Trends in Malaria Indicators After Scale-Up of Community-Based Malaria Management in Afghanistan

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Abstract

**Objectives:** The Community-Based Malaria Management (CBMM) strategy, introduced in 2013 and expanded to all health facilities and health posts in Afghanistan by 2016, aimed to deliver rapid diagnostic testing and more timely treatment to all communities nationwide. In this study, we compared the trends in several malaria outcome indicators before and after the expansion of the CBMM strategy.

**Study Design:** Cross-sectional analysis of surveillance data

**Methods:** Generalized estimating equation (GEE) models with a Poisson distribution were used to assess trends of three key outcomes before (2012-2015) and after (2016-2019) CBMM expansion. These outcomes were annual malaria incidence rate (both all and confirmed malaria incidence), malaria death rate, and malaria test positivity rate. Additional variables assessed included annual blood examination rates (ABER) and malaria confirmation rate.

**Results:** Average malaria incidence rates decreased from 13.1 before CBMM expansion to 10.0 per 1000 persons per year after CBMM expansion (P<0.001). The time period after CBMM was expanded witnessed a 339% increase in confirmed malaria incidence as compared to the period before (IRR 3.39, 95% CI 2.18, 5.27; P<0.001). In the period since the expansion of CBMM (2016-2019), overall malaria incidence rate declined by 19% each year (IRR 0.81, 95% CI 0.71,0.92; P=0.001) and the malaria death rate declined by 85% each year (IRR 0.15, 95% CI 0.12, 0.20, P<0.001). In comparing the before period to the after period, the ABER increased from 2.3 to 3.5 per 100 person/year, the malaria test positivity rate increased from 12.2% to 20.5%, and the confirmation rate increased from 21% before to 71% after CBMM.

**Conclusions:** Afghanistan's CBMM expansion to introduce rapid diagnostic tests and provide more timely treatment for malaria through all levels of care temporally correlates with significant improvement in multiple indicators of malaria control.

Background

Worldwide, malaria is a major public health problem with 228 million new infections and 405,000 deaths annually [1]. Afghanistan, a country in the WHO Eastern Mediterranean Region, has relatively low transmission of malaria [2]. The Afghanistan National Malaria and Leishmania Control Program reported 174,893 malaria cases and zero deaths in 2019, the lowest number that has ever been reported for the country. The two main species of malaria in Afghanistan are *Plasmodium vivax* (PV, 98% of all cases) and *Plasmodium falciparum* (PF, 2%) [2].

In Afghanistan, malaria incidence rates vary by location. The variation results from differences in parasites, vectors, human population density, behaviors, ecological, high temperature, humidity and agriculture (rice cultivation), socio-economic conditions, and access to health services for detection and treatment of malaria. Nationally, 27% of the Afghan population lives in areas at high risk for malaria. Areas at high risk are defined as provinces and districts with annual parasite incidence (API) rate per 1000 persons at risk of 1 or above and test positivity rate (TPR) at 9% and above. Half (50%) of the population lives in areas at medium risk (API<1, TPR<9%), and the remaining 23% live in areas with low and very low risk of malaria transmission or its absence in malaria free areas [3]. In 2019, more than 93% of total malaria cases were reported from six provinces that border with Pakistan (Nangarhar, Laghman, Kunar, Nooristan, Khost, and Paktika) and one district of Kabul. Nangarhar is one highest endemic province in the country and accounted for more than 45% of total malaria cases and 35% of total PF cases [2].

Malaria diagnosis either by microscopy or rapid diagnostic tests is recommended by WHO for all suspected malaria cases before starting the treatment. Early and accurate diagnosis is essential both for effective management of the disease, and for malaria surveillance and elimination strategies. In Afghanistan, the Community-Based Management of Malaria (CBMM) strategy was designed to progressively expand access to malaria diagnosis and effective antimalarial treatment at non-diagnostic health facilities and community including health posts [4]. Malaria diagnosis using microscopy has been available in all hospitals and Comprehensive Health Centers (CHCs) of Afghanistan. Since 2013, the focus of the CBMM in Afghanistan has changed to specifically increase access to rapid diagnostic testing (RDT) and timely treatment at the community level in all malaria endemic and non-endemic areas of Afghanistan. The programme consists of two key modules; case management, vector control; CBMM was scaled up nationwide in 2016 with the support of the Global Fund. A main pillar of this revised strategy is introducing RDT in all health facilities, not only those providing diagnosis and treatment for malaria, and expanding screening of malaria to health posts to run community-based screening programs. In addition, the CBMM expanded the community-based malaria case management program using networks of community health workers (CHW) to reach all patients with suspected malaria at a level closer to the home. Since 2016, more than 30,000 CHWs were trained on malaria case management, RDT use and distribution of Long-lasting insecticidal net (LLIN) to community through mass campaign. Other malaria commodities, including medicines, were supplied to health posts and health facilities without laboratory services. As a result, in 2017 more than 90% of CHW reported screening and referral of newly identified cases of malaria, and more than 50% reported providing counselling, chloroquine treatment for PV, and artemisinin-based combination therapy for PF to suspected and confirmed malaria cases [5].

While the magnitude of the scale-up and shift in focus of the CBMM are encouraging, the effectiveness of the program in Afghanistan has not yet been evaluated. In this study, we assessed trends in annual malaria incidence and death rates during two time periods, four years before the expansion of CBMM (2012–2015), and four years after expansion the CBMM program (2016–2019). We also tracked additional indicators of program impact. The scope of our analysis included both national and subnational trends in Afghanistan.

Methods

Data were extracted from the Malaria Leishmania Information System (MLIS) of the National Malaria Control Program and Health Management Information System (HMIS). Data included clinical (diagnosed without a diagnostic test) and confirmed (diagnosed with a diagnostic test) malaria cases reported by approximately 2800 health facilities on a monthly basis. Patients were those with symptoms or diagnosis of malaria who visited health facilities, health posts
and community member reached through outreach or mobile services. Data were initially collected on paper forms. The HMIS officers of non-governmental organizations (NGOs) and provincial malaria case managers checked the quality and completeness of the forms and entered them into the HMIS database. Hard and soft copies of collected data were shared with the provincial health directorate HMIS team on a monthly basis. The provincial HMIS and malaria officers reviewed and compiled the data and reported to the National Malaria Control Program on a quarterly basis. Data were analyzed and feedback provided to implementers on a quarterly basis. For this analysis, we used all data reported since 2012.

Analysis

To assess trends in malaria before and after the expansion of the CBMM program in Afghanistan, we measured seven indicators (Table 1). We first descriptively assessed the following indicators: the malaria incidence rate (both all and confirmed malaria) per 1000 persons per year, malaria death rates per 100,000 persons per year, malaria test positivity rate, annual blood examination rate per 100 per year (ABER) and the malaria confirmation rate. Reporting completeness during this time period was assessed to understand the reliability of the data.

We used generalized estimating equation (GEE) models with a Poisson distribution to assess the differences in these indicator rates before (2012-2015) and after (2016-2019) CBMM was expanded (a binary predictor variable of before and after was used). We also assessed temporal trends during the before and after years using GEE models by stratifying on time period and using year as a predictor variable. Analyses were conducted at the provincial level with all the provinces of Afghanistan included. Stata v. 15 was used for statistical analysis and ArcGIS v.10.3.1 was used to create maps of average annual malaria incidence and average annual incidence of death due to malaria during the before and after periods.

Results

Between 2012 and 2019, the total number of malaria cases (including clinical and confirmed) fell from 391,365 to 174,893. The overall malaria incidence rate declined from 15.4 to 5.5 per 1,000 per year and the malaria confirmation rate increased from 14% to 99% (Figure 1A). The number of malaria cases that were confirmed by testing rose from 54,840 to 173,859; clinical cases declined 336,525 to 1,034 (Figure 1B). The malaria death rate fell from 0.1416 to 0 per 100,000 per year.

Table 2 presents annual malaria data and combined data for the two time periods based on the start of CBMM expansion (2012-15 vs. 2016-19). Between 2012-2015, the total number of tests conducted was 2,365,753. After the expansion of CBMM (2016-2019), the total number of tests conducted was 4,097,900 (Table 2, Figure 1B). Meanwhile, average malaria incidence rates decreased from 13.1 before CBMM expansion to 10.1 per 1000 persons per year after CBMM expansion. The malaria death rates per 100,000 decreased from 0.1345 to 0.0493 for the years after CBMM expansion. The malaria test positivity rate increased 12.2% to 20.5%. The ABER increased from 2.3 to 3.5 per 100 per year. The malaria confirmation rate increased from 14% in 2012 to 99% in 2019. Annual malaria testing, incidence, and deaths are presented in Annex-1 by province from 2012 to 2019.

In the time period after CBMM expansion there was an 8% decrease in the malaria incidence rate as compared to the period before CBMM expansion (IRR 0.92, P=0.692) (Table 3). For the time period after CBMM expansion, the confirmed malaria incidence rate increased 339% as compared to the period before CBMM was expanded (IRR 3.39, P<0.001). There was a 65% decrease in the malaria death rate in the period after the expansion of CBMM compared to the period before (IRR 0.35, P<0.001).

In examining only, the period since the expansion of CBMM (2016-2019), the overall malaria incidence rate declined by 19% each year (IRR 0.81, P=0.001). The confirmed malaria incidence rate declined by 2% each year (IRR 0.98, P=0.840). Malaria death incidence declined by 85% each year (IRR 0.15, P<0.001) (Table 4).

Discussion

Our malaria trend analysis revealed several encouraging outcomes for malaria control in Afghanistan following the scale-up of the CBMM strategy. In line with the expansion of RDT, there was an increase in the number of suspected cases that received parasitological testing in a health facility and at community levels. During the period since this expansion, the malaria incidence rate and malaria death rate declined. The magnitude of the decline in incidence is remarkable - from 15.5 to 5.5 per 1000 persons/year between 2012 and 2019. The malaria deaths rate declined from 0.1416 to 0 per 100,000 persons per year for the same periods. Additionally, number of confirmed malaria cases increased following the expansion of RDT and the number of clinical cases decreased during the period. The ABER have increased, leading to a confirmation rate of nearly 100%.

Our results are similar to positive outcomes of other community-based malaria control models. A systematic review conducted in 2019 investigated the impact of community-delivered models (namely, Integrated Community Case Management and Home Management of Malaria) on coverage and malaria outcomes compared to non-community-delivered models [6]. The result of meta-analysis indicated that the implementation of community-delivered models improved malaria-attributed mortality. Community-delivered models also reduced the risk of parasitemia from 25–70% compared to non-community-delivered models [6].

We recognize limitations of our analysis. First, we used surveillance and health system data which meant we were not fully able to assess quality (however, there was very high reporting completeness throughout the study period). Second, data were reported as aggregated and individual characteristics such as gender, age, and other personal and behavior data were not available. Studying the potential associations between malaria and these characteristics will help target future interventions towards malaria eradication. Third, the surveillance data did not include most of the cases who were diagnosed or received treatment in private health sectors. It is also unclear how use of the private health sector changed over time. Lastly, treatment data were not reported to the surveillance system and therefore we were not able to assess trends in this important indicator.
There are also potential confounders that may explain or partially explain the differences witnessed in malaria indicators during the before versus after CBMM scale up. These include vector control measures, the Basic Package of Health Services (BPHS), the Essential Package of Health Services (EPHS) and strengthening of malaria surveillance, Malaria Leishmania Information System (MLIS). The diagnosis and treatment of malaria has been integrated into BPHS and EPHS services, with malaria diagnosis and treatment (including microscopy and antimalarial therapy) provided from health post level up to regional hospitals and provided malaria reports on monthly basis. Additionally, since expansion of CBMM after 2016, approximately 6,015,826 long lasting insecticide nets (LLIN) have been distributed to targeted provinces. The LLIN distribution program ensured 100% operational coverage (i.e., all target provinces and districts were covered through mass distribution campaigns and through continuous distribution at antenatal clinics). The program sought to improve coverage and accessibility for at-risk populations, including pregnant women and children. We also did not assess ecological factors such as changes in temperature or rainfall, variables that could influence malaria transmission in Afghanistan.

Our trend analysis for the period after CBMM expansion shows that most of the targets of Afghanistan's National Strategic Plan for Malaria 2018-22 are on track to being met. The plan aims to reduce malaria incidence by 73% at the national level compared with 2016. Between 2016 and 2019, the number of reported malaria cases were reduced from 385,015 to 174,893 (55%). The proportion of confirmed malaria cases increased to 99% in 2019 compared to the baseline 49% in 2016. Nonetheless, 12 provinces remain at high risk for malaria with reported annual parasite incidence rates per 1000 persons at 1 and above and test positivity rate at 9% and above.

In summary, the CBMM expansion which introduced rapid diagnostic tests for malaria to many primary care settings correlated with significant increase in the number of confirmed cases, while also being correlated with significant reduction in annual malaria incidence and death rates. Use of RDTs for the diagnosis of malaria could be best applied as a tool at the community level to facilitate the early treatment of malaria in settings where microscopy services are not available. Our data corroborate similar studies that recommend community-based interventions as best practices for malaria control, especially in resource-limited settings.

**Declarations**

**Ethics approval and consent to participate:**

We used deidentified public health surveillance data which does not require participant consent.

**Consent for publication**

All co-authors have reviewed the final draft of the paper and approved it before submission to the journal.

**Availability of data and material:**

All details of data (case numbers) that we used for our analysis are presented in Table 2 and Annex 1.

**Competing interests:**

Nothing to declare

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**Authors' contributions:**

SDM (study design, implementation, data cleaning and analysis, reporting, manuscript writing), AAA, AWS, WM, TBA, MSN, HH, GQQ, ST (study design, interpretation of results, critical review of the manuscript), and SG, AM (study design, data analysis, reporting, critical review, manuscript writing, funding). All authors read and approved the final manuscript.

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### Tables

**Table 1.** Indicators of malaria, Afghanistan, 2012-2019

| Indicator                                      | Numerator                                                                 | Denominator                                                                 |
|------------------------------------------------|---------------------------------------------------------------------------|----------------------------------------------------------------------------|
| **Malaria incidence rate**<br>(per 1,000 persons per year) | Number of reported (clinical and confirmed) malaria cases during the reporting year ′ 1,000 | Mid-year number of people at risk for malaria infection during the reporting year |
| **Confirmed malaria incidence rate**<br>(per 1,000 persons per year) | Number of confirmed malaria cases by microscopy or RDT during the reporting year ′ 1,000 | Mid-year number of people at risk for malaria infection during the reporting year |
| **Malaria death rate**<br>(per 100,000 persons per year) | Number of in-patient malaria deaths during the reporting year ′ 100,000 | Mid-year number of people at risk for malaria infection during the reporting year |
| **Malaria test positivity rate**<br>(per 100 malaria tests per year) | Number of confirmed malaria cases by microscopy or RDT during the reporting year ′ 100 | Total number of tests for malaria (RDT and microscopy) during the reporting year |
| **Malaria confirmation rate**<br>(per 100 reported cases per year) | Number of malaria cases confirmed by microscopy or RDT during the reporting year ′ 100 | Total reported malaria cases (clinical and confirmed) |
| **Annual blood examination rate**<br>(per 100 population per year) | Number of persons receiving a parasitological test for malaria (microscopy or RDT) ′ 100 | Population at risk (number of people living in areas where malaria transmission occurs) |
| **Malaria reporting completeness**<br>(%) | Number of monthly malaria reports that were received from health facilities for the reporting year ′ 100 | Number of all monthly malaria reports expected from health facilities for the reporting year |

Data source for all indicators: Afghanistan Health Management Information System (HMIS), Malaria and Leishmaniasis Information System (MLIS); Years when data were available for all indicators: 2012-2019

**Table 2.** Annual Malaria data and indicators in Afghanistan from 2012 to 2019
| Year   | 2012       | 2013       | 2014       | 2015       | 2016       | 2017       | 2018       | 2019       | 2012-15   | 2016    |
|--------|------------|------------|------------|------------|------------|------------|------------|------------|-----------|---------|
| Population | 25,427,322 | 25,740,700 | 26,588,632 | 27,101,365 | 27,657,145 | 28,227,323 | 30,075,018 | 31,575,018 | 26,214,505 | 29,316  |
| Microscopy and rapid tests done for Malaria diagnosis | 511,408    | 507,145    | 670,385    | 676,815    | 860,575    | 1,040,539  | 1,184,227  | 1,012,559  | 2,365,753 | 4,097  |
| Rapid diagnostic tests done for Malaria | NA         | NA         | NA         | NA         | 262,019    | 431,157    | 519,360    | 451,505    | NA        | 1,664  |
| Plasmodium Vivax (PV) Malaria cases | 53,609      | 43,842     | 77,937     | 98,357     | 180,729    | 216,064    | 239,762    | 170,746    | 273,745   | 807.7  |
| Plasmodium Falciparum (PF) Malaria cases | 1,231       | 2,272      | 5,983      | 5,020      | 9,430      | 10,111     | 8,927      | 3,113      | 14,506    | 31.5   |
| Confirmed Malaria cases | 54,840      | 46,114     | 83,920     | 103,377    | 190,159    | 226,175    | 248,689    | 173,859    | 288,251   | 838.1  |
| Clinical Malaria cases | 336,525     | 273,628    | 211,130    | 263,149    | 194,784    | 100,450    | 51,174     | 1,034      | 1,084,432 | 347.4  |
| Reported malaria cases (clinical and confirmed) | 391,365     | 319,742    | 295,050    | 366,526    | 384,943    | 326,625    | 299,863    | 174,893    | 1,372,683 | 1,187  |
| Malaria Deaths | 36          | 24         | 32         | 49         | 47         | 10         | 1          | 0          | 141       | 58     |

**Indicators of Malaria:**

- **PV incidence rate per 1000 persons per year**
  - 2012: 2.11
  - 2013: 1.7
  - 2014: 2.93
  - 2015: 3.63
  - 2016: 6.53
  - 2017: 7.65
  - 2018: 7.97
  - 2019: 5.41
  - 2012-15: 2.61
  - 2016: 6.87

- **PF incidence rate per 1000 persons per year**
  - 2012: 0.05
  - 2013: 0.09
  - 2014: 0.23
  - 2015: 0.19
  - 2016: 0.34
  - 2017: 0.36
  - 2018: 0.3
  - 2019: 0.1
  - 2012-15: 0.14
  - 2016: 0.27

- **Malaria incidence rate (per 1,000 persons per year)**
  - 2012: 15.4
  - 2013: 12.4
  - 2014: 11.1
  - 2015: 13.5
  - 2016: 13.9
  - 2017: 11.6
  - 2018: 10.0
  - 2019: 5.5
  - 2012-15: 13.1
  - 2016: 10.1

- **Confirmed malaria incidence rates (per 1,000 persons per year)**
  - 2012: 2.2
  - 2013: 1.8
  - 2014: 3.2
  - 2015: 3.8
  - 2016: 6.9
  - 2017: 8.0
  - 2018: 8.3
  - 2019: 5.5
  - 2012-15: 2.7
  - 2016: 7.1

- **Malaria death rate (per 100,000 persons per year)**
  - 2012: 0.1416
  - 2013: 0.0932
  - 2014: 0.1204
  - 2015: 0.1808
  - 2016: 0.1699
  - 2017: 0.0354
  - 2018: 0.0033
  - 2019: 0
  - 2012-15: 0.1345
  - 2016: 0.041

- **Malaria test positivity rate (per 100 malaria tests per year)**
  - 2012: 10.7
  - 2013: 9.1
  - 2014: 12.5
  - 2015: 15.3
  - 2016: 22.1
  - 2017: 21.7
  - 2018: 21
  - 2019: 17.2
  - 2012-15: 12.2
  - 2016: 20.5

- **Malaria confirmation rate (per 100 reported cases per year)**
  - 2012: 14
  - 2013: 14
  - 2014: 28
  - 2015: 28
  - 2016: 49
  - 2017: 69
  - 2018: 83
  - 2019: 99
  - 2012-15: 0.21
  - 2016: 0.71
Annual blood examination rate (per 100 population per year)

| Year | Rate |
|------|------|
| 2012 | 2    |
| 2015 | 2.5  |
| 2016 | 2.5  |
| 2017 | 3.1  |
| 2018 | 3.7  |
| 2019 | 3.9  |
| 2020 | 3.2  |
| 2021 | 3.2  |
| 2022 | 2.3  |
| 2023 | 3.5  |

Malaria reporting completeness (%)

| Year | Completeness |
|------|--------------|
| 2012 | 93.4         |
| 2015 | 90.1         |
| 2016 | 86.0         |
| 2017 | 92.3         |
| 2018 | 92.0         |
| 2019 | 92.6         |
| 2020 | 89.1         |
| 2021 | 89.3         |
| 2022 | 90.4         |
| 2023 | 90.8         |

Gray lines: Years of Expansion of Rapid Diagnostic Test for Malaria

Table 3. Comparison of the period before CBMM and the period after the expansion of CBMM for Malaria in Afghanistan.

| Predictor Variable: Binary before and after CBMM | Unadjusted univariable model |
|--------------------------------------------------|------------------------------|
| Outcome: malaria incidence                      | IRR* 95% CI** P-Value        |
| Outcome: confirmed malaria incidence             | 0.92 0.62 1.38 0.692         |
| Outcome: malaria death incidence                 | 3.39 2.18 5.27 <0.001        |
| Outcome: malaria death incidence                 | 0.35 0.28 0.44 <0.001        |

*IRR: Incidence Rate Ratio; CI**: Confident Interval

Table 4. Average annual change in malaria outcomes before (2012-15) and after (2016-2019) expansion of CBMM for Malaria in Afghanistan.

| Predictor Variable: Year | Before CBMM expansion (2012-2015) | After CBMM expansion (2016-2019) |
|--------------------------|----------------------------------|---------------------------------|
| Outcome: malaria incidence | IRR* 95% CI** P-Value | IRR 95% CI P-Value |
|                          | 0.97 0.89 1.05 0.431 | 0.81 0.71 0.92 0.001 |
| Outcome: confirmed malaria incidence | 1.29 1.09 1.53 0.003 | 0.98 0.85 1.14 0.835 |
| Outcome: malaria death incidence | 1.13 0.88 1.44 0.344 | 0.15 0.12 0.20 <0.001 |

*IRR: Incidence Rate Ratio; CI**: Confident Interval

Figures
Figure 1

Several Malaria indicators in Afghanistan before (2012-15) and after (2016-2019) expansion the Rapid Testing for Malaria.
Figure 2

Malaria incidence and death rates due to malaria in Afghanistan before (2012-15; average of annual incidence) and after (2016-2019; average of annual incidence) expansion of CBMM.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Annex.docx