

# Improving prompt access to malaria diagnostics and treatment in rural remote areas using financial benefit for community health workers in Kilosa district, Tanzania

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**Purpose:** Improving access to malaria treatment in rural remote areas remains a major challenge facing innovative strategies, such as Accredited Drug Dispensing Outlets (ADDOs) and Community Health Workers (CHWs) programs in Tanzania. This study tested the effectiveness of a financial benefit approach to motivate CHWs to improve prompt access to malaria treatment.

**Patients and methods:** We applied a quasi-experimental study design in rural-remote areas in Kilosa district, Tanzania. Febrile children in selected intervention areas were provided access to malaria diagnostic and treatment at a minimal fee to CHWs and compared with non-intervention areas. We measured impact using difference in differences (DID) analysis.

**Results:** At baseline, 870 children <5 years of age were recruited and 1,127 in post-intervention. The DID in prompt access to malaria diagnostics and treatment was 28.0% in favor of intervention. A net pre and post decrease (DID=24.1%) in seeking care from public facilities was observed, signifying decrease in workload. Incidentally, knowledge on malaria treatment increased in intervention area (DID 11%–21%).

**Conclusion:** Using the financial benefit approach, CHWs were able to significantly improve prompt access to malaria diagnostics and treatment in rural remote areas. Scaling up of the strategy might speed up the pace toward achieving national target of accurate diagnosis and appropriate treatment by 80% in 2020.

**Keywords:** financing, artemether-lumefantrine, malaria, children under-five years, rural areas, prompt access, community health workers

## Introduction

Sub-Saharan African countries contribute >95% of the global malaria morbidity and mortality.<sup>1</sup> Despite a wide coverage of malaria interventions, the decline in disease burden is lowest in these countries.<sup>1</sup> Reducing mortality through prompt diagnosis and treatment is the cornerstone for the control of malaria<sup>2</sup> by taking advantage of simple-to-perform malaria rapid diagnostic test (mRDT) and highly efficacious artemisinin combination therapies (ACTs).

The WHO recommends prompt treatment, within 24 hours of the onset of fever, with recommended anti-malarial medicines, after confirmation of malaria using appropriate diagnostic tests.<sup>3</sup> Prompt access is fundamental to the reduction of malaria mortality among children <5 years of age.<sup>3,33</sup>

Delayed fever treatment is a major bottleneck in achieving the global target of reducing malaria mortality by half.<sup>4</sup> Studies done in Tanzania reveal that less than

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half of febrile children are reported to receive ACT within 24 hours across Sub-Saharan Africa.<sup>5,6</sup> Other factors limiting prompt access include distance to public health facilities (PHFs), availability of ACTs, cost of transport, affordability of diagnostics and ACTs, inadequate number and unskilled staff, inadequate quality of health care services, and poor prescribing habits.<sup>7-9</sup>

Global efforts to increase access to ACT, such as subsidization of artemether-lumefantrine (ALu) have made considerable impact.<sup>10</sup> However, the pace toward attaining universal access to ACT has been quite slow,<sup>11</sup> particularly with regard to people in rural areas where poverty level and malaria burden are higher<sup>12</sup> but access to means of malaria diagnosis and treatment are lower.<sup>13</sup> This renders national strategies to improve access unlikely to be achieved.<sup>14</sup>

In Tanzania, access to ACT is still low despite the decline in malaria morbidity and mortality. This implies that more could be achieved if the drugs' potential was optimized through effective coverage.<sup>5,14</sup> Since the drug efficacy is high, the major challenge that remains is finding effective ways to deliver these drugs to those who need them most.<sup>15</sup> Effort to reach the needy, majority of whom reside in rural areas includes deployment of Community Health Workers (CHWs) to deliver some essential and life-saving services.<sup>16</sup> However, these efforts are challenged by a high CHWs' dropout rate apparently for lack of incentives.<sup>17</sup> Efforts to improve access to essential and life-saving medicine in rural areas included the involvement of the private sector through the introduction of Accredited Drug Dispensing Outlets (ADDOs) program.<sup>5,18</sup> Despite the success in country-wide scaling up,<sup>10</sup> the ADDOs program has not been able to adequately contribute to ensuring prompt access to anti-malarials in rural and hard to reach areas.<sup>5</sup> This is partly due to majority of them being located in semi-urban areas.<sup>19</sup>

Innovative intervention is therefore needed to address the problem of high dropout rate among CHWs and extend ADDOs services to rural remote areas in order to improve prompt access to diagnostic and effective malaria treatment among children <5 years of age in rural remote areas. We designed a strategy to specifically address these challenges.

## Study objective

This intervention strategy aimed to improve prompt access to diagnostics and treatment of uncomplicated malaria among children <5 years of age in rural remote areas.

## Hypothesis

Improving availability of malaria diagnostic and treatment services in rural remote areas using this strategy would

result in prompt access to malaria diagnostics and treatment among children <5 years of age suffering from uncomplicated malaria.

## Materials and methods

### Study design

This was a quasi-experimental study performed in 2013–2014, with before and after intervention cross-sectional studies in an intervention and a non-intervention area.

### The intervention strategy

The strategy involved orientation of stakeholders that included health facility workers in August 2013, ADDO providers, and village leaders, on the objectives and implementation plan of the intervention. This was followed immediately by a baseline study and CHWs training. Prior to intervention, an advocacy campaign was conducted with support from village and hamlet chairpersons to motivate caretakers to take children to the CHWs whenever they get fever. CHWs were deployed to provide services, including testing for malaria parasites using mRDT for children brought with symptoms of fever. Intervention lasted for 12 months, climaxing with a post-intervention study. We took advantage of

1. Existence of CHWs living within the villages: thus, they are available all the time, including on weekends and during nights when most PHFs are closed.<sup>20</sup> CHWs also foster equity through preferentially reaching the poorest with their services.<sup>20,21</sup>
2. Country-wide scaling up of the ADDO program to enlist the services of ADDO providers to sell mRDT and ALu to CHWs at market price. In turn, CHWs sold the same to caretakers at a small profit margin.
3. Organized and functioning village leadership to take their febrile children to the CHWs and the rationale for paying for the services.

### Study setting

The study was conducted in Kilosa district between August 2013 and September 2014. About one-third of its population lives below 1 dollar per day. The level of poverty was higher in rural areas. Kilosa had a population of 473,180, of whom 230,346 were males and 242,834 were females, living in 118 villages.<sup>22</sup> There were 67 health facilities – 56 dispensaries, 8 health centers, and 3 hospitals. It had 244 drug shops, which were converted to ADDOs. Among health facilities, faith-based organizations owned 9 dispensaries, 1 health center, and 2 hospitals. Malaria is one of the leading

causes of outpatient attendance and admissions in the district, accounting for more than half (55.5%) of outpatient attendance, and 60% of deaths among children <5 years of age admitted to the hospitals<sup>24</sup> (District Annual Report, 2014). Rural villages were purposely selected because of the high malaria burden – 10% in rural vs 3% in urban.<sup>23</sup>

Intervention and non-intervention areas: Masanze division had a population of 41,000<sup>22</sup> residing in 17 villages comprising 102 hamlets (as explained in Definitions). The division was served by 7 government-owned dispensaries and Kimamba division had 51,000 people residing in 17 villages comprising 83 hamlets. There were 9 dispensaries (5 government and 4 private) and 1 health center (government). The main occupation in both divisions was agriculture and livestock keeping.

### Sample size determination and sampling

Implementation of the strategy was done in Masanze, 1 of the 7 divisions in Kilosa district. Kimamba division was selected as non-intervention area. The 2 divisions were purposely selected because of their proximity to Kilosa town where the study site was located. All hamlets situated  $\geq 5$  km from the nearest PHFs or ADDO were involved. Thirty-three hamlets qualified in the intervention area and 30 in the non-intervention one.

The sampling unit was children <5 years of age. Using the formula  $n = z^2 p(1-p)/e^2$  where  $n$ =sample size,  $p$ =proportion of children <5 years of age, and  $e$ =margin of error/CI, we assumed that 50% had access to ALu and 95% CI, the unadjusted sample size for independent observations was found to be 384 children. Adding 10% for possible loss to follow-up and another 38% as correction factor for clustering effect (ICC=0.01), the total sample size was 583, approximated to 600 in the intervention and another 600 in the non-intervention villages. The number of children from each hamlet was determined using hamlet population proportions. Using systematic sampling, a starting point was selected and the direction to follow was determined by spinning a bottle. With the help of the CHWs, households with children <5 years were identified. Random selection was done to select one child where >1 was found. During data collection, we found fewer number of children <5 years of age in both intervention and non-intervention groups than the sample size. We then decided to enroll all the children <5 years of age.

Inclusion and exclusion criteria: at baseline, children aged 3–59 months and whose caretakers were residents of the respective hamlets, for the past  $\geq 6$  months, were enrolled in the study; children <2 months of age were excluded. ALu

is currently not recommended for infants <2 months of age (approximately <5 kg).

### Data collection procedure

Two research assistants (RAs) were recruited from the National Institute for Medical Research (NIMR) site at Kilosa to collect data. They received a 2-day training on the study objectives and administering research tools. A pilot test was done in 1 hamlet near the training center to perfect the tools and for RAs to practice on the use of the tools. Hamlet chairperson guided the RAs and introduced them to the selected households. The household head or spouse or any other well-informed household member was interviewed after obtaining an informed written consent. The RAs collected data using a structured questionnaire. Caretakers were interviewed at their homes to obtain demographic and socio-economic data; and knowledge, attitude, perception, and practice related to the access to ACT. Although presumptive treatment is no longer recommended by WHO, this study classified a child as having malaria if the caretaker reported the child had fever within the past 2 weeks. Most children found to have fever were treated for malaria without confirmation with mRDT due to unavailability of diagnostic facilities.<sup>24</sup> Anecdotal reports during implementation of this study indicate that some children were referred by health workers to CHWs for mRDT due to frequent shortages of PHFs. Despite some challenges on its interpretation,<sup>25</sup> prompt access to malaria diagnostics and treatment was assessed by whether treatment was started on the same day or a day after the onset of fever.

Caretakers whose children had history of fever were interviewed about the source of care sought and treatment received. Verification of drug used was done using exercise books used to record medical notes. Where these books were not available, drug containers/packets were examined to identify the type of drug provided. We established knowledge of malaria by asking questions on the cause of malaria, method of transmission, prevention, and treatment.

### Data analysis

Questionnaires were filed and stored at the Kilosa NIMR site. Coding was done and double entered into EpiData 3.0. Analyses were performed using STATA version 9.0.

Dependent variables and measurements:

- Proportion of children whose caretakers sought care from PHFs, including public, private, and health facilities owned by governmental organizations (NGOs), drug stores (ADDO); drug vendors, and ordinary shops

- Proportion of children whose caretakers accessed appropriate treatment (ALu)
- Proportion of children whose caretakers accessed the effective treatment promptly.

Independent variables:

- Socio-demographic data (age, sex, marital status, education, and the main occupation of the mother/guardian), age of the child;
- Source of treatment: includes public, private, and health facilities owned by NGOs, drug stores (ADDO), drug vendors, and ordinary shops;
- Type of drug used: included ACT, other anti-malarials, and antipyretics;
- Socio-economic status was measured using household assets and categorized into quintiles using principal component analysis.<sup>6</sup> Membership to health insurance schemes: available schemes are Community Health Fund (CHF) and National Health Insurance Fund;
- Knowledge of malaria was measured by asking questions on the cause of malaria, method of transmission, prevention, and treatment.<sup>6</sup>

## Analyses

We calculated the proportion of children whose caretakers: 1) sought care from PHFs; 2) accessed appropriate treatment (mRDT and ALu); and 3) accessed the treatment promptly in the intervention and non-intervention areas.

We applied the difference in differences (DID) analysis to calculate the difference attributed by the intervention using the following formula<sup>26</sup>:

$$(I_p - I_B) - (N_p - N_B)$$

Where I = Intervention area, N = Non-intervention area, <sub>p</sub> = post intervention, and <sub>B</sub> = Baseline.

Using the same formula, we calculated the difference in knowledge between intervention and non-intervention areas. Strength of association was measured using chi-square tests and Fisher's exact test (for tables where cell values were <5). *P*-values <0.05 were considered significant. Multivariate analyses were done to control for confounding factors. The AOR and 95% CI are used to report the magnitude of association between dependent and independent variables.

## Ethical considerations

Non-clinical workers have previously been used in home-based care treatment of febrile illnesses, including the use of

RDT for malaria.<sup>27,28</sup> This is because, in the absence of such services, children residing in rural remote areas might not get prompt access to malaria diagnostics and treatment, thus predisposing them to avoidable deaths and malaria complications.<sup>29,30</sup> The research proposal received ethical clearance from the Muhimbili University of Health and Allied Sciences, Tanzania. Permission to implement the research was obtained from the regional, district, and village authorities. Informed consent was sought from the caretakers of the children.

## Results

### Socio-economic and demographic comparison

A total of 870 children were enrolled in the baseline study, of whom 467 (53.7%) were from the intervention and 403 (46.3%) from non-intervention areas. During post-intervention, we enrolled 1,127 children <5 years of age of whom 611 (54.2%) were from the intervention and 516 (45.8%) from the non-intervention areas. The mean age of the children was 30 months. Over half of the enrolled children were ≥2 years of age and about half of them were females. The mean age of the caretakers was 29.6 years and over half of them were <30 years of age and married (Table 1). Less than 5% of the caretakers reported enrollment in the CHF insurance scheme.

There was no statistically significant difference between the intervention and non-intervention areas with regard to child age and sex and caretakers' marital status. However, mothers' education was higher in the non-intervention than in intervention areas (*P*<0.001). While over half of the mothers in the non-intervention area had primary education level, in the intervention one, less than half had.

### Knowledge on malaria treatment

Over 80% of the respondents knew that ALu is the recommended treatment for uncomplicated malaria (Table 2). Almost all respondents reported to have heard about a drug for treating malaria. Prior to intervention, knowledge that ALu is the recommended drug for treating uncomplicated malaria was higher among the respondents in the non-intervention (90.8%) than in intervention areas (85.7%). This pattern reversed in the post-intervention period with 94.8% of respondents in the intervention compared with non-intervention areas (88.8%). The DID was 11.1% (*P*-value <0.05). Less than one-third of the respondents agreed that sulfadoxine-pyrimethamine is the recommended treatment for uncomplicated malaria. However, the proportion of caretakers with this misconception was higher among the respondents in the intervention than in non-intervention areas. Again,

**Table 1** Demographic and socio-economic characteristics

Variables	Pre-intervention				P-value	Post-intervention				
	Non-intervention area		Intervention area			Non-intervention area		Intervention area		
<b>Child's age</b>	n=403	%	n=467	%		n=516	%	n=670	%	
<2 years	169	41.9	180	38.5	0.309	203	39.3	289	43.1	0.189
2+ years	234	58.1	287	61.5		313	60.7	381	56.9	
<b>Child's sex</b>										
Male	201	49.9	237	50.7	0.797	259	50.2	351	52.4	0.454
Female	202	50.1	230	49.3		257	49.8	319	47.6	
<b>Mothers age</b>										
<30 years	251	62.3	266	57.0	0.111	297	59.9	340	50.9	0.020
30+ years	152	37.7	201	43.0		219	44.2	330	49.4	
<b>Mothers' education</b>										
<7 years	168	41.7	274	58.7	0.0001	185	35.9	362	54.0	0.0001
7+ years	235	58.3	193	41.3		331	64.1	308	46.0	
<b>Marital status</b>										
Not married	83	20.6	93	19.9	0.803	198	38.4	262	39.1	0.797
Married	320	79.4	374	80.1		318	61.6	408	60.9	
<b>Occupation</b>										
Farming	368	91.3	395	84.6	0.003	451	87.4	567	84.6	0.174
Business/livestock	35	8.7	72	15.4		65	12.6	103	15.4	
<b>CHF membership</b>										
Not member	388	96.3	447	95.7	0.675	514	99.6	635	94.8	0.0001
Member	15	3.7	20	4.3		2	0.4	35	5.2	
<b>Socio-economic status</b>										
Poor (1 and 2)	160	39.7	188	40.3	0.847	231	44.8	407	60.7	0.0001
Better off (3–5)	243	60.3	279	59.7		285	55.2	263	39.3	

Abbreviation: CHF, community health fund.

the pattern reversed post-intervention and the DID between intervention and non-intervention areas was 20.9% ( $P$ -value  $<0.05$ ). About one-third or less respondents had correct knowledge on the recommended treatment for severe malaria. The DID between intervention and non-intervention area was 11.0% ( $P$ -value  $<0.05$ ). Incidentally, knowledge on the causes and prevention of convulsion increased dramatically in both areas, however, the difference was not statistically significant for knowledge on the cause of convulsion. After controlling for confounding factors that included mother's age, education and occupation, we found that the intervention had an influence on caretakers' knowledge on recommended treatment for uncomplicated malaria (DID 11.1% [ $P$ -value  $<0.05$ ] and AOR 2.01, 95% CI: 1.26 to 3.15).

### Care seeking, access and treatment of children <5 years of age

Prior to intervention, a higher proportion of caretakers (59.0%) in the intervention area sought care from PHFs compared with non-intervention one (44.8%) (Table 3). However, this pattern reversed during intervention period by having more caretakers

from the non-intervention (57.1%) than in intervention areas (44.9%). The DID was  $-26.4\%$  ( $P$ -value  $<0.05$ ), implying that caretakers in the intervention area sought care from PHFs less frequently compared with those from non-intervention one. When controlled for potential confounders, caretakers in the non-intervention area were twice more likely to seek care for their children compared with those in intervention one AOR  $-1.9$  (95% CI:  $-1.04$  to  $-3.3$ ).

Over half of the children reported to have had a fever episode were treated with ALu. Whereas, before intervention, the proportion of febrile children treated with ALu was significantly higher in the non-intervention area (71.3%) compared with intervention one (53.4%), this pattern reversed during post-intervention study. The proportion of those treated with ALu in the intervention area increased from 53.4% to 70.8%. The DID between the intervention and non-intervention areas was 26.1%. After controlling for potential confounders, children in the non-intervention area were twice more likely to be treated with ALu compared with those in the intervention one AOR 0.5 (95% CI: 0.3 to 0.8) meaning that the observed DID was influenced by the confounding factors.

**Table 2** Knowledge on malaria and treatment

Variable	Pre-intervention				Post-intervention				DID estimation				
	Non-intervention		Intervention		P-value	Non-intervention		Intervention		P-value	DID%	P-value	AOR (95% CI)
	No.	%	No.	%		No.	%	No.	%				
<b>Knowledge that ALu is the recommended treatment for uncomplicated malaria</b>													
Spontaneous response	366	90.8	400	85.7	0.064	458	88.8	635	94.8	0.0001	11.1	0.0001	2.01 (1.26 to 3.15)
After probe	31	7.7	57	12.2		46	8.9	33	4.9				
Do not know	6	1.5	10	2.1		12	2.3	2	0.3				
<b>Knowledge that SP is the recommended treatment for uncomplicated malaria</b>													
Spontaneous response	35	8.7	85	18.2	0.0001	168	32.6	142	21.2	0.0001	-20.9	0.0001	-2.12 (-1.31 to -3.41)
After probe	332	82.4	330	70.7		234	45.3	354	52.8				
Do not know	36	8.9	52	11.1		114	22.1	174	26				
<b>Knowledge that quinine is the recommended treatment for uncomplicated malaria</b>													
Spontaneous response	28	6.9	37	7.9	0.194	85	16.5	77	11.5	0.0001	-6	0.0001	-0.44 (-0.18 to 0.91)
After probe	304	75.4	327	70		283	54.8	295	44				
Do not know	71	17.6	103	22.1		148	28.7	298	44.5				
<b>Which drug is recommended for treating severe malaria?</b>													
Others	323	80.1	345	73.9	0.029	419	81.2	429	64.0	0.0001	11	0.0001	1.09 (0.87 to 1.33)
Quinine	80	19.9	122	26.1		97	18.8	241	36.0				
<b>What causes convulsion in children?</b>													
Others	257	63.8	281	60.2	0.276	202	39.1	262	39.1	0.988	-3.6	0.0001	-0.20 (-0.12 to 0.32)
High fever	146	36.2	186	39.8		314	60.9	408	60.9				
<b>How can you prevent a child from getting convulsion?</b>													
Others	398	98.8	443	94.9	0.001	399	77.3	550	82.1	0.042	-8.7	0.0001	-3.85 (-1.16 to 11.29)
Sponging or analgesics	5	1.2	24	5.1		117	22.7	120	17.9				

Abbreviations: ALu, artemether-lumefantrine; AOR, adjusted OR; DID, difference in differences; SP, sulfadoxine-pyrimethamine.

**Table 3** Care seeking and treatment practices for caretakers with febrile children

	Pre-intervention				Intervention				DID estimation				
	Non-intervention		Intervention		P-value	Non-intervention		Intervention		P-value	DID%	P-value	AOR (95% CI)
	No.	%	No.	%		No.	%	No.	%				
<b>Seeking care from public health facility by caretakers with febrile children</b>													
Total	n=105		n=117			n=98		n=176					
No	58	55.2	48	41.0	0.034	42	42.9	97	55.1	0.052	-26.4%	0.034	-1.9 (-1.04 to 3.3)
Yes	47	44.8	69	59.0		56	57.1	79	44.9				
<b>Febrile children treated with ALu</b>													
Total	n=108		n=133			n=99		n=178					
No	31	28.7	62	46.6	0.005	37	37.4	52	29.2	0.163	26.1%	0.006	0.5 (0.3 to 0.8)
Yes	77	71.3	71	53.4		62	62.6	126	70.8				
<b>Prompt treatment of uncomplicated malaria (treatment within 24 hours)</b>													
Total	n=104		n=119			n=90		n=151					
24+ hours	29	27.9	41	34.5	0.292	30	33.3	18	11.9	0.0001	28.0%	0.0001	2.8 (1.4 to 5.6)
<24 hours	75	72.1	78	65.5		60	66.7	133	88.1				

Abbreviations: ALu, artemether-lumefantrine; AOR, adjusted OR; DID, difference in differences.

At pre-intervention, the proportion of febrile children treated with ALu promptly was significantly higher in the non-intervention area (72.1%) compared with intervention one (65.5%). This also reversed during post-intervention (88.1% intervention and 66.7% non-intervention). The DID between intervention and non-intervention areas was 28.0%. Controlled for potential confounders, children in the intervention area were almost 3 times more likely to promptly access ALu compared with those in intervention one (AOR 2.8 [1.4 to 5.6]).

## Discussion

This study has shown that using the financial benefit approach for CHWs to treat malaria in children <5 years of age can increase prompt access to malaria diagnostics and effective malaria treatment by 28% (3-fold) in rural remote areas. Over 80% of the children in the intervention area were able to promptly access effective anti-malarials. Previous studies have shown that <50% of children <5 years of age accessed appropriate malaria treatment promptly.<sup>5,6</sup>

Achievement reported in this intervention study could be attributed to the financial benefit that might have directly or indirectly motivated CHWs to provide services efficiently and hence, enhanced their gratification, which ensured sustainability. Although CHWs are reportedly engaged to work on voluntary basis, studies show their motivation by material gains.<sup>31,32</sup> The achievement could also be attributed to the proximity of CHWs to caretakers that ensured timely access to care even during nights and weekends, which is uncommon with PHFs. Moreover, CHWs are more acceptable to the community they serve because they tend to share common values, traditions, and prejudices.

Caretakers in rural remote areas have limited access to ADDO because most ADDOs are situated in semi-urban areas where there is profit gains.<sup>19</sup> We, therefore, used ADDOs available in intervention areas to supply CHWs with mRDT and ALu, at a market price, thus extending ADDOs reach to a wider geographical area. Procurement through ADDOs ensured maintenance of the supply chain because ADDO providers also work on financial benefit. We deliberately avoided procurement of supplies through the public sector because the system is overwhelmed with frequent shortages. Stockout rates ranging from 69% to 95%, were reported between 2011 and 2015 (Ministry of Health-HMIS Database, 2015 – unpublished).

Implementation of this strategy was associated with a 2-fold decrease in the proportion of febrile children taken to PHFs. This could be explained by the presence of CHWs who provided a service that was supposed to be provided by PHFs.

Community-based management of fever in children <5 years of age is reported to reduce workload in health facilities<sup>33</sup> since CHWs shoulder some of the health workers' responsibilities.<sup>34</sup> Malaria in children <5 years of age, accounts for about one-third of outpatient department attendances in malaria hyper-endemic areas in the country<sup>35</sup> (Ministry of Health - HMIS Database, 2015 - unpublished). This strategy, therefore, has the potential to reduce workload in PHFs.

In this intervention study, we observed a 2-fold increase in knowledge in knowledge on treatment of uncomplicated malaria in the intervention area compared to non-intervention area. This could be due to the multiplier effect resulting from advocacy campaigns held in the villages prior to implementation and the interaction between CHWs and caretakers in the course of service provision.

## Implications of intervention

This intervention increased prompt access to malaria treatment in children residing in rural remote areas. The increase in prompt access is likely to have averted deaths and serious complications commonly associated with delayed treatment. These include increased risk of neurological and cognitive deficits, behavioral difficulties, and epilepsy.<sup>30</sup> These complications ultimately compromise victims' educational achievements and some of them end up with lifelong dependency and poverty. Scaling up of a similar financial benefit approach is likely to speed up the pace toward attaining the National Malaria Strategic Plan goals.<sup>12</sup> Implementation research might be needed to explore the feasibility and applicability of this approach in different contexts. Encouragingly, the malaria treatment guidelines and the recent community-based health care policy guidelines provide for CHWs to treat common conditions, including uncomplicated malaria after testing positive with mRDT (Ministry-of-Health-and-Social-Welfare, 2006).

We do not have data to ascertain the decline in workload in PHFs. However, we can confidently use the significant decrease in utilization of PHFs in the intervention area as enough evidence. Tanzania has been facing a major shortage of health care workers for over a decade, with staffing gap running at nearly half the required numbers. The situation is worse among clinicians in remote and rural areas in PHFs.<sup>36</sup> Adoption of this strategy might give health facility staff ample time to concentrate on conditions that require more training, hence, increasing productivity and quality of health care.<sup>34</sup>

The selection of Kilosa district and the 2 divisions was purposive. However, findings from this study can be generalized to many other places within and outside the country that are typical rural areas with high malaria endemicity and

facing considerable health system challenges such as shortage of health workers, medicines and supplies and inadequate number of health facilities.

## Methodological considerations

Ensuring constant supply of mRDT and ALu in PHFs could have reduced the magnitude of observed intervention achievement. However, it is equally true that frequent drug shortages have been there for a considerably long time (Ministry of Health HMIS Database, 2015. Unpublished) and is likely to continue existing in the foreseeable future given the meager budget allocation to the health sector. Since prompt access to effective malaria treatment is an urgent concern, findings from this intervention will remain relevant. Nevertheless, the study could have benefited from a second control in which uninterrupted supply of mRDT and ALu would be ensured but without the financial benefit approach.

Promptness of access was defined by whether or not the child received ALu on the same or next day. This definition suffers from the limitation of extending to over 24 hours.<sup>5,25</sup> The alternative could be to elicit and record the time of fever onset and ALu treatment from the caretakers. However, this alternative has the limitation of inaccuracy in a community where literacy rate is low. We used fever as a proxy presumption of malaria. However, in areas where malaria has significantly declined, this assumption no longer holds.

The targeted number of 1,200 (600 interventions and 600 non-interventions) could not be attained because, in some of the hamlets, all the children <5 years of age were enrolled before reaching the targeted number. Apparently, in some of these hamlets, the number of children found in the census/village register was higher than the actual. This could be attributed to inadequacies in updating the village register and some children <5 years of age might have crossed over the age without being deleted from the registers.

We chose pre–post test quasi-experimental with non-intervention group to control for known and unknown confounders. However, mothers' level of education, during pre-test, was found to be higher in non-intervention than in intervention area. This was associated with increased knowledge on malaria treatment and in prompt access to effective malaria treatment.<sup>6</sup> Such bias has the effect of understating the effect of the intervention, thus diluting the observed difference. This source of error can be ignored given the significant evidence observed in this study.

We based malaria diagnosis on presumptive treatment in both baseline and post intervention studies. Therefore, we can confidently ascribe the improved access to ALu but

not mRDT. However, since all children in the intervention area were treated after diagnosis with mRDT, the improved access to ALu is attributed to the intervention – we can, with caution, generalize our findings to access to mRDT.

## Conclusion

This study has shown that using a financial benefit approach enables CHWs to successfully improve prompt access to diagnostic and effective malaria treatment in areas situated  $\geq 5$  km from a nearby PHF or ADDO. Scaling up of the strategy is likely to speed up the pace toward attaining national target of accurate diagnosis and appropriate treatment by 80% in 2020.

## Definitions

**Prompt access** is defined as ability to access appropriate anti-malarial treatment within 24 hours from the onset of fever.<sup>2</sup> In this study, we operationalized the definition based on whether or not the child received ALu on the same or next day.

**Community health workers (CHWs)** are defined as members of the communities engaged in activities that support the health system.<sup>37</sup>

**Rural remote areas** are communities located  $\geq 5$  km from a nearby health facility or a drug shop.

A **hamlet** is the smallest administrative unit in the government structure in Tanzania, after the village level. An average hamlet has about 50 households and is led by a hamlet chairperson elected from among members of the respective hamlet. Hamlet chairperson represents the hamlet in the village government meetings.

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## Author contributions

All authors contributed to data analysis, drafting and revising the article, gave final approval of the version to be published, and agree to be accountable for all aspects of the work.

## Disclosure

The authors report no conflicts of interest in this work.

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