bitten a human to digest the blood. They rest on the walls long enough to absorb a lethal dose of insecticide which breaks the transmission cycle. The length of time that insecticide lasts on the home's walls is influenced by factors like construction materials of the housing structures (wood, mud, concrete, etc.); the class of insecticide used (e.g.: pyrethroid vs. carbamate); and the environmental factors like climate and humidity levels. The intervention costs an average of $2.62 per person per year.[2(pIX)]
	Strategy: Indoor residual spraying is a valuable tool to control malaria, when critical conditions exist: a) there are a high percentage of structures in a targeted area that can be sprayed; b) the mosquito vector behavior rests indoors after feeding; and c) the mosquito vector is susceptible to the insecticide being used. To ensure maximum public health impact, indoor residual spraying must be timed carefully with the onset of the transmission season (the arrival of the seasonal rains). There has to be a sustained political commitment over multiple years, adequate funding, and perhaps most importantly, the right environmental conditions to allow for such an undertaking to be operationally feasible.[8] The public health benefits and impact of this intervention comes when all of the homes in the community are sprayed, causing the overall mosquito population in the area to drop. The logistics associated with implementing an indoor residual spraying program are substantial. The percentage of people protected by indoor residual spraying in Africa rose from 5% in 2005 to 11% in 2010.[2(pVIII)]

Malaria Diagnosis	The World Health Organization recommends that, where possible, every fever be tested for malaria and only confirmed cases should be treated. This policy encourages rational use of anti-malarial drugs and proper treatment of non-malaria fevers.[2(p7)] Malaria diagnosis can be conducted through either microscopy or a rapid diagnosis test.
	Strategy: • Microscopy: Microscopy remains the gold standard for diagnosing malaria. The laboratory technician must be well trained to accurately diagnose the condition. It is usually performed at higher level facilities, district and reference hospitals. An operational challenge for microscopy is the timeliness of testing—most facilities do not have a technician available 24 hours a day to test blood smears from patients when they come in with fevers. • Rapid Diagnostic Test: This is a relatively new technology that provides a low-tech way to scale up confirmed malaria diagnostics in lower-level health facilities and at the community level. The rapid tests do not require specialized training. All health care providers, with minimal training, can use them when treating a child with fevers. Countries are currently working hard to scale up this intervention; a total of 88 million rapid diagnostic tests were procured in 2010.[2(pX)] Test prices vary, but average about US$0.75 per unit.
Malaria Treatment	Artemisinin combination therapy is designed to provide the patient with multiple drug classes to minimize the risk of resistance emerging. While artemisinin resistance has been found in South East Asia, it has not yet emerged in Africa. As compared to older monotherapies, artemisinin combination therapy are expensive and average about $1 per treatment (before subsidies, if any, are provided). This cost is about ten times the price of chloroquine (a common monotherapy with widespread resistance in Africa). In 2010, 181 million artemisinin combination therapy treatments were procured in 2010, 80% of which were for the public sector.[2(pXI)] Total demand for malaria drugs is projected to reach 287 million treatments in 2011—the main driver of this increase is a donor-driven subsidy program of selling subsidized artemisinin combination therapy drugs to the private sector.[2(pXI)]
	Strategy: • Community Case Management is the World Health Organization-sponsored strategy to improve access to prompt and effective treatment of malaria episodes through trained community health volunteers who live and treat fevers within the community. This strategy was developed to ensure that access to life saving medicine was not a barrier to malaria treatment, and is implemented mostly in rural areas. Treatment is usually provided for free or heavily subsidized.[9] • Public sector, facility-based treatment: Most countries provide treatment for free or a highly-subsidized cost. The majority of fevers are treated through the public health facility system. Challenges with delivering malaria treatment include: ensuring that there are no drug stock outs, linking treatment with confirmed diagnosis, ensuring fevers are tested for malaria within 24 hours. • Private Sector: A major push towards expanding the private sector role in malaria treatment is underway, and the share of drugs going through the private sector is expected to increase. Treatment is not free through this channel and patients will be charged either a full or subsidized price, so there will be populations (in the lower income quintiles) that are prices out of the private sector options. Challenges include ensuring diagnostics are linked with treatment purchases as well as eliminating chemists from selling the less expensive monotherapies that are ineffective and promote drug resistance.

Funding for Malaria Control Programs

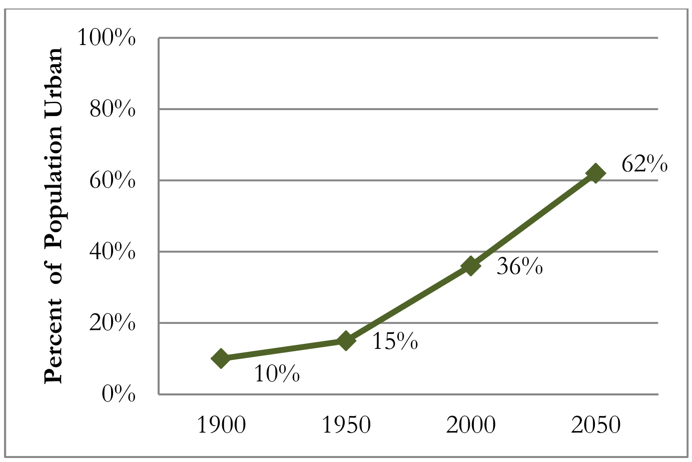
The available funding from the Global Fund to Fight HIV/AIDS, Tuberculosis and Malaria and the US Government's President's Malaria Initiative, in combination of significant resources from other donors, including the United Kingdom's Department for International Development and international non-government organizations, means that this past decade has benefited from unprecedented levels of funding for malaria prevention and control programs. International funding peaked in 2011 with US$2 billion donated for malaria prevention and control efforts, but even at this unparalleled funding level, it was not sufficient to meet the identified annual needs (estimated at over US$5 billion per year from 2010-2015).[2(p15)] While funding is expected to remain stable in 2012 and 2013, it is expected to decrease starting in 2015, which will have negative repercussions for malaria control programs and reducing the malaria disease burden.[2 (pVII, 15)]

While donor and international funding for malaria is beginning to level off and could begin to decline, domestic funding for malaria programs remains limited and varied—ranging from a few cents per person at risk to several dollars per year—but averages less than $1 per at-risk person in most highly endemic countries.[2(p16)] Given that malaria is a disease that can quickly resurge and become more lethal once prevention and control measures are relaxed and susceptible populations are re-exposed to *Plasmodium* parasites, sustaining the malaria control gains made to date is essential. If future funding will be limited (as is currently predicted), then malaria experts will need to develop a malaria control program for the 21st century that is smarter, more cost effective, and with customized interventions for specific settings.[2(pVIII)] One element to focus on is strengthening control programs in Africa's urban settings.

Africa's 21st Century Urbanization Trends

Urbanization is a largely new phenomenon in Africa. Figure A, below, shows the urbanization trends in Africa over the past century and the forecasted growth rate for the next 50 years. While Africa remains the least urbanized region of the world, since 1950 the region has had the highest annual rate of urbanization in the world, and is projected to continue lead the world in growth well into the 21st century.[10] It is estimated that 50% of Africa's population will be urban by 2030, which will further expand to 62% by 2050, when 1.2 billion people in Africa will be living in urban settings.[10(p4,29)]

Figure A: Urbanization Trends in Africa, 1900-2050



Since World War 2, African cities have grown faster than those in any other region.[11] In 1950, not a single city in the African region had a population that exceeded 750,000 inhabitants. By 2000, there were 43 that hosted 11.9% of the continent's population.[12] This population shift to cities is not expected to abate any time soon. By 2025, of the 29 cities in the world estimated to have 10 million inhabitants or more, two will be in sub-Saharan Africa: Lagos and Kinshasa, both of which currently have active malaria transmission.[10(p6)]

Urbanization in Africa does not tend to follow conventional patterns seen in other regions and has occurred without a corresponding development of urban infrastructure and services, which has a profound effect on environment and disease patterns.[13] African cities can experience some of the highest urbanization rates in the world, often in the range of 2-6% per year. Most cities are struggling to cope with this pace of growth, as municipal authorities are not able to effectively keep up with the population growth and rural migration into their jurisdictions. [12(p118)] It is common to find well-developed city centers that are surrounded by underdeveloped in shantytowns and slums that support a large proportion of the population. [12(p119)]

Urbanization's Impact on Malaria Transmission

As populations shift from rural to urban settings, the patterns of disease and mortality will also change. Historically, population movements have contributed to the spread of disease; failure to consider this fact contributed to the breakdown of the malaria eradication campaign (1955-1978). At that time, the movement of people from malaria endemic areas to locations where the disease had been eliminated, in conjunction with a relaxation of control measures, contributed to malaria's resurgence in Africa in the 1970s and 1980s.[14] The uncontrolled and rapid population shift that Africa is now experiencing is establishing new areas and strengthening current pockets of malaria transmission.[3(p3)]

With a large population shift to urban settings, cities may be subjected to a "ruralization", which occurs when migrants bring their rural practices and traditions to urban areas, including: raising livestock, traditional patterns of water use and storage (wells), agriculture and food cultivation. These elements are common in urban residential, market and commercial areas of the city, which contribute to the emergence of vector and pest problems, influencing the development and spread of disease, including malaria. [1(p169-70),15]

Given the anticipated demographic shifts over the next quarter century, Africa is going to continue to urbanize and will need to address the implications of the population shift in the coming decades.[6(p81)] This trend will not end any time soon, and it is important for national malaria control programs to understand the urban dynamics occurring in each of their countries in order to help them prepare appropriate malaria control interventions.

Characteristics of Urban Malaria

Urbanization alters the dynamics of malaria transmission, frequency and immunity, significantly influencing its associated morbidity and mortality.[12(p118)] A sampling of research conducted over the past decade in different African city capitals (summarized in Annex 1) documents that urban malaria offers complex dynamics the need to be uniquely addressed in each setting. The characteristics of urban malaria are as varied as the cities themselves. [1(p170-2),4(p104),13,16-29]

Risk Factors Differ in Diverse Urban Settings

Risk factors such as urban agriculture practices (Accra, Ghana[16,17]), salinity of water (Cotonou, Benin[20]), and living in close proximity to breeding sites (Kampala, Uganda[22] and Dakar, Senegal[19]) all influence which interventions are most effective to control malaria in these different settings. These studies also show that malaria transmission is highly localized, and not all urban residents of a city have the same infection risk. Further analysis confirms that while malaria is widely transmitted in some cities (as seen in Accra, Ghana,[17] and Brazzaville, Congo[19]), other cities experience highly focalized transmission (such as Maputo, Mozambique[25,26] and Ouagadougou, Burkina Faso[28,29]). Yet still, other cities have virtually no documented local transmission, with known cases primarily imported by travelers coming from other regions (such as in Antananarivo, Madagascar,[18] and Nairobi, Kenya[27]).

It is thus evident that malaria's epidemiological triangle—the relationship balance between the *Plasmodium* parasites (the Agent), the human and *anopheles* mosquito behaviors (the Hosts), and the physical setting (the Environment)—shifts in urban settings, as Host and Environment factors influence how the Agent is transmitted.

Host Behaviors Facilitate Transmission

As hosts, the behavior of both mosquito vectors and human beings change in response to living in urban settings. Contrary to long-held beliefs, there is growing evidence to suggest that *anopheles* mosquito vectors can evolve to breed in polluted water (common in urban settings), which is enabling both the *anopheles* mosquito and the *Plasmodium* parasite to remain present and survive in cities.[11(p1)] Research suggests that these adaptations are leading to increased transmission in urban settings as diverse as Accra, Dar es Salaam, and Lagos.[14(p105), 19(p155)]

Like the *anopheles* mosquito, humans behave differently in cities than their rural counterparts, which further facilitates malaria transmission. With electricity, there are more activities at night, causing people to go to bed later in the evenings that those living in rural areas. Evening shift work and socializing at outdoor venues can also result in greater exposure. Ultimately, urban populations spend less time indoors under insecticide treated nets during high risk biting periods, which make known preventative measures that work in rural areas potentially less effective.[1(p172), 11(p6), 19(p139,140,155),21(p34),30,31]

Urban Environments Create Disparate Transmission Dynamics

Additionally, an urban environment can create high level of heterogeneity in malaria transmission—both in different areas within the same city as well as between cities in a region (see Annex 1 entries on Dakar, Senegal[19] and Brazzaville, Congo[1(p169-70),19]). This heterogeneity may be explained, in part, by how different areas of urban cities are used, settings that create new breeding sites, and risky environments that are exacerbated by the socioeconomic status of vulnerable populations. A central business district of a city, for example, is likely one of the few areas of a city with working water and sewage system (resulting in fewer breeding sites), and be the most sparsely inhabited areas at night during peak biting hours when everyone has returned home.[1(p170),12(p118),29(p2,11)] The lower risk in city centers contrasts sharply with peri-urban settings where infection risk can approach levels found in rural settings. A meta-analysis of malaria transmission found that the mean annual infective bites from a mosquito was 7.1 in urban centers, 45.8 in peri-urban areas, and 167.7 in rural areas.[1(p170),32]

Urban construction also creates environments that can facilitate disease transmission. The physical deterioration of buildings as well as new building activities can all contribute to increased opportunities for breeding by creating artificial water collection reservoirs and increasing the likelihood of human-vector contact.[12(p118)] Poor housing, neighborhoods with little or no sanitation facilities, and ineffective drainage of surface water are also known risk factors.[33]

Unlike in rural areas where malaria transmission is well-understood and thoroughly studied, in urban settings where a city is constantly evolving and growing, the relationship between the environment, hosts and agent in malaria transmission remains dynamic. It is essential that program managers understand this interactive balance in urban contexts so that malaria control efforts are responsive to the specific conditions found on the ground and can customize the interventions accordingly.

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History of Urban Malaria Control Programs

For the most part, malaria in Africa has largely been considered a rural disease, primarily because the majority of the disease burden occurs in rural areas—a combination of Africa's predominantly rural population and transmission cycle factors that favor rural settings. As such, extensive research on malaria in rural settings exists and has driven the development of the interventions and strategies described earlier in Table 1.

However, with more than 100 years of urban malaria control efforts in Africa, there is a long and well-documented history of control efforts in urban settings.[4(p105)] The challenge is building upon past experiences while using modern technologies. Key elements of past successful urban control campaigns included: extensive environment management (water management: draining standing pools of water), mosquito population reduction (larviciding: killing larval stages of mosquitoes), improved housing construction (including house screening), using biting barriers (bed nets), and effective drug treatment (chemoprophylaxis).

Analyzing case studies of selected malaria control programs in Dar es Salaam,[4,21] Nairobi,[27] and Khartoum[23] confirm the success of key factors for successful malaria control programs in urban settings (see Annex 2 for a more complete summary of each case study). In these three cases, malaria control was achieved primarily by reducing the mosquito population. These efforts were accomplished through eliminating breeding sites (environmental management) and applying insecticide to remaining breeding sites (larval control) and homes (indoor residual spraying). Also, in Dar es Salaam, parasitemia levels in infected human hosts were reduced by mass drug administration of anti-malarial drugs. Further, the Nairobi case documents the important role surveillance plays in disease control. Classified as a notifiable disease, all suspected malaria cases found in Nairobi had to receive laboratory confirmation and be reported, which enabled the city's health department to track locally acquired infections (and, thus identify when and where transmission was occurring in the city).

Of note, all three case studies cite the collapse of disease surveillance and the overall decline of the public health care system as one of the primary reasons for the resurgence of malaria. These cities were not unique. During the post-colonialism period, urban malaria programs throughout Africa's newly-independent countries suffered from an erosion of infrastructure, surveillance capacity, and grossly inadequate financing, which resulted in poorly designed and funded programs that provided quite limited success.[4(p103-4), 12(p124-5), 21(p29)] In the 1980s, upon the advice of the World Health Organization, most countries integrated their remaining vertical malaria surveillance systems into their primary health care system. Coupled with relaxed reporting requirements, by the mid-1980s accurate reporting on the malaria disease burden in each country was simply not feasible.[3(p111)]

Customized Interventions for Urban Malaria Control

In the mid-2000s, when international funding for malaria control rose to a level that made massive scale-up of prevention and treatment programs possible, efforts were focused (correctly) on maximizing the public health impact by reducing the malaria burden in rural settings with the intervention strategies described earlier in Table 1. Examples of how the interventions meet specific disease transmission needs in rural areas include: a) providing universal coverage of insecticide treated nets to extend individual-level protection (provided by the barrier of the net) to community-level protection as the overall mosquito population in the geographic area is reduced; and b) creating community case management programs to improve the access rural community residents have to prompt treatment of anti-malarial drugs. Because of the unique aspects of malaria transmission in urban settings, the standard package of interventions needs to be adapted.

Table 2, below, summarizes the ways the literature suggests customizing interventions to make them more suitable to urban settings. Recommendations include:

- Gradually restricting distribution of free insecticide treated nets for specific geographic areas and vulnerable populations in response to reduced transmission risk, while increasing the full and subsidize priced nets available for sale in markets.[a]
- Carefully calculating the operational constraints and costs before implementing an IRS program in a densely populated urban setting. Since indoor residual spraying is most effective when most structures in a geographic area are sprayed, densely populated urban areas can significantly increase the costs of the intervention.
- Rigorously ensuring that all fevers are diagnosed before being treated for malaria to reduce over treatment of malaria, given the lower disease burden in urban settings.

With some controversy, many experts are also encouraging for a revitalization of larval source management (used extensively in the 1960-era eradication movement) as an appropriate way to manage mosquito populations in certain settings. As noted in Table 2, this intervention is not fully adopted by the global malaria control community, but is being implemented in some settings (see the Khartoum case study in Annex 2). A Cochrane Review is currently underway and is expected to be released in June 2012, which will provide the global community with further insight into the effectiveness of this intervention. Until more data is gathered on the effectiveness of this intervention in African settings, the World Health Organization is urging countries to be very cautious as they consider this option.[b]

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[a] Findings from an unpublished analysis of urban distribution programs, presented by Ms. Andrea Brown, at the Alliance for Malaria Prevention 2012 Annual Partners Meeting. http://allianceformalariaprevention.com/resources/Urban%20distribution%20analysis%20-%20Andrea%20Brown.pdf Accessed 3/25/2012.

[b] Public statement made by Dr. Robert Newman, Director of WHO Global Malaria Program, during a plenary address at the Roll Back Malaria's Vector Control Working Group 2012 Annual Meeting. Author was in attendance. February 2012.

The adaptations of standard malaria control interventions include taking advantage of the resources provided by the private sector in urban settings. Urban residents have a greater ability to pay for commodities and services (at least amongst the higher income quintiles) than rural populations. The private sector also plays a greater role in delivering malaria prevention and treatment services, including: private health care providers, regulated chemists, and informal sector kiosk owners. Integrating the private sector into an urban malaria control program, as noted in Table 2, increases the quality of services they are providing while alleviating the demand on the public sector services.

Table 2: Recommended Intervention Adjustments for Urban Settings

Intervention	Adaptations for Urban Settings	Private Sector Role
Insecticide Treated Nets	• Universal Coverage: Universal coverage policies should reflect the reduced risk of malaria and the heterogeneity of transmission patterns found in urban settings. Customization for urban settings should include both targeted distributions based on disease transmission patterns, consideration of the ability to pay (full price or subsidized price), increase access to insecticide treated nets in the public and private sectors, and coverage in low transmission areas.[c] • Targeted Vulnerable Populations: Continue to distribute insecticide treated nets to vulnerable populations (pregnant women, children under five and people living with HIV/AIDS) to ensure that those most susceptible to malaria have sufficient personal protection.	Sell insecticide treated nets at full price in market places. Partner with the public sector and sell subsidized, socially-marketed nets at partner vendor shops and kiosks. Offer a variety of sizes, shapes and colors to meet personal preferences.
Indoor Residual Spraying	Indoor residual spraying program costs can increase significantly because of the housing density and the number of homes that need to be sprayed in the targeted geographic area. Security issues are also more of a problem in urban settings. The operational constraints need to be carefully considered before implementing an indoor residual spraying program in a densely-populated urban setting.	Private companies can partner with government programs to conduct spray campaigns that protect their employees. Most common within sectors such as: mining, plantations, and general agriculture.[41,42]
Larval Source Management	Larval source management has been an intervention used in urban malaria control programs as part of the malaria eradication efforts of the 1960s. There is limited contemporary data that documents how effective larval source management is in the modern African context. A Cochrane Review is expected to be released in June 2012 that will document overall effectiveness, but since much of the data will be from Asia-based randomized control trials, it is not expected to resolve the question of promoting larviciding in Africa at a large scale At the moment, the World Health Organization is hesitant to fully recommend this intervention,[d] and encourages countries to adopt it only when a program has a setting where breeding sites are few in number, in fixed locations, and are in findable sites. [11(p6), 12(p118), 19(p156),27(p146),34]	Consider partnerships with companies where their operations create breeding sites or increases risk. Companies can use larval source management to reduce risk of malaria transmission at their workplace.

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[c]Findings from an unpublished analysis of urban distribution programs, presented by Ms. Andrea Brown at the Alliance for Malaria Prevention 2012 Annual Partners Meeting. http://allianceformalariaprevention.com/resources/Urban%20distribution%20analysis%20-%20Andrea%20Brown.pdf Accessed 3/25/2012.

[d]Dr. Robert Newman, Director of WHO Global Malaria Program, during a plenary address at the Roll Back Malaria's Vector Control Working Group 2012 Annual Meeting. Author was in attendance.

Malaria Diagnosis	The accuracy of diagnosis is essential to appropriate management of fevers in urban settings because the reduced burden of disease in urban settings no longer justifies presumptive treatment of malaria for all patients presenting with fever. Therefore, all urban programs should require diagnostic confirmation before treatment. While microscopy remains the gold standard for malaria diagnosis, timely deployment of trained microscopists at the volume needed in urban settings is not feasible. Programs should use rapid diagnostic tests as a low-tech and scalable way to ensure that all fevers are tested for malaria.[27(p139-45),35]	Ensure that pharmacies and chemists sell malaria treatments only to those with a diagnostic test positive for malaria.
Malaria Treatment	• Community Case Management: There is little evidence that community case management works in urban areas, where there is lower incidence and people have better access to health care clinics. Because fevers are not synonymous with malaria in urban settings, this intervention brings substantial over-treatment and is more expensive to treat per child than through the national health system. [9(p1629-30),36] • Facility-based treatment: Treatment of fevers in urban settings are best addressed in clinic settings; however, over treatment of fevers clinically diagnosed as malaria is a well-documented problem in urban areas. Given the density of populations and the tendency to treat all fevers as malaria infections, it means that there is significant misdiagnosis of illness and under diagnosis of other causes of fever which could also be life threatening.[24,37] In-service training is recommended to help health care workers adhere to the malaria diagnosis results and provide them with a treatment algorithm to follow if a febrile patient does not test positive for malaria.	Because the majority of urban residents seek treatment outside the formal health care setting (private practitioners, NGOs, mission clinics, and retailers), the private sector has a large role to play in improving case management and linking treatment with confirmed diagnosis (see above). [27,31(p15)] Program managers should engage the private sector to help enforce national policies on testing and treating malaria.

Part 2:
Designing Malaria Control Interventions in Urban Settings: A 5-Step Decision Tool

The current practice of applying malaria control interventions designed for controlling malaria in rural settings to an urban context ignores previous practice, wastes resources, and does not fully address specific risk factors. As Africa continues to urbanize, national programs must customize the malaria control efforts conducted in these areas. This section distils the literature findings previously discussed into a comprehensive, innovative five-step decision tool to guide the design and implementation of urban malaria control programs. The primary target audience is a malaria control program manager and her team, but can be used by other groups to evaluate their own programs and identify how to further refine their interventions.

Elements of Successful Urban Malaria Control Programs

Analysis of successful urban malaria efforts (including the case studies in Annex 2) confirms that customizing strategies and tools to meet the specific transmission dynamics in the targeted locations is essential.[4(p104)] As in the 1950s and 1960s, when environmental measures were replaced with the insecticide DDT (dichlorodiphenyltrichloroethane) to dramatically reduce the mosquito population, programs today need to adapt to the latest technologies. Programs should have multiple, complementary interventions in order to establish control and begin to reduce overall transmission in a specific area.[12(p124-25)] Successful programs also developed intervention packages that were flexible enough to be adapted and refined over time in response to malaria incidence, and were allowed to mature over a three to five-year timeframe before showing impact.

In addition, program design should take into account factors that make urban malaria easier to control than in rural settings, including: access to better transportation options, greater access to media and communication tools (television, radios, advertising, etc.); higher education levels among targeted populations; stronger health infrastructure and improved accessibility of services, and easier access to breeding sites. Conversely, dynamics that can limit program success in urban settings and should to be considered when adapting programs include: increased household security concerns (and allowing access to homes), need for crowd control measures (especially during public gatherings or events), and adapting to commuting and work schedules, all of which influence and affect the population's access to health services and preventative measures.[1(p173),12(124-5)]

Choosing Effective Urban Malaria Control Tools: A 5-Step Decision Tool

A strategy for urban malaria control should always be part of the broader national malaria control strategy. The national goal, vision, and mission statement that inform the overall malaria control strategy should also guide the direction of specific urban malaria control efforts. This decision tool is designed to help program managers select the appropriate mix of customized interventions through the following five steps:

1. Identify and map the disease burden;
2. Use the data to identify the appropriate strategy, goal and objective;
3. Select appropriate interventions;
4. Expand partnerships to include (among others) the private sector; and,
5. Continue monitoring program progress.

Annex 3 is a worksheet for program managers to complete with their own data for each of these five steps described in more detail, below.

Step 1: Identify and Map the Disease Burden

An early and thorough assessment of the malaria risk patterns in any city is essential to designing an integrated urban malaria control program.[16(p585-6)] Precise mapping of malaria transmission levels are critical. To begin, programs must gather both epidemiologic and entomologic data to quantify the disease burden and track transmission patterns in the targeted area.[12(p124)] Program managers should look specifically for highly vulnerable and most disadvantaged urban environments where risk of disease is highest and people are at most need.[12(p125)]

It is important to gather existing data either through a health monitoring information system (if available), or new data from specific surveys. This data is needed to determine a) the current disease burden, b) the intensity of transmission, and c) the local transmission factors (breeding sites and the volume of locally acquired cases). If this standard data are not already being collected, it could take a substantial amount of time to gather because the seasonality of malaria means that one should track fluctuations in disease incidence and transmission patterns over the course of the entire year. Program managers should be patient, as the more robust data that can be gathered, the more precisely the program can be customized and redesigned to best suit the targeted area. Specifically, the following entomological and epidemiological data should be collected:

- <u>Disease burden measures</u> to document actual malaria burden among the general population should be calculated from incidence of confirmed cases by the slide positivity rate in both dry and rainy seasons. This is a surrogate measure of malaria incidence and is calculated from collected blood smear slide samples. The formula used is: total positive x 100/total slides examined.[38]
- <u>Entomological data</u> to track the intensity of malaria transmission and to document the actual risk of exposure to malaria in a given area. This is commonly measured through the entomological inoculation rate, and is a measurement of transmission intensity (rather than

incidence or prevalence of actual malaria infection). This calculation measures the number of bites a human receives by an infectious mosquito (as opposed to non-infectious mosquito) per person per year.[3(p90), 39]

- Determine the density of breeding sites, including identifying the location and number of breeding sites, through either existing data (from previous research studies) or by collecting new data using standard practices, geographic information systems, or satellite remote sensing with high spatial resolution to identify and map the malaria risk spatially and temporally and target interventions accordingly.[3(p94-5),4(p115),40]
- Distinguish between locally-acquired and imported cases to understand the infection risks for local residents and those travelling to other malaria endemic areas. This data will need to be gathered through taking case histories from a sampling of confirmed cases.

Step 2: Design the program, based on Appropriate Strategy and Goals

The Urban Malaria Control Strategy Score Card and Quadrant Matrix (Figure B below) described in this section is designed to identify the appropriate goal, strategy and program objective for the urban setting in question, given its specific parameters. The framework outlined below allows program managers to hone in on the appropriate activities given the malaria transmission factors present in the targeted areas. It is based on a quadrant analysis of shifting levels of malaria transmission and disease burden.

For example, if the targeted urban setting has widespread transmission and high disease burden, the city's score will place it in Quadrant 1, meaning that the primary program objective would be to ensure scale up and widespread use of interventions in order gain control over disease transmission. In contrast, if the final score places the city in Quadrant 4, the program will focus on deploying interventions designed to help the city reach disease elimination status.

To calculate the appropriate quadrant for the targeted area, use the data gathered in Step 1 to complete the score card. At the end of the questions, add up the total score and identify the intervention quadrant into which the targeted urban malaria setting falls. Given the transmission dynamics found in most African cities, most results will be clustered in Quadrants 1, 2 and 3. A Quadrant 4 placement will be rare.

Figure B: Urban Malaria Control Strategy Score Card and Risk Matrix

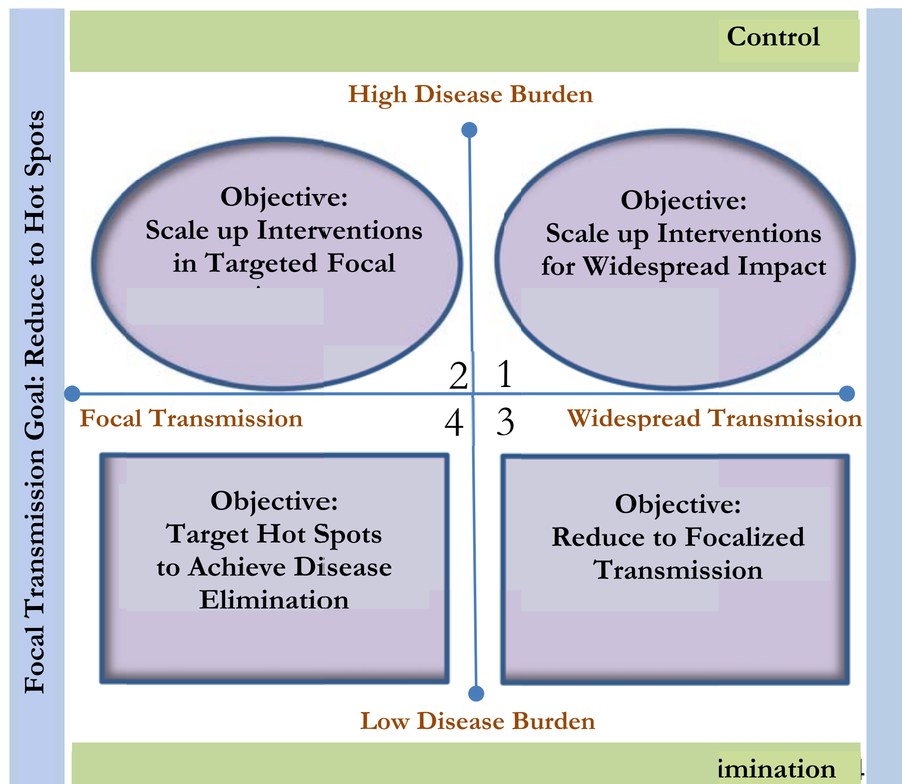
Part 1: Calculate your Points:

Data Source	Data Values	Category Status	Points Score
Disease burden[38(p9)]			
Data source: Slide Positivity Rate (SPR)	<1 case/1,000 population	Low	1
	<5% in fever cases	Medium	3
	>5% in fever cases	High	5
Entomological Burden[38(p23)]			
Data source: Entomological Inoculation Rate (EIR)	<0.25	Low	1
	0.25-10	Medium	3
	11-140+	High	5
Breeding Site Density[3(p90)]			
Data source: Calculated density from GIS, satellite data, field survey		Fixed, Few, Findable Sites	1
		Mixed	3
		Widespread	5
Source of Infections[4(p115), 12(124)]			
Data source: Confirmed malaria patient case history		Imported only	1
		Combination	3
		Locally-acquired only	5

Part 2: Identify your Quadrant

Risk Analysis Results:	
If the score is:	**…then the Risk Quadrant is:**
<5 points	Quadrant 4
5-10 points	Quadrant 3
11-15 points	Quadrant 2
16-20 points	Quadrant 1

Part 3: Identify the Strategy, Goal and Objective



Step 3: Select Appropriate Interventions

Now that the overall strategy, goal and objective are identified for the targeted urban area, it is time to select appropriate interventions. As discussed earlier, this is an art not a science. The variability in levels of transmission in urban areas means that each situation must be carefully evaluated before an intervention method is adopted. Program managers must gather city-specific information in order to make informed investments into specific interventions. [11(p12)] Below, Table 3 lists the recommended interventions for the four different transmission and disease burden categories. Use the table to identify the recommended interventions for the targeted area.

Table 3: Recommended Urban Intervention Strategies, by Risk Quadrant

Intervention, by deployment strategy	**Risk Category**				**Private Sector?** (Yes/No)
	Quad 1	Quad 2	Quad 3	Quad 4	
Insecticide Treated Nets					
Universal Coverage (ratio of 1 ITN/2 people)	X	X (focal only)	X	N/A	Y
Targeted Populations (those at high risk get ITNs)	X	X	X	X	Y
Indoor Residual Spraying					
Blanket Coverage (in geographic area)	X	X	N/A	N/A	N
Targeted Spraying (select areas in geographic area)	N/A	N/A	X	X	Y
Larval Source Management					
Breeding Sites are widespread and difficult to find	*Do not use strategy*				
Breeding Sites are Fixed, Few and Findable	N/A	X	N/A	X	Y
Malaria Diagnosis					
Microscopy (higher level facilities)	X	X	X	X	Y
Rapid Diagnostic Test (all health facilities)	X	X	X	X	Y
Malaria Treatment					
Community Case Management	*Do not use strategy in urban areas*				
Facility-based Treatment (public sector facilities)	X	X	X	X	N
Private Sector Treatment (private clinics, pharmacies, etc.)	X	X	X	X	Y

Step 4: Expand Partnerships and Develop New Allies

Effective programs include groups from outside the public health sector that have access to targeted populations. Malaria is a disease that does have cross-sectional application, and it is beneficial to engage other disciplines in efforts to implement the program. Successful previous programs were managed by teams from a wide range of technical backgrounds, including: clinical malaria, ecology, epidemiology, entomology and hydrology.[4(p104)] Also, it is helpful to engage and coordinate with other sectors of the government, such as departments (or ministries) of urban planning, agricultural and education, as they can offer complementary contributions to control program efforts.

As noted in both Tables 2 and 3, there is a role for the private sector to play in urban malaria control programs that just is not possible in rural areas. Private sector companies have a vested interest in ensuring that their work place and employees remain healthy and malaria-free.[41,42] The private sector also offers outreach to consumers especially for health care needs. A high percentage of urban populations, with the financial means to pay for goods and services, access the private sector for their health care needs. The private sector is an essential partner in ensuring successful implementation of urban malaria control efforts. As program managers design their malaria control programs, they should consider how to leverage and partner the private sector in their efforts.

At this stage of the program design, identify relevant actors and organizations. Approach these new potential partners to develop ways to link and strengthen the deployment and uptake of malaria control interventions in targeted areas.

Step 5: Monitor progress

To have a successful monitoring and evaluation program, one needs reliable disease surveillance information. While important in all settings, because the risk factors, disease burden, and appropriateness of targeted interventions in urban areas remains highly variable, monitoring progress is a critical component in urban programs.[27(p139)] Urban malaria control demands a rigorous case-detection system, and confirmed malaria cases need to be documented and reported across all sectors (public, private, and civil). [27(p146)]

Further, programs should actively track the outputs and results of each intervention and continuously monitor progress by strengthening health management information systems and tracking epidemiologic and entomologic data. It is critical for successful urban malaria programs to use this information to target resources appropriately and to adjust programs quickly in response to changing risk profiles. To that end, program managers should revisit the first four steps of this tool on a regular basis (perhaps once every 12-24 months) and:

a. Review the data gathered in Step 1. Has any of the data changed significantly over time?
b. Recalculate the risk profile, as outlined in Step 2, based on the updated data. Have the risk factors stayed the same? Have new ones arisen?
c. Evaluate the current interventions selected in Step 3 and consider making adjustments or revisions to the strategy if the risk profile has changed, or the program is experiencing implementation challenges that require adjustments. It is important to remain flexible to changing interventions and/or deployment strategies if the program is not generating the results intended.
d. Examine current partnerships and identified allies listed in Step 4. Are the current partnerships productive? Is there a need for any new partners? Is your program maximizing the benefits the private sector brings to your urban area?

Conclusion

Africa's rapid pace of urbanization, coupled with specific dynamics of urban settings that facilitate transmission, means that malaria will remain an important public health concern for this region's urban populations well into the 21st century. Since urban malaria transmission experiences a high level of heterogeneity, successful programs should have multiple, complementary interventions that can be adapted in response to context-specific dynamics. These urban malaria control programs will need to become more strategic and cost effective, and should have customized interventions designed to meet the specific disease transmission scenarios present in urban contexts.

The five-step decision tool developed and presented in this paper allows urban malaria control program managers to: a) identify and map the disease burden, b) recognize the appropriate strategy, goal and objective; c) select the appropriate interventions; d) identify and expand partnerships; and e) monitor program progress. This level of analysis is designed to facilitate decision making, but not to replace practical experience and judgment. Program managers should use this decision tool to guide decisions and help prioritize areas to focus interventions, but always continue to refine it as programs gain both data and practical experience.

Despite designing programs to meet public health priorities, political realities (especially during election years) may trump the best evidence-based practices and epidemiology. It is difficult, for example, for politicians (and their Ministers of Health) to not offer insecticide treated nets to all residents of a city (as a very tangible proof of government services to voters) instead of to just those at risk. Program managers should remain cognizant of these challenges. Selecting the right mix of interventions to develop an effective urban malaria control program is a difficult balancing act and a lesson in navigating public health and political considerations. But, if successfully implemented, urban malaria control programs can ultimately improve the health for millions of Africans and be well worth the effort.

Annex 1: Sample of Urban Malaria Study Findings in Africa

City	Study Findings
Abidjan, Cote D'Ivoire[13]	About 45.8% (7.4 million people) of the population lives in urban areas. The country is highly urbanized, and city growth is uncontrolled. Between 73-88% of all fever cases presenting at health facilities are unlikely to have suffered from malaria, meaning that there is substantial over-treatment with anti-malarial drugs and providers are missing other conditions that need treatment.
Accra, Ghana[16, 17]	The study documents high parasitemia rates in Accra and local transmission was indicated. This study illustrates that it can remain a significant problem in high density population centers. Urban agriculture was a risk factor for breeding habitats that increase transmission in cities.
Antananarivo, Madagascar[18]	The study confirmed a very low incidence of a malaria transmission. There is no real threat to urban areas of Antananarivo. Of the presumed malaria cases, only 5.1% were confirmed. Travel to other regions was the primary case of cases identified. Imported malaria may be enough to sustain the pocket transmission found in the city.
Brazzaville, Congo[1(p170-172),19]	The study found that prevalence among school children varied from 3% in central quarter to 81% in peripheral areas. Confirmed that risk varies within the city, and here urban malaria is highly localized
Cotonou, Benin[20]	Malaria transmission and vector density is associated with lagoon salinity. Transmission is lower in communities near the beach, (where standing water is much saltier) than in other areas. The study found five infective bites per person per year near the beach as compared to 29 infected bites per person in the center of Cotonou. Malaria infections may also be associated with poor urban agriculture irrigation systems. There is significant over-diagnosis of malaria in the dry season, and the risk areas do vary in the city. Care seeking behavior is varied and the private sector is a significant player.
Dakar, Senegal[19]	Transmission is highly focalized, and temporary breeding sites can emerge during rainy season. Documented sites include tires, tracks, puddles, ditches and garbage cans, construction sites, water basins, wells, etc.
Dar es Salaam, Tanzania[4(p104), 21]	Overall, knowledge of malaria among city residents is very high. Risk factors facilitating malaria transmission includes substantial urban agriculture activities, which keeps breeding sites high (one study identified more than 400 breeding sites in central Dar es Salaam). There is not a direct correlation from breeding sites to malaria risk; the landing rates per person remain low which suggests that the larvae are not able to fully mature. Less than 5% of all fever-related consultations were due to malaria in the 2003 dry season, meaning actual malaria burden is low.
Kampala, Uganda[22]	Residents living near potential mosquito breeding sites were associated with increased risk of clinical malaria episodes. There was significant variation in the incidence of clinical episodes of malaria was observed over small distances.
Khartoum, Sudan[23]	Elimination efforts are possible in the city, because the mosquito breeding can be identified. Core intervention was larval control through weekly application of organophosphate larvicide product and environmental management. The program mapped and identified all breeding sites, treated breeding sites, intermittent irrigation, rehabilitation and immediate repair of leaking pipes and land modification where applicable. Vector control efforts were complemented by malaria case management: improved microscopy, and effective drug treatment.

Luanda, Angola[24]	Luanda has low prevalence among those with fever. There is a low parasitemia prevalence of 5.5% among children under five years of age in Luanda province compared with 29% in surrounding rural provinces. There is overuse of ACTs and an under diagnosis of other causes of fever. Data suggests that resources for diagnosis and treatment of malaria as well as resources for prevention should be focused in areas at least 15 kilometers from city center.
Maputo, Mozambique[25, 26]	A study in a peri-urban area of Maputo found that individuals living within 200 meters of malaria breeding sites were at much higher risk than those living 500 meters or more away. Location and proximity to breeding sites affects malaria risk.
Nairobi, Kenya [27]	Malaria is a common diagnosis of fever at out-patient facilities across the city, and is estimated to be 9-16% of the outpatient annual burden. While there is evidence that malaria is still in Nairobi, cases are not linked to travel histories, making it impossible to identify local infections and hindering reliable estimations of malaria risks in Nairobi. The actual burden of local transmission remains uncertain.
Ouagadougou, Burkina Faso[28, 29]	Urban malaria in the city is low. Transmission sites are primarily in irregular and sparsely built up areas, and within 200-300 meters of the hydrographic system. Those at greater risk of infection include poorer households, traveling outside of the city, and seasonal agricultural activities. The study confirmed the heterogeneity of endemnicity within a small distance from the urban center and the periphery of the city.

Annex 2: Review of Past Urban Malaria Control Efforts: Successes and Setbacks

Country	Successful Urban Malaria Control Actions	Urban Malaria Control Setbacks
Dar es Salaam, Tanzania[4,21]	Malaria was fairly well contained after adopting: • 1891: mass drug administration (with quinine) • 1900: environmental management and targeting the larval stages of the mosquitoes to control the vector population. • 1945/46: started larviciding and aerial spraying with DDT, and introduced a new, more effective anti-malarial: chloroquine	• 1970s: Due in part to the deterioration of the health care system, malaria reemerged as a major public health program.
Nairobi, Kenya[27]	Nairobi controlled malaria after adopting: • 1930s: malaria becomes a notifiable disease, and all suspected malaria cases were required to be reported and laboratory confirmation was required for any cases deemed to be due to locally acquired infections. • 1930-1960s: authorities adopted control measures: oiling, cleaning streams & drains, grass cutting, DDT spraying. • 1950-1961: The municipal council invested an average of 3.9% of total health expenditures on direct malaria control effort. Malaria was a public health priority, documentation was complete. • 1960s: malaria incidence was being controlled effectively.	• 1970s-1990s: Malaria is integrated into general care; the accuracy and completeness of health information and malaria reporting declines. • 1980s: Malaria becomes over-diagnosed: only 5% of adults admitted to Kenyatta National Hospital with a malaria diagnosis actually had malaria. • 2010: malaria remains a common diagnosis at out-patient facilities across the city, is 9-16% of outpatient annual burden. • Malaria cases are not linked to travel histories, making it impossible to tell which infections occur locally. No study has identified sporozoite-positive adult vectors in the city since the 1920s, so local transmission remains uncertain.
Khartoum, Sudan[23]	• 1904: malaria control began; 1960s malaria was eliminated. • 2002: a malaria free initiative launched, focused primarily on larval control. Mapped, identified and treated all breeding sites. Adopted environmental management: monitored intermittent irrigation, rehabilitated and repaired leaking pipes, land modification • Vector control efforts complemented by malaria case management: improved microscopy, and malaria treatment based on confirmation diagnosis	• 1970s-1980s: malaria resurged due to the deterioration of the control program and the large influx of internally displaced persons into Khartoum from malarial areas (introduced parasites back to the existing vectors). • 1980s-1990s: malaria was leading cause of outpatient attendances, hospital admissions and deaths in all facilities. • 2005: Malaria transmission is reduced, but at subject to resurgences. Monitoring and evaluation of interventions needs to be strengthened.

Annex 3:
Urban Malaria Control
Program Design Work Sheet

Targeted Area: ___________________________ Date Form Completed: ____________________

Step 1:
Identify and Map the Disease Burden

Category	Data	Data Collection Date	Data Source
Disease Burden	**SPR: ______________**		
Entomological Burden	**EIR: ______________**		
Breeding Site Density	☐ **Few, Fixed Findable** ☐ **Mixed** ☐ **Widespread**		
Source of Infection	☐ **Imported Only** ☐ **Combination** ☐ **Locally Acquired Only**		

Step 2:
Design the program, based on Appropriate Strategy and Goals

Data Source	Data Values	Category Status	Score
Disease burden[38(p9)]			
Data source: Slide Positivity Rate (SPR)	<1 case/1,000 population	Low	1
	<5% in fever cases	Medium	3
	>5% in fever cases	High	5
Sub-Category Score:			
Entomological Burden[38(p23)]			
Data source: Entomological Inoculation Rate (EIR)	<0.25	Low	1
	0.25-10	Medium	3
	11-140+	High	5
Sub-Category Score:			
Breeding Site Density[3(p90)]			
Data source: Calculated density from GIS, satellite data, field survey		Fixed, Few, Findable Sites	1
		Mixed	3
		Widespread	5
Sub-Category Score:			
Location Source of Infection[4(p115), 12(124)]			
Data source: Confirmed malaria patient case history		Imported only	1
		Combination	3
		Locally-acquired only	5
Sub-Category Score:			
Total Points:			

Risk Matrix Results	
Quadrant:	
Strategy:	
Goal:	
Objective:	

Step 3:
Select Appropriate Interventions

Intervention, by deployment strategy	Selected Interventions (Y/N)	Private Sector? (Y/N)	Notes/ Customization
Insecticide Treated Nets			
Universal Coverage (ratio of 1 ITN/2 people)			
Targeted Populations (at high risk get ITNs)			
Indoor Residual Spraying			
Blanket Coverage (in geographic area)			
Targeted Spraying (selected areas)			
Larval Source Management			
Breeding Sites: widespread and difficult to find			
Breeding Sites: Fixed, Few and Findable			
Malaria Diagnosis			
Microscopy (higher level facilities)			
Rapid Diagnostic Test (all health facilities)			
Malaria Treatment			
Community Case Management			
Facility-based Treatment (public sector facilities)			
Private Sector Treatment (clinics, pharmacies)			

Step 4:
Expand Partnerships and Develop New Allies

List Possible Government Partners Here (expand as needed)
1. 2. 3. 4.
List Possible Private Sector Partners Here (expand as needed)
1. 2. 3. 4.

Step 5:
Monitor Progress

Next Scheduled Data Reporting Period:	______________________________
1. Has any of the data gathered in Step 1 changed significantly over time?	□ Yes: Update the figures in Step 1. □ No: Check data again in 1 year, continue monitoring.
2. Have the risk profile and strategy calculated in Step 2 changed?	□ Yes: Recalculate the risk profile in Step 2. □ No: Continue monitoring progress of the program.
3. Based on experience & the risk profile, do current interventions need to be adjusted?	□ Yes: Adjust or revise strategy & update Step 3. □ No: Continue monitoring progress of interventions.
4. Have any new potential partners emerged?	□ Yes: Explore new partnerships and update Step 4. □ No: Foster existing partners & seek new ones.

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