


RESEARCH ARTICLE

Effectiveness of peer-supervision on pediatric fever illness treatment among registered private drug sellers in East-Central Uganda: An interrupted time series analysis

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Abstract

Rationale, aims, and objectives: Appropriate treatment of pediatric fever in rural areas remains a challenge and maybe partly due to inadequate supervision of licensed drug sellers. This study assessed the effectiveness of peer-supervision among drug sellers on the appropriate treatment of pneumonia symptoms, uncomplicated malaria, and non-bloody diarrhea among children less than 5 years of age in the intervention (Luuka) and comparison (Buyende) districts, in East-Central Uganda.

Methods: Data on pneumonia symptoms, uncomplicated malaria, and non-bloody diarrhea among children less than 5 years of age was abstracted from drug shop sick child registers over a 12-month period; 6 months before and 6 months after the introduction of peer-supervision. Interrupted time series were applied to determine the effectiveness of the peer-supervision intervention on the appropriate treatment of pneumonia, uncomplicated malaria, and non-bloody diarrhea among children less than 5 years of age attending drug shops in East Central Uganda.

Results: The proportion of children treated appropriately for pneumonia symptoms was 10.84% ($P < .05$, CI = [1.75, 19.9]) higher, for uncomplicated malaria was 1.46% ($P = .79$, CI = [−10.43, 13.36]) higher, and for non-bloody diarrhea was 4.00% ($P < .05$, CI = [−7.95, −0.13]) lower in the intervention district than the comparison district, respectively.

Post-intervention trend results showed an increase of 1.21% ($P = .008$, CI = [0.36, 2.05]) in the proportion appropriately treated for pneumonia symptoms, no difference in appropriate treatment for uncomplicated malaria, and a reduction of 1% ($P < .06$, CI = [−1.95, 0.02]) in the proportion of children appropriately treated for non-bloody diarrhea, respectively.

Conclusions: Peer-supervision increased the proportion of children less than 5 years of age that received appropriate treatment for pneumonia symptoms but not for uncomplicated malaria and non-bloody diarrhea. Implementation of community-level interventions to improve pediatric fever management should consider including peer-supervision among drug sellers.

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KEYWORDS

appropriate treatment, childhood illnesses, interrupted time series, peer-supervision, Uganda

1 | INTRODUCTION

Acute febrile illness is a major cause of morbidity and mortality among children less than 5 years of age in low and middle-income countries.¹⁻³ In 2018, the World Health Organization (WHO) reported that acute febrile illnesses due to malaria and diarrheal diseases caused approximately 272 000 and 525 000 deaths among children less than 5 years of age, respectively.^{4,5} An additional 808 694 deaths of children less than 5 years were caused by pneumonia in 2019.⁶ The majority of the deaths due to malaria, diarrhea, and pneumonia occur in Africa.^{7,8}

Uganda is one of six countries that accounted for more than half of all malaria cases worldwide in 2019.⁵ According to the Ministry of Health (MoH) Uganda, in 2019, pneumonia, malaria, and diarrhea combined accounted for over 30% of mortalities in children less than 5 years of age making the three febrile illnesses the leading causes of death among this age group.⁹

In a bid to curtail common childhood illnesses among this vulnerable age group, in 2010, the WHO and the United Nations Children's Fund (UNICEF) recommended the provision of integrated community case management (ICCM) at community level^{10,11}. The ICCM is a strategy focused on enhancing equity of public health services by providing timely and effective treatment of malaria, pneumonia, and diarrhea to populations with limited access to facility-based health care. In Uganda, ICCM was extended to include private health providers comprised mainly of drug shops targeting those who offer care to children less than 5 years of age.

Drug shops are small medicine outlets authorized to sell class-C drugs over-the-counter (OTC) that do not require a prescription, used for treating minor and self-limiting conditions. Class C drugs are regarded as relatively safe drugs. They may also sell cosmetics and sundries deemed fit for sale by the Uganda National Drug Authority (NDA)—the medicine regulatory agency.¹²

More than half (59%) of the children less than 5 years of age with febrile illness first seek care from private health providers because of physical in access to, and sometimes health system challenges in public health facilities.^{13,14} Despite receiving ICCM training and government inspection, inappropriate treatment of febrile children persists among drug sellers in the small medicine outlets.¹⁵

The national professional guidelines for licensing, renewal, and new licenses for class C drug shops in Uganda stipulate that licensed drug sellers shall be responsible for supervising drug shops, which they own and or operate.¹⁶ Relatedly, the inspection of drug shops is carried out by the NDA on behalf of MoH. The NDA does periodic inspection through zonal inspectors. The zonal inspectors collaborate with District Drug Inspectors (DDIs) who derive their inspection mandate from the District Health Officer (DHO) at the district level. Other officers under the DHO's office are illustrated in Figure 1.

Countrywide, DDIs are required to visit every drug shop in their district once every month.¹⁷ However, inspection of drug shops by DDIs and self-supervision as is practiced by licensed drug sellers in rural settings seem not to address the inappropriate treatment of febrile illnesses in children less than 5 years.

1.1 | Aim of the study

This study assessed the effectiveness of peer-supervision among drug sellers on appropriate treatment of pneumonia symptoms, uncomplicated malaria, and non-bloody diarrhea among children less than 5 years of age in an intervention (Luuka) and comparison (Buyende) district in East-Central Uganda.

2 | METHODS

2.1 | Design of the study

This study employed a quasi-experimental study with interrupted time-series design¹⁸⁻²⁰ that assessed the proportion of children less than 5 years of age treated for pneumonia symptoms, uncomplicated malaria, and non-bloody diarrhea. The pre-intervention period was between May and October 2016 while peer supervision was carried out from November 2016 to May 2017.

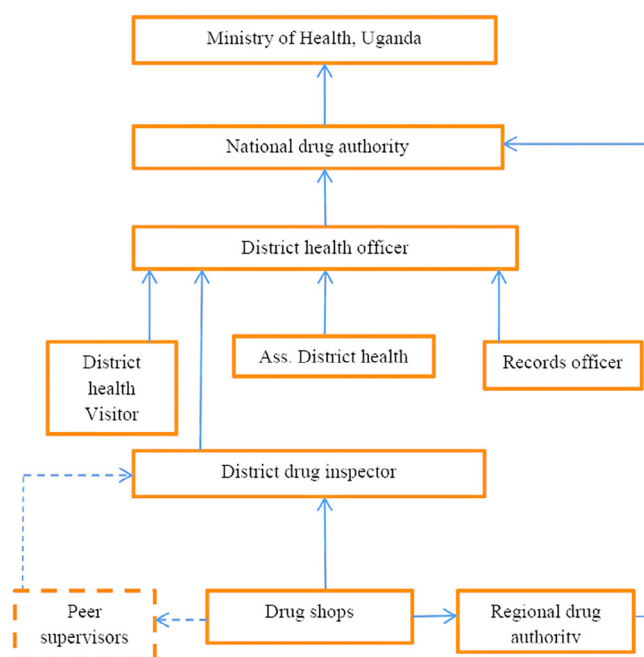


FIGURE 1 The peer supervision process

2.2 | Setting of the study

2.2.1 | Intervention district with peer supervision

Investigators of this study used peer-supervision to augment the current self-supervision being practiced by drug sellers. Peer-supervision was aimed at supporting inspection of drug sellers by DDIs since the evidence shows that inspection coupled with supervision improves the quality of care.²¹ Peer-supervision is a type of supervision where supervisees encourage and enhance learning and development as peers. Peers are people of similar hierarchical status or who perceive themselves as equal.²² Since peer supervision had been successful elsewhere,^{23–25} it was envisaged that learning and development facilitated by peers would improve drug seller treatment of febrile illnesses in children under 5 years of age.

The intervention was carried out only in Luuka district, which has a total population of 238 020 persons.²⁶ Presently, the district has no hospital, has one health center (level IV), six health centers (level III), and 16 health centers (level II).

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Peer-supervisors in the intervention district were chosen according to the proposed criteria. The criteria involved peer supervisors being democratically chosen by drug sellers from that particular sub-county by show of hands. Having higher academic qualifications compared to other drug sellers was the second criteria. In the event that the peer supervisors chosen had similar qualifications, the person with the highest number of votes became the peer supervisor for that sub-county. Each sub-county in the intervention district had a peer supervisor. The peer supervisors underwent refresher ICCM training in October 2016. The refresher training was carried out by the investigators of the study and was based on ICCM guidelines by WHO/UNICEF adopted by the MoH Uganda.²⁷ The training lasted a total of 3 days for each supervisor in each sub-county. Peer supervisors were deemed fit for supervision if they could explain to the trainers what constituted appropriate treatment, including recognizing danger signs in children less than 5 years with pneumonia symptoms, uncomplicated malaria, and non-bloody diarrhea. The training was supplemented by clearly defining roles for peer supervisors. These roles included; instructing and monitoring drug sellers on how to correctly fill sick child registers. In addition, peer supervisors were taught how to counsel drug sellers that were not giving appropriate treatment to children under 5 years of age. Peer supervisors were also mandated to cross-check with drug sellers whether the respiratory timers and brand of rapid diagnostic tests (RDTs) being used were the recommended ones by the MoH.

More so, peer supervisors were taught how to be role models in their course of supervision by advising drug sellers to adhere to treatment guidelines. Peer supervisors were instructed to adhere to the highest form of privacy, professionalism, integrity, and empathy. In all sub-counties of the intervention district, peer supervisors were tasked to work with an active district drug shop association where drug sellers met every month particularly, to attend continuous medical education organized by the drug shop association secretariat.

Peer supervisors were then provided with supervision checklists where they were asked to summarize treatment given to children by drug sellers on a monthly basis. The summarized information from the checklists was used by investigators to corroborate with information of drug shop sick child registers filled in by drug sellers every month. This was done to ensure the accuracy of data filled in by drug sellers and data collected by peer supervisors. To ease the work of peer supervisors, the peer supervisors were also provided with summary extracts from ICCM treatment and referral algorithms.²⁷

In line with guidelines for data collectors of the school of public health, Makerere, Uganda, every peer supervisor was given a safari day allowance of 80 000 Uganda shillings (equivalent to USD 22 at an exchange rate of USD 1 equal to 3700 Uganda shillings). A safari day allowance is paid when a data collector travels within Uganda for a period of 6 hours or more and returns the same day. It is paid to cater for lunch, transport, and other incidentals. The assumption was that each peer supervisor would visit all drug sellers within the sub-county every month and that supervision visits would not exceed 1 day.

The aim of peer supervision was to strengthen the existing health system by supporting the district local government. During peer supervision, the peer supervisors worked directly under the office of the DDI who carried on his inspection role as usual.

2.2.2 | Comparison district

Buyende district has a population of 323 067 persons.²⁶ The district has one health center (level IV), six health centers (level III), 11 health centers (level II), and approximately 503 village health team members. In both districts, there was at least one drug shop in every village. The East-Central region where these two districts are located has a very high under-five mortality ranging from 73 to 90 per 1000 live births.²⁸

2.3 | Characteristics of participants and description of materials

In both districts, there were 135 registered drugs shops (Luuka 60 and Buyende 75) operated by nursing assistants, enrolled and comprehensive nurses, midwives, and clinical officers. By law, drug shops in Uganda are authorized to sell class-C drugs (over the counter) that do not require prescription, used for treating minor and self-limiting conditions and are relatively safe. However, with the introduction of the ICCM strategy in the private sector, drug sellers were allowed to prescribe and dispense drugs for malaria (artemisinin combination therapies), pneumonia (amoxicillin), and diarrhea (a combination of zinc and oral rehydration salts) for children. This study was conducted among registered drug shops.

Before the introduction of peer-supervision, registered drug sellers in both the intervention and comparison districts received training on how to treat children less than 5 years presenting with symptoms of pneumonia, uncomplicated malaria, and non-bloody

diarrhea based on standard treatment guidelines developed by UNICEF, MoH, and WHO.²⁷ The training was conducted between May 2015 and May 2016 by the Clinton Health Access Initiative (CHAI). The period between May 2016 and October 2016 was the period before peer-supervision was introduced.

2.4 | Data collection

Socio-demographic data were collected from drug sellers using a questionnaire. All drug sellers provided written informed consent for themselves and for the children whose information was abstracted from sick child registers. Data on the number of government inspection visits per drug shop was collected on a monthly basis from both districts from drug sellers when information on appropriate febrile treatment was being collected. Only data on the number of peer-supervision visits were collected from the intervention district after the introduction of peer supervision. Other data collected from drug shops included: age, gender, and qualifications of drug sellers. In addition, prescription and treatment data of the under-five children who attended the drug shops were extracted from sick child registers line by line as is, to ensure accurate data capture. This data included the name of the child, age, gender, caregiver name, duration of symptoms, danger signs, respiratory rate (breaths per minute), fast breathing, RDT results as well as any other symptoms. Names of the children and caregivers were given unique identifiers and anonymized during data management, analysis, and report writing. Data were collected from the intervention and comparison districts between June 2016 and May 2017.

2.4.1 | Outcome variable

The outcome variable for the study was appropriate treatment-defined as a drug seller prescribing and dispensing age-appropriate medication to children less than 5 years old with symptoms of pneumonia, uncomplicated malaria, and non-bloody diarrhea in the right dose, frequency, and duration for the right indication as per the standard ICCM treatment guidelines²⁷.

2.5 | Data analysis

To assess the effectiveness of peer supervision among drug sellers on the appropriate treatment of children less than 5 years of age with pneumonia symptoms, uncomplicated malaria, and non-bloody diarrhea, interrupted time series (ITSA) for multiple group analysis was conducted.²⁹ The ITSA method was the preferred choice for this study because it was not possible to randomize peer supervision (the intervention).³⁰ In addition, we wanted to cater for policy shifts if they occurred during the study period—a major strength of using interrupted time series.³¹ Consideration was made in using interrupted time series since the study had six data points before and six data

points after introduction of peer supervision, which are considered a minimum for reliable results.^{32,33}

The mean with the corresponding SD and the median number of visits by DDIs and peer supervisors was computed. Then, the percentage of appropriately treated children by a drug seller by month by the district was calculated by dividing the total number of appropriately treated children for a given childhood illness by the total number of children presenting with symptoms of that particular illness multiplied by 100. Results were then aggregated at the district level by month covering both the pre-intervention and intervention period and used to show the trend of appropriate treatment in both districts for both periods.

This was followed by fitting the multiple group ITSA model (Equation (1)). In the final step, the Cumby-Huizinga test was used to test for autocorrelation. The model was re-run by specifying the lag order accounting for autocorrelation. Data from the sick child registers were entered in Epi Data (www.epidata.dk), exported to excel for cleaning and coding. Data analysis was done using STATA version 15 (Stata Corp, College Station, Texas, 2015). The ITSA model is as follows;

$$y_t = \beta_0 + \beta_1 T_t + \beta_2 X_t + \beta_3 X_t T_t + \beta_4 Z + \beta_5 Z T_t + \beta_6 Z X_t + \beta_7 Z X_t T_t + \epsilon_t. \quad (1)$$

The names and definitions of all variables used in this model are listed in Table 1.

The ITSA uses ordinary least squares (OLS) approaches to estimate the effects of the intervention (peer supervision) on appropriate treatment for multiple treatment (intervention) periods. The ITSA model accounts for autocorrelation among equally spaced observation data by comparison for the lag order for which autocorrelation is assumed to be present. The estimated coefficients from the model together with their SEs are reported.

3 | RESULTS

3.1 | Descriptive and analytic results

The frequency of inspection visits carried out by government DDIs in both the intervention and comparison districts of the study is presented in Table 2. Following the introduction of peer supervision, the mean (SD) monthly visits for DDIs in the intervention district was 0.98(0.34) while in the comparison district was 0.78(0.31). The mean (SD) visits for peer supervisors in the intervention district was 1.2(0.87).

The aggregated monthly district percentages of appropriately treated children are presented in Table 3 and Figure 2. There was a general increase in the overall percentage of children treated appropriately for pneumonia symptoms (using amoxicillin tablets) and non-bloody diarrhea (using a combination of zinc and oral rehydration salts) in both the intervention and comparison districts from May to October 2016 before the introduction of peer supervision.

Following the introduction of peer supervision, there were monthly improvements in the overall appropriate treatment of

TABLE 1 Definitions of variable names used in the econometric analysis

Variable names	Definitions
y_t	Aggregated outcome variable (appropriately drug use in treatment of malaria, diarrhea, and pneumonia symptoms)
β_0	Intercept, which represents the starting level of the outcome variables (appropriately drug use in treatment of pneumonia symptoms, malaria, and diarrhea)
T_t	Equally spaced time points in months
X_t	Indicator variable representing pre-peer supervision period-0, otherwise 1
Z	Indicator variable representing intervention and comparison groups (Luuka-1, Buyende -0)
$X_t T_t, Z T_t, Z X_t, \text{ and } Z X_t T_t$	Interaction terms
β_1	Slope or trajectory of the outcome variable (appropriately drug use) until the introduction of peer supervision.
β_2	Change in the level of appropriately drug use that occurs in the period immediately following the introduction of peer supervision.
β_3	Difference between pre-peer supervision and post-peer supervision slopes of the Outcome
β_4	Difference in the level between intervention and comparison prior to peer supervision
β_5	Difference in the slope between intervention and comparison prior to peer supervision
β_6	Difference in level between intervention and comparison in the period immediately following introduction of peer supervision
β_7	Difference between intervention and comparison in the slope after initiation of peer supervision compared with before peer supervision being introduced.
ε_t	Error term at time t representing unexplained random variability in the model

children with pneumonia symptoms in the intervention district while there was a decline in the comparison district.

There was no difference in the appropriate treatment of children with uncomplicated malaria between the two districts. Noticeably, more children were appropriately treated for non-bloody diarrhea than malaria and pneumonia symptoms in both districts over the study period.

3.1.1 | Effectiveness of peer supervision on appropriate treatment of Pneumonia symptoms

As shown in regression Table 4 and visual inspection of Figure 3, prior to the introduction of peer supervision, 21.4% of the children were appropriately treated for pneumonia symptoms in the comparison district while 15.4% of the children were appropriately treated for pneumonia symptoms in the intervention district. This was followed by a 0.37% monthly decrease ($P = .59$, $CI = [-1.80, 1.06]$) until October 2016. A month after introduction of peer supervision (November 2016), the proportion of children appropriately treated for pneumonia symptoms was 10.84% significantly higher in the intervention ($P < .05$, $CI = [1.75, 19.9]$) compared to the comparison district.

This was followed by a decrease in appropriate treatment of children with pneumonia symptoms of 2.19% per month ($P = .07$, $CI = [-4.56, 0.18]$). The intervention decreased the proportion of appropriately treated children with pneumonia symptoms by 1.68% during the intervention period ($P = .29$, $CI = [-4.93, 1.57]$) compared to the comparison district. Post-intervention trend results revealed that the introduction of the intervention increased the proportion of

TABLE 2 Frequency of monthly inspection and peer supervision visits in the study period

Number of visits	Intervention (Luuka)	Comparison (Buyende)
Inspection visits before introduction of peer supervisors		
Median	0.88	1.00
Mean	0.88	0.94
std. deviation	0.31	0.38
Inspection visits following introduction of peer supervisors		
Median	1.00	0.86
Mean	0.98	0.78
std. deviation	0.34	0.31
Peer supervision visits		
Median	1.00	
Mean	1.2	-
std. deviation	0.87	-

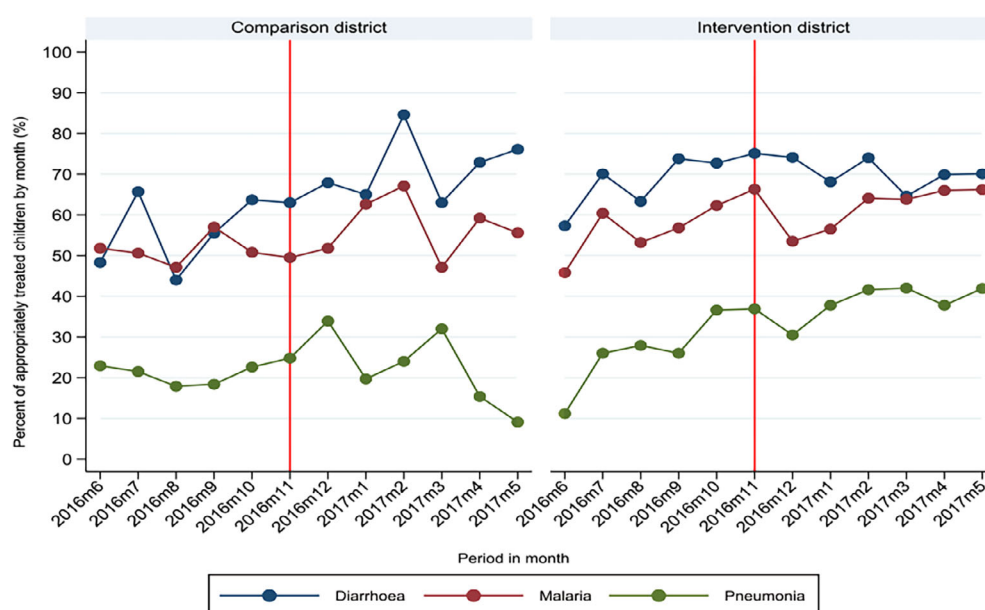
appropriately treated children exhibiting pneumonia symptoms at a rate of 1.21% ($P = .008$, $CI = [0.36, 2.05]$).

3.1.2 | Effectiveness of peer supervision on appropriate treatment of uncomplicated Malaria

Again, from regression Table 4 and visual inspection of Figure 4, prior to introduction of peer supervision, 50.6% of the children were

TABLE 3 Monthly appropriate treatment of childhood illnesses by district (%)

District	Month		Appropriate diarrhea treatment	Appropriate Malaria treatment	Appropriate pneumonia symptoms treatment
Intervention	Before	16-Jun	57.3	45.8	11.2
		16-Jul	70.1	60.4	26
		16-Aug	63.3	53.2	27.9
		16-Sep	73.8	56.8	26
		16-Oct	72.7	62.3	36.6
	After	16-Nov	75.1	66.3	36.9
		16-Dec	74.1	53.5	30.5
		17-Jan	68.1	56.5	37.8
		17-Feb	74	64.1	41.6
		17-Mar	64.6	63.8	42
		17-Apr	69.9	66	37.8
		17-May	70.1	66.2	41.9
Comparison	Before	16-Jun	48.3	51.8	22.9
		16-Jul	65.7	50.6	21.5
		16-Aug	44	47.1	17.9
		16-Sep	55.5	57	18.4
		16-Oct	63.7	50.8	22.6
	After	16-Nov	63	49.5	24.8
		16-Dec	67.9	51.8	33.9
		17-Jan	65	62.6	19.7
		17-Feb	84.6	67.1	24
		17-Mar	63	47.1	32
		17-Apr	72.9	59.2	15.4
		17-May	76.1	55.6	9.1

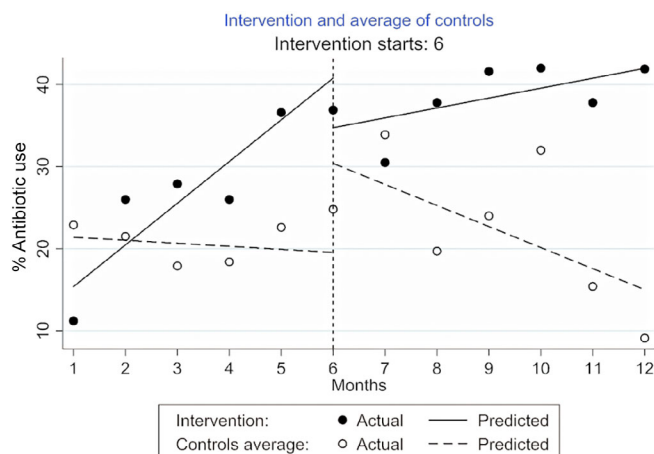
**FIGURE 2** Trend in month-to-month appropriate treatment of childhood illnesses June 2016 to May 2017

appropriately treated for uncomplicated malaria in the comparison district. Then, a 0.44% monthly increase ($P = .585$, $CI = [-1.23, 2.11]$) occurred until October 2016. There was no statistically

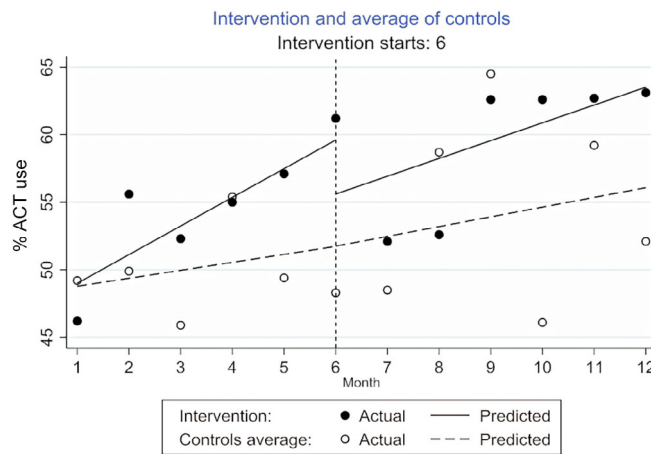
significant difference in appropriate treatment of children with uncomplicated malaria symptoms between the intervention and comparison districts.

TABLE 4 Effect of peer supervision on appropriate treatment of childhood illnesses

Variable	Diarrhea			Malaria			pneumonia symptoms		
	Coef	95% CI	P-value	Coef	95% CI	P-value	Coef	95% CI	P-value
Time (T)	2.06	−1.32, 5.44	.099	0.44	−1.23, 2.11	.585	−0.37	−1.80, 1.06	.592
Baseline slope (Z)	9.22	−1.50, 19.9	.025	−0.76	−11.42, 9.89	.882	−6.02	−12.37, 0.33	.062
Interaction (Z*T)	1.39	−2.45, 5.23	.313	2.5	−0.88, 5.88	.137	5.45	2.85, 8.04	.000**
Pre-intervention slope (X)	3.67	−9.85, 17.19	.448	1.46	−10.43, 13.36	.798	10.84	1.75, 19.9	.022*
Interaction (X*T)	−0.37	−3.74, 2.99	.741	0.19	−2.39, 2.77	.879	−2.19	−4.56, 0.18	.068
Intervention slope (Z*X)	−7.73	−22.52, 7.05	.155	−7.07	−24.35, 10.21	.399	−16.89	−28.81, −4.96	.008*
Interaction (Z*X*T) ^a	−4.04	−7.95, −0.13	.007*	−1.98	−6.60, 2.63	.375	−1.68	−4.93, 1.57	.291
Constant ^b	51.3	41.85, 60.78	.001	50.6	47.48, 53.67	.001	21.4	18.33, 24.46	.001
Post intervention trend (November 2016 to May 2017)									
Intervention	−0.96	−1.95, 0.02	.06	1.14	−1.30, 3.58	.336	1.21	0.36, 2.05	.008
Comparison	1.69	0.57, 2.80	.005	0.63	−1.34, 2.59	.507	−2.56	−4.78, −0.34	.026

* $P < .05$.** $P < .001$.^aDifference between pre-intervention and post-intervention slope (effect of the intervention over time).^bRepresents the starting level or percentage of infants appropriately treated in the comparison district.**FIGURE 3** Newey-West regression analysis for monthly rational treatment of pneumonia, June 2016 to May 2017

A month after the introduction of peer supervision (November 2016), the proportion of appropriately treated children for uncomplicated malaria was 1.46% higher in the intervention ($P = .79$, $CI = [-10.43, 13.36]$) compared to the comparison district. This was followed by a small increase in appropriate uncomplicated malaria treatment of 0.19% per month ($P = .88$, $CI = [-2.39, 2.77]$). The intervention decreased the proportion of children appropriately treated for uncomplicated malaria by 1.98% during the intervention period ($P = .38$, $CI = [-6.60, 2.63]$) compared to the comparison district. In addition, post-intervention trend results revealed that the introduction of the intervention increased the proportion of appropriately treated children with uncomplicated malaria at a rate of 1.14% ($P = .34$, $CI = [-1.30, 3.58]$).

**FIGURE 4** Newey-West regression analysis for monthly rational treatment of malaria, June 2016 to May 2017

3.1.3 | Effectiveness of peer supervision on appropriate treatment of non-bloody diarrhea

As seen in regression Table 4 and visual inspection of Figure 5, prior to the introduction of the intervention (peer supervision), the proportion of appropriately treated children with non-bloody diarrhea in the comparison district were 51.3%. This was followed by a 2% monthly increase ($P = .099$, $CI = [-1.32, 5.44]$) until October 2016.

In the first month of the intervention (November 2016), the proportion of appropriately treated children with non-bloody diarrhea was 4% higher in the intervention ($P = .448$, $CI = [-9.85, 17.19]$) compared to the comparison district. However, this difference was not statistically significant. Consequently, there was a slight decrease in appropriate non-bloody

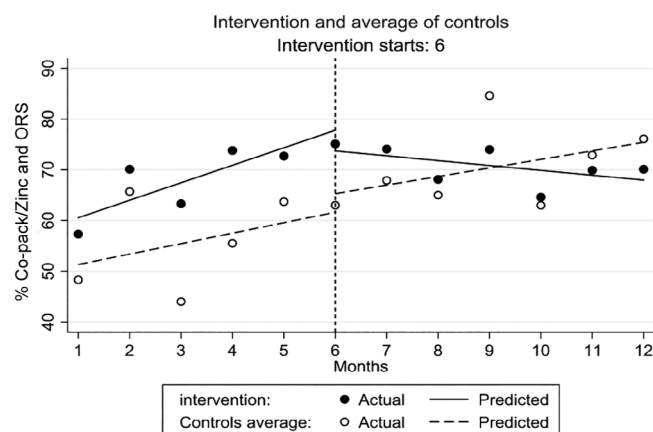


FIGURE 5 Newey-West regression analysis for monthly rational treatment of diarrhea, June 2016 to May 2017

diarrhea treatment of 0.37% per month ($P = .74$, $CI = [-3.74, 2.99]$). The intervention significantly decreased the proportion of children appropriately treated for non-bloody diarrhea by 4% during the intervention period ($P < .05$, $CI = [-7.95, -0.13]$) compared to the comparison district. In addition, post-intervention trend results revealed that the introduction of the intervention decreased the proportion of appropriately treated children at a rate of 1% ($P < .06$, $CI = [-1.95, 0.02]$).

4 | DISCUSSION

This study aimed at assessing the effectiveness of peer supervision on pediatric fever treatment among registered private drug sellers in two districts in East-Central Uganda. There was an increase in the number of inspection visits by the DDI in the intervention district after peer-supervision was introduced. Overall, post-intervention trend results revealed that the introduction of peer supervision was associated with a significant long-term increase in the proportion of appropriately treated children with pneumonia symptoms. Peer supervision did not increase the proportion of appropriately treated children with uncomplicated malaria and non-bloody diarrhea.

4.1 | Government inspection and peer supervision visits

The government recommends monthly inspection visits by DDIs. However, results in Table 3 revealed that inspection was not done as per statutory recommendations. The slight but insignificant increase in the number of inspection visits by the DDI in the intervention district was in tandem with what has been referred to by many scholars as social proof.^{34,35} In the social proof theory, people tend to do things because other people are doing them. This is in line with what the researchers of this study wanted to achieve-strengthening the district health system. Given that there was no statistical difference in

inspection visits between DDIs from the two districts overall, we were able to attribute observable intervention effects to peer supervision.

4.2 | Effectiveness of peer supervision on the appropriate treatment of pneumonia symptoms

Examination of health system effects due to peer supervision at the district level revealed that appropriate treatment of pneumonia symptoms using antibiotics may be achieved on a long term rather than a short-term basis. These results are in agreement with those obtained by Li Zhen and colleagues while looking at the impact of prescription audit and feedback for antibiotic use in rural clinics.³⁶ The difference is that while Li Zhen and colleagues used a single group comparison, the investigators of this study used a reference group, which may have strengthened the validity of the findings. Evidence from different settings shows that even among trained community health workers, diagnosis and rightful classification of children with pneumonia symptoms remains a challenge.³⁷⁻³⁹ As such, several studies emphasize the importance of supervision in improving the appropriate treatment of acute respiratory tract infections, which are associated with community pneumonia in children under 5 years of age.^{40,41} This further strengthens the importance of peer supervision among drug sellers in rural settings where supervision has been inadequate. Thus, even though drug sellers in both districts were trained prior to the introduction of peer supervision, the continuous professional development received through peer supervision improved diagnosis of pneumonia symptoms.

4.3 | Effectiveness of peer supervision on appropriate treatment of uncomplicated Malaria

Considering results 1 month after introduction of peer supervision as well as post trend results, there was no statistically significant difference in appropriate treatment of uncomplicated malaria among drug sellers in the intervention and comparison districts. In Uganda, studies evaluating ICCM in eight districts of central Uganda also found no statistical difference in appropriate treatment of children between intervention and comparison districts.⁴¹ This may be because malaria has affected the Ugandan population for a long time and maybe endemic.

4.4 | Effectiveness of peer supervision on appropriate treatment of non-bloody diarrhea

The results show that peer supervision did not improve appropriate non-bloody diarrhea treatment in children in the intervention district compared to the comparison district.

This is because in both districts, drug sellers prescribed more ORS and not Zinc and yet they should have prescribed the two as a combination. These study results are in agreement with what Agnes Nanyonjo and colleagues found while seeking to understand the impact of the ICCM strategy on uptake of appropriate diarrhea and

pneumonia treatment in Uganda.⁴² In her study, she points to the fact that this behavior is driven more by the poverty levels of the population. The East-Central region is one of the poorest regions in Uganda.⁴³ Nevertheless, there is a need to discourage the sale of zinc and ORS as separate entities because this seems to encourage inappropriate treatment of non-bloody diarrhea. Drug sellers need to be encouraged to stock and prescribe co-packaged ORS and zinc since evidence shows that a combination improves adherence to and appropriate treatment of non-bloody diarrhea in children under 5 years of age.^{44,45}

4.5 | Study limitations

In order to obtain valid results for all the three outcomes (pneumonia symptoms, uncomplicated malaria, and non-bloody diarrhea), the investigators ought to have found a district that was comparable to Luuka (the intervention district) both at the baseline average (Z) and the baseline trend (ZT_t) before peer supervision was introduced. However, the baseline average and trend were done for uncomplicated malaria only. This may have affected the results presented in this paper in that observed differences may have already started even before the intervention hence impacting the final results.

Appropriate treatment of children less than 5 years with symptoms of pneumonia, uncomplicated malaria, and non-bloody diarrhea is done with reference to the child's age without necessarily making any weight considerations. In many rural settings, a record of the child's birth date is not accurately recorded. In addition, the difference in weight may also determine how fast some drugs take to cure children. Therefore, the investigators of this study feel that since appropriate treatment was based on age alone, this may have affected the accuracy of the results by wrongly classifying some children as having been appropriately treated and some children inappropriately treated.

4.6 | Policy implications

The national professional guidelines for licensing, renewal, and new licenses for class C drug shops in Uganda stipulate that licensed drug sellers are responsible for supervising drug shops 16. This may be one of the reasons contributing to persistent inappropriate treatment of children less than 5 years of age by drug sellers since their primary business motive is profit. Peer supervision may be an effective method of improving appropriate treatment of children aged 5 years or less with febrile illnesses.

4.7 | Areas for more research

The researchers feel that while effectiveness of peer supervision on appropriate treatment among drug sellers has been assessed at the aggregate district level, it is still not clear whether prescribed drugs are given to children in the right doses by caregivers after they have

been dispensed by drug sellers. There is a need for more research to understand what happens at the household level.

5 | CONCLUSIONS

In conclusion, this study demonstrated that peer supervision was associated with a significant long term increase in appropriate treatment of children aged 5 years or less with pneumonia symptoms but not uncomplicated malaria and non-bloody diarrhea. Implementation of community-level interventions to improve pediatric fever management should consider embedding the component of peer-supervision.

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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All authors reviewed and approved the final version of the manuscript.

Arthur Bagonza had full access to all the data in this study and acts as guarantor for the integrity of the data and the accuracy of the data analysis.

TRANSPARENCY STATEMENT

Arthur Bagonza affirms that the manuscript is an honest, accurate, and transparent account of the primary data analysis and study being

reported: that no important aspects of the study have been omitted and discrepancies from the study have been explained.

DATA AVAILABILITY STATEMENT

The data supporting this study is available on request from the corresponding author. The data are not publicly available due to privacy and ethical restrictions.

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