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Research Article

Contribution of Community Health Workers in the Management of Malaria, Acute Respiratory Infections and Diarrhea in Children in Mali from 2010 to 2024

Borodjan Diarra[1, 2, *], Oumar Sangho[1], Cheick Abou Coulibaly[1], Bakary Diarra[1], Abdoul Salam Diarra[3], Abou Sogodogo[4], Nouhoum Telly[1], Hamadoun Sangho[1]

[1]Sub-Directorate of Health Establishments and Regulations (SDESR), Directorate General of Health and Public Hygiene (DGSHP), Bamako, Mali

[2]Department of Teaching and Research in Public Health and Specialties (DERSP), University of Sciences, Techniques and Technologies of Bamako (USTTB), Bamako, Mali

[3]National Center for Scientific and Technological Research (CNRST), Directorate General for Higher Education and Scientific Research (DGESRS), Bamako, Mali

[4]University Clinical Research Center (UCRC), University of Sciences, Techniques and Technologies of Bamako (USTTB), Bamako, Mali

Abstract

In Mali, community health workers (CHWs) were introduced in 2010 to implement Essential Community Care (ECC). This strategy aims to reduce high mortality rates (infant: 51.8‰; juvenile: 46.0‰) that exceed the targets of Sustainable Development Goal (SDG) 3.2 (25‰). Mortality is primarily caused by malaria (24%), pneumonia (11%), and diarrhea (8%), in a context of chronic shortages of skilled personnel. This study evaluated the outcomes and effectiveness of CHWs in managing these childhood illnesses. A cross-sectional mixed-methods study was conducted from September 2022 to August 2025. Quantitative program data from 2010 to 2024 were extracted from the district health information system (DHIS2). The study covered the first five regions in Mali to implement Essential Community Care (ECC), involving 4,230 Community Health Workers (CHWs) and 415 key stakeholders. Data were collected via questionnaires and analyzed using SPSS v.25.0 and R software. The majority of CHWs were women (68.24%) and were between 28 and 38 years old (57.85%). Between 2010 and 2024, community health workers (CHWs) managed 2,429,438 cases of malaria (annual average: 269,938; 12.03% of all cases), 520,439 acute respiratory infections (ARIs) (annual average: 57,827; 6.89%), and 325,316 cases of diarrhea (annual average: 36,146; 14.19%) in the study areas. Satisfaction rates were 95% within the community and 67% among healthcare workers. CHWs demonstrate significant effectiveness in managing malaria, ARIs, and diarrhea. Although their role is essential and well-regarded by the community, ARIs coverage remains lower than that for other illnesses. Strengthening supply chains and supervision is crucial to maximizing their impact on reducing infant mortality in Mali.

[*]Correspondence: Borodjan Diarra (borodjand@gmail.com)

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Keywords

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1. Introduction

Community Health Workers (CHWs) are community members trained to provide essential health care, whether preventive, curative, or promotional, directly within populations, particularly targeting rural or peri-urban areas far from health facilities [1, 2]. This intervention is embodied in Essential Community Care (ECC), a set of basic health interventions including, among others, the management of malaria, acute respiratory infections (ARIs), and diarrhea [3].

Globally, the role of community health workers (CHWs) is well established. They have demonstrated their effectiveness in combating infectious diseases, promoting maternal and child health, and contributing to reducing infant mortality by nearly half in countries with a high disease burden [4, 5]. In Africa, CHW programs have experienced strong expansion and a "renaissance" over the past two decades (2000-2023 [6].

Mali, a low-income Sahelian country, faces complex health challenges, marked by a high burden of disease due to communicable illnesses, including malaria, diarrheal diseases, and acute respiratory infections (ARIs) [7]. Reducing infant and child mortality remains a major public health challenge. Despite national efforts, mortality rates remain high, with 51.8 per 1,000 for infant mortality and 46 per 1,000 for child mortality, Figures that significantly exceed Sustainable Development Goal (SDG) target 3.2 of 25 per 1,000 by 2030 [8]. The under-five mortality rate is estimated at 95.4 per 1,000, meaning that approximately one in five children does not reach the age of five [9]. although it fell to 94‰ live births in 2023 from 130‰ in 2013 [10].

This situation is mainly due to the prevalence of preventable causes of death, including malaria (24%), pneumonia (11%) and diarrhea (8%) [11, 12]. These challenges are exacerbated by structural vulnerabilities in the health system, such as chronic shortages and unequal distribution of qualified health professionals, as well as limited access to quality services for a large part of the rural and isolated population [13].

To address this crisis in access to basic healthcare, the Community Health Workers (CHWs) program was introduced into the Malian health system in 2010 [14]. These frontline workers were tasked with implementing community-based healthcare (CBHC) strategies, particularly through integrated management of childhood illnesses at the community level (IMCI-C) [15, 16].

The community health worker (CHW) approach is a key strategy for decentralizing care and improving health coverage. Integrated Management of Childhood Illness (IMCI), developed jointly by the World Health Organization (WHO) and the United Nations Children's Fund (UNICEF), provides the evidence-based clinical framework for the effective management of childhood illnesses. By acting as the first filter and entry point into the health system for remote populations, CHWs aim to address gaps in access, prevention, and management of uncomplicated cases [16].

Ten years after its adoption, an evaluation of the impact of this strategy is essential. This article aims to assess the outcomes and effectiveness of Community Health Workers (CHWs) in managing common childhood illnesses in Mali. This evidence is intended to inform health policies and optimize the integration of CHWs within the national health system.

2. Materials and Methods

2.1. Place of Study

The study covered the first five regions to implement Essential Community Care (ECC) in Mali, namely the regions of Kayes, Koulikoro, Sikasso, Segou and Mopti.

2.2. Type and Period of Study

This is a cross-sectional mixed-methods study (quantitative DHIS2 + qualitative/quantitative questionnaire survey). The study was conducted from September 2022 to August 2025. Quantitative program data from 2011 to 2024 were extracted from the district health information software (DHIS2).

2.3 Data Sources

The study mobilized two types of information sources: routine data (secondary sources), aggregated data from the health information system (DHIS2) for counting the cases taken care of; the 2024 master list of community health workers for mapping staff; SEC review reports, Local Health Information System (LHIS) reports and national statistical yearbooks for triangulation and data complementation and survey data (primary sources): Field surveys carried out directly with community health workers and key actors involved in the implementation of SECs at different levels of the health pyramid.

2.4. Population

The study targeted three groups of actors involved in the

community health system: community health workers (CHWs) operating within essential care sites, beneficiaries, and key strategic and operational actors responsible for the implementation of community health initiatives (CHIs) at all levels of the health pyramid (health areas, districts, regions, and the national level), as well as representatives of technical and financial partners (TFPs). The study included data from 4,230 CHWs, 119 key actors involved in the implementation of CHIs at all levels of the health pyramid (health area, district, regional, national, and TFP), and 266 community beneficiaries (users residing in the areas covered by CHW sites).

2.5. Inclusion Criteria

The study included all practicing Community Health Workers (CHWs) during the period from January 1, 2011, to December 31, 2024, regardless of their seniority. These CHWs were required to have submitted a monthly activity report, the data from which was entered into the DHIS2 system. All key stakeholders involved in the implementation of the Community Health Services (CHS) at their respective levels of intervention (national, regional, district, health area) were also included.

2.6. Sampling

The sampling strategy was mixed: The exhaustive approach was applied to all community health worker (CHW) data entered into DHIS2 for cases of malaria, acute respiratory infections (ARIs), and diarrhea in children under five years of age. This approach also covered the mapped list of CHWs. Simple random sampling was also used. was used for selecting community health workers (CHWs) for the surveys. The minimum sample size of CHWs was calculated based on the population coverage rate by CHWs in 2023 (28.44%), resulting in n=313 plus 10% to reach n=344. Purposive (or targeted) sampling was used for the selection of key actors participating in the in-depth interviews, taking into account their involvement in the SEC program.

We conducted a comprehensive sampling for the use of community health worker (CHW) data in the DHIS2 and the 2024 CHW Master List. This included data on cases of illness in children under five years of age managed by CHWs in the relevant regions during the specified period, all CHWs registered on the 2024 CHW Master List, and all CHWs registered in the ASA Mali application.

Simple random sampling was used to select CHWs and key actors implementing the Community Health Initiatives (CHIs). We used random sampling without replacement to distribute CHWs equitably across regions, health districts, and health areas for in-depth interviews using interview guides.

2.7. Primary Performance Measurement Indicators

The following indicators were used to assess performance: Therapeutic Coverage Rates (TCR), which represent the proportion of sick children who received appropriate treatment from community health workers (CHWs), relative to the target population. The specific treatments evaluated were Malaria (Artemisinin-based Combination Therapy (ACT)), Diarrhea (Oral Rehydration Salts (ORS) and Zinc), and AKI (Amoxicillin). Secondary variables The data collected included the socio-demographic characteristics of the ASCs (age, sex, seniority, level of education, profile), the therapies actually administered, the socio-cultural support of the community and the level of satisfaction of the beneficiaries.

Key Performance Indicator: Therapeutic Coverage Rate (TCR). This measures the actual effectiveness of the SEC strategy in reaching sick children in the community. It is defined as follows:

Mathematical Definition: The TCR is the ratio between the number of children aged 0 to 59 months who received appropriate treatment from a Community Health Worker (CHW) and the total number of children expected (sick) for that condition in the area.

Calculation Method: TCR = (Number of expected cases in the target population / Number of cases treated by CHWs) × 100.

Specific Treatments Evaluated:

Malaria: Proportion of children with fever who received Artemisinin-based Combination Therapy (ACT) after a positive Rapid Diagnostic Test (RDT).

Diarrhea: Proportion of children who received the recommended dual therapy: Oral Rehydration Salts (ORS) and Zinc.

Acute Respiratory Infections (ARIs): Proportion of children presenting with cough or rapid breathing who received Amoxicillin dispersion.

Socio-demographic variables of Community Health Workers (CHWs): These variables help to profile the community healthcare provision:

Age and Sex: Biological characteristics of the CHW often influence social acceptability (e.g., a high proportion of women was observed at 68.24%).

Seniority: Length of service of the CHW, an indicator of experience acquired in case management.

Education Level and Profile: Initial educational level and status within the community (e.g., locally recruited worker), determining the ability to understand protocols.

Secondary Process and Perception Variables: Therapies actually administered: Analysis of the conformity between the diagnosis made and the medication actually administered by the CHW compared to national protocols.

Community sociocultural support: Degree of involvement of community leaders and families in the operation of the SEC site (transportation assistance, social mobilization).

Beneficiary satisfaction level: Perceived quality indicator measured among users, reflecting the alignment between the ASC's care services and parents' expectations (e.g., high satisfaction of 97.92% in your study).

2.8. Data Collection and Tools Used

Data collection: Data collection was based on a triangulation approach. Routine data were extracted from the Health Information System (DHIS2) for the period 2016–2024, marking the phase of full digitization of reports. For the earlier period (2011–2015), and to address potential gaps in the digital database, reports from the Local Health Information System (SLIS) and national statistical yearbooks were consulted. These secondary sources were supplemented by reports from the annual reviews of Community Health Workers (CHWs), allowing for cross-referencing of reported activity volumes with the master list of operational Community Health Workers (CHWs) in 2024. Interview questionnaires were specifically designed and administered individually to the selected CHWs and stakeholders.

Data collection tools: The survey data was collected digitally using KoboCollect, then exported to Excel for the cleaning and processing stage.

2.9. Analysis Plan

The data was processed according to the following steps:

Data preparation and cleaning: Survey data collected via KoboCollect was exported to Excel for the verification, cleaning and preparation stage.

Quantitative analysis: the quantitative data were transferred to SPSS version 25.0 software to perform descriptive analyses (frequencies, percentages, and means) and the generation of graphs.

Qualitative analysis: the qualitative data were processed using the R software for thematic analysis and synthesis aimed at enriching the interpretation of the results.

2.10. Ethical Aspects

"The research protocol was submitted to and approved by the Biomedical Research Ethics Committee (CERB) of the Faculty of Medicine and Odonto-Stomatology (FMOS/USTTB). Access to routine DHIS2 data was subject to prior authorization from the National Health Directorate. Regarding field surveys, informed consent was obtained from each participant (community health workers, healthcare professionals, patients) before any interview. The anonymity of respondents and the confidentiality of data were strictly preserved in accordance with the principles of the Declaration of Helsinki."

3. Results

3.1. Sociodemographic Characteristics of ASCs (Table 1)

The proportion of female community health workers (CHWs) was 68.24%. The 28-38 age group comprised 57.85% of the workforce. Regarding their background, 67.89% of CHWs had prior experience as midwives or nursing assistants. Marital status indicated that 80% of CHWs were married, and 68% had completed secondary education. Ten percent (10%) of CHWs were native to the village where the intervention site was located. In 2024, 3.10% of CHW sites were not operational.

Table 1. *Distribution of respondents according to socio-demographic characteristics (n=4002).*

Variables	n (Number of employees) = 4002	Proportion (%)
Sex		
Female	2731	68.24
Male	1271	31.76
Age		
≤ 18 years old	16	0.40
18 to 28 years old	1039	25.96
28 to 38 years old	2315	57.85
38 to 48 years old	494	12.34
48 to 58 years old	104	2.60
≥ 58	34	0.85
Profile		
Midwife/ Caregiver	2717	67.89
Health worker	545	13.62
Not a healthcare worker	740	18.49
Marital status		
Bride)	3202	80.00
Divorced	120	03.00
Bachelor	680	17.00
Level instruction		
First cycle	120	03.00
Second cycle	1121	28.00
Secondary	2721	68.00
Superior	120	03.00
Native of the village, ASC site		
Yes	400	10.00
No	3602	90.00
ASC website functionality		
Yes	3878	96.90
No	124	3.10

3.2. The Opinion of Stakeholders and Users on the Service Provided by the ASCs (Table 2)

According to the data collected, 56.7% of users reported consistently obtaining the medications they needed at the community health center (CHC). Regarding consultation fees, 81.1% of respondents considered them acceptable, and 86.9% felt the cost of medications was acceptable. As for stakeholder satisfaction, 66% of those involved in implementing community health services (CHS) reported being very satisfied with the work done by the CHCs. Concerning the target population, 63.1% of CHCs indicated that children were the primary beneficiaries of their interventions.

Table 2. *The opinion of stakeholders and users on the service provided by the ASCs.*

Variables	n (Number of employees) = 359	Proportion (%)
Drug availability at the ASC website		
Always	204	56.70
Often	96	26.80
Rarely	33	9.30
Opinion on the consultation fee		
Acceptable	291	81.10
Dear	1	0.30
No Opinion	67	18.60
Opinion on the cost of medicines		
Acceptable	312	86.90
Dear	4	1.10
No Opinion	43	12.00
Opinion on the cost of other services		
Acceptable	227	63.20
Dear	0	0.00
No Opinion	132	36.80
Stakeholder satisfaction with the performance of the ASC		
Very satisfied	237	66.00
Satisfied	115	32.00
Not satisfied	7	2.00
The opinion of the ASCs on the most affected targets		
Children	227	63.10
Women	132	36.90

3.3. Management (PEC) of Malaria, ARI and Diarrhea Cases from 2011 to 2024 by ASCs

3.3.1. Management (PEC) of Malaria Cases

Between 2016 and 2024, community health workers (CHWs) provided care for 2,429,438 cases of uncomplicated malaria. This activity followed a remarkable upward trajectory, rising from 171,348 cases in 2016 to a peak of 352,897 cases in 2024, representing a 106% increase. The Koulikoro (599,974 cases) and Segou (588,131 cases) regions accounted for the largest volume of treatment activity, averaging 269,938 cases per year. The percentage of malaria cases treated by CHWs, compared to the total number of malaria cases recorded in the area, averaged 12.03% over the study period (Table 3).

Table 3. *Total number of uncomplicated malaria cases managed by ASCs per year in the study areas from 2016 to 2024.*

Year	Kayes	Koulikoro	Sikasso	Segou	Mopti	Total
2016	13583	37357	56147	33348	30913	171,348
2017	13683	41382	49190	48000	26660	178,915
2018	19797	67062	72542	60090	46990	266,481
2019	20360	70234	80848	62096	60061	293,599
2020	16719	63334	52916	56436	54798	244,203
2021	13145	77236	58142	65475	59124	273,122
2022	16458	87789	70013	73260	81375	328,895
2023	10290	75977	58356	87964	87391	319,978
2024	11869	79603	60010	101462	99953	352,897

Year	Kayes	Koulikoro	Sikasso	Segou	Mopti	Total
Total	135,904	599,974	558,164	588,131	547,265	2,429,438

3.3.2. Percentage of Malaria Cases Managed by Community Health Workers

On average, community health workers (CHWs) managed 12.03% of all uncomplicated malaria cases reported in the study areas. There was significant geographical heterogeneity. Mopti recorded the highest contribution, averaging 17.85%, with peaks exceeding 21% at the end of the period (2023-2024). Kayes had the lowest contribution at 5.64%, showing a worrying downward trend over the past four years (falling to 3.34% in 2023). (Table 4).

Table 4. *Percentage of uncomplicated malaria cases in children under five years of age managed by ASCs by year and by region.*

Year	Kayes	Koulikoro	Sikasso	Segou	Mopti	Average
2016	6.85	9.30	10.14	8.87	14.40	9.82
2017	7.06	10.30	8.44	11.76	14.87	10.13
2018	7.59	14.05	11.18	12.60	18.16	12.55
2019	7.77	13.78	11.39	13.63	19.24	13.05
2020	6.74	13.93	11.29	13.44	17.46	12.82
2021	3.88	12.88	9.93	14.26	16.08	11.62
2022	4.08	12.53	10.35	13.89	16.31	11.72
2023	3.34	11.92	9.63	18.88	22.35	13.29
2024	3.47	11.80	9.71	18.13	21.76	13.30
Average	5.64	12.28	10.23	13.94	17.85	12.03

3.3.3. Number of Cases of Acute Respiratory Infections (ARIs) PEC by ASCs.

Between 2016 and 2024, community health workers (CHWs) provided care for 520,439 cases of Acute Respiratory Infections (ARIs) in the five study regions. An exponential increase was observed at the beginning of the period: the annual volume rose from 6,170 cases in 2016 to 77,757 cases in 2024, representing a more than twelvefold increase. The regions of Sikasso (126,393 cases), Segou (119,002 cases), and Koulikoro (112,873 cases) recorded the highest activity volumes. Conversely, the Kayes region had the lowest contribution, with a cumulative total of 47,706 cases (Table 5).

Table 5. *Number of cases of acute respiratory infection (pneumonia and cough/cold) managed by ASCs per year and per region.*

Year	Kayes	Koulikoro	Sikasso	Segou	Mopti	Total
2016	704	0	3711	820	935	6,170
2017	2601	1373	6755	10898	6169	27,796
2018	8018	10945	13913	11877	10918	55,671
2019	8692	16693	21219	12981	11447	71032
2020	7667	17428	17334	13548	12674	68,651

Year	Kayes	Koulikoro	Sikasso	Segou	Mopti	Total
2021	5454	16274	15042	15694	15094	67,558
2022	5992	17353	16842	16474	16300	72,961
2023	4396	15997	16632	16289	19529	72,843
2024	4182	16810	14945	20421	21399	77,757
Total	47,706	112,873	126,393	119,002	114,465	520,439

3.3.4. Percentage of AKIs Cases Managed by ASCs

The proportion of childhood ARIs treated at the community level has seen sustained growth, increasing from a marginal contribution of 1% in 2016 to 9% coverage in 2024, with an average of 6.89% over the entire period. Regional analysis revealed notable disparities: the Mopti (9.67%) and Segou (9.56%) regions consistently exceeded the national average, while the Kayes region (3.22%) showed a decline in its curative performance from 2021 onwards (falling to 2% in 2023-2024) (Table 6).

Table 6. *Percentage of ARI cases in children under five years of age managed by ASCs by year and by region.*

Regions	Kayes	Koulikoro	Sikasso	Segou	Mopti	Average
2016	1.00	0.00	2.00	1.00	1.00	1.00
2017	2.00	1.00	4.00	8.00	7.00	4.00
2018	6.00	6.00	6.00	9.00	9.00	7.00
2019	5.00	9.00	9.00	10.00	9.00	8.00
2020	5.00	10.00	9.00	11.00	10.00	9.00
2021	3.00	9.00	7.00	11.00	12.00	8.00
2022	3.00	9.00	8.00	11.00	12.00	8.00
2023	2.00	9.00	8.00	11.00	13.00	8.00
2024	2.00	9.00	8.00	14.00	14.00	9.00
Average	3.22	6.89	6.78	9.56	9.67	6.89

3.3.5. Number of Cases of Diarrhea Managed by ASCs

Over the period 2016-2024, community health workers (CHWs) provided treatment for 325,316 cases of diarrhea in children under five years of age across the five study regions. After a ramp-up phase between 2016 (4,360 cases) and 2018 (39,135 cases), the volume of activity stabilized, reaching 46,519 cases in 2024. The Mopti (88,032 cases) and Segou (84,364 cases) regions absorbed the largest share of this disease burden, representing more than 53% of the total cumulative volume. (Table 7).

Table 7. *Number of cases of diarrhea PEC by ASCs per year and per region.*

Year	Kayes	Koulikoro	Sikasso	Segou	Mopti	Total
2016	436	00	2317	729	878	4,360
2017	1977	763	3588	9239	5681	21,248

Year	Kayes	Koulikoro	Sikasso	Segou	Mopti	Total
2018	5001	6477	7756	9974	9927	39,135
2019	5559	8849	11289	9518	9348	44,563
2020	4561	8177	9900	9548	9694	41,880
2021	3385	7638	8408	10020	11363	40,814
2022	3285	7603	9024	11140	11873	42,925
2023	2439	7386	8936	11145	13966	43,872
2024	2308	8297	7561	13051	15302	46,519
Total	28,951	55,190	68,779	84,364	88,032	325,316

3.3.6. Percentage of Diarrhea Cases Managed by Community Health Workers

The average contribution of community health workers (CHWs) to diarrhea management was 14.19%. This coverage has steadily increased over the years, rising from 2% in 2016 to a plateau of around 17% since 2019. Geographic analysis highlights remarkable performance in the Segou (19.83%) and Mopti (19.69%) regions, where nearly one in five children with diarrhea is treated by CHWs. Conversely, the Kayes region recorded the lowest contribution, with an average of 7.21%, marked by a continuous decline since 2019, projected to fall below 5% in 2024 (Table 8).

Table 8. *Percentage of diarrhea cases managed by ASCs in children under five years of age per year and per region.*

Year	Kayes	Koulikoro	Sikasso	Segou	Mopti	Average
2016	1.00	0.00	4.00	2.00	3.00	2.00
2017	5.00	2.00	7.00	20.00	14.00	9.00
2018	11.00	12.00	12.00	21.00	21.00	15.00
2019	12.00	17.00	16.00	21.00	21.00	17.00
2020	10.00	17.00	17.00	21.00	20.00	17.00
2021	8.00	15.00	15.00	21.00	23.00	16.00
2022	7.00	15.00	16.00	23.00	24.00	17.00
2023	6.00	15.00	16.00	25.00	26.00	18.00
2024	4.93	14.21	12.87	24.46	25.23	16.74
Average	7.21	11.91	12.87	19.83	19.69	14.19

3.4. Effectiveness of Community Health Workers (CHWs) in Carrying out Curative Activities from 2016 to 2024

3.4.1. Coverage Rate of Malaria Targets Reached by ASCs

Table 9. *Coverage rates of uncomplicated malaria targets managed by ASCs by region from 2016 to 2024.*

Year	Kayes	Koulikoro	Sikasso	Segou	Mopti	Average
2016	26.94	50.56	79.52	52.04	57.38	47.58

Year	Kayes	Koulikoro	Sikasso	Segou	Mopti	Average
2017	18.99	47.28	55.98	56.80	36.21	44.11
2018	35.62	99.34	98.46	92.24	82.81	83.63
2019	35.39	100.48	106.02	92.20	102.23	89.02
2020	32.25	100.55	77.00	92.82	103.51	82.14
2021	21.31	103.09	71.10	90.50	93.85	77.21
2022	15.98	70.16	51.27	60.64	77.35	55.68
2023	17.08	103.82	73.07	124.51	142.06	92.63
2024	20.03	110.55	76.38	145.96	165.10	103.82
Average	24.84	87.31	76.53	89.75	95.61	75.09

Performance of ASCs in achieving the malaria target objectives of the ASC site in the study regions from 2016 to 2024. The average coverage rate for uncomplicated malaria managed by community health workers (CHWs) is 75.09% in the study areas. This performance is very low in the Kayes region (24.84%). CHWs in the Mopti region (from 52.04% in 2016 to 165.10% in 2024) and the Segou region (from 52.04% in 2016 to 145.96% in 2024) have a performance well above the average (75.09%) (Table 9).

3.4.2. Coverage Rate of IRA Targets Achieved by ASCs

(Performance of ASCs in achieving the objectives of the ASC site IRAs target in the study regions from 2016 to 2024).

Overall dynamics and temporal progression: Over the entire period, the average coverage rate was 27.89%. The analysis reveals three distinct phases:

A start-up phase (2016-2017): Starting from a near zero level in 2016 (3%), coverage saw a spectacular jump from 2017 onwards to reach 21%.

A peak phase (2019-2020): Performance reached its peak in 2019 with an average coverage of 42%.

A resilient stabilization phase (2021-2024): After a decline in 2021 (21), probably linked to the global health context or logistical challenges, coverage resumed steady growth to reach 35% in 2024.

Regarding regional disparities: Performance varied considerably depending on the geographical context:

The Mopti region recorded the highest performance with an average of 33.67%. It shows remarkable resilience at the end of the period, reaching 53% coverage in 2024, the highest rate in the entire series.

The regions of Segou (31.33%) and Sikasso (30.22%) maintain a solid contribution and above the overall average.

The Kayes region had the lowest coverage with an average of 15.22%. After peaking at 29% in 2019, the region has stagnated at around 11% over the last three years.

Key highlights: 2019 was marked by record performances in Sikasso (54%) and Koulikoro (46%). By the end of the period (2024), the regions of Mopti (53%) and Segou (44%) were driving the average upwards, demonstrating the increasing effectiveness of the SEC strategy in these areas (Table 10).

Table 10. *Target coverage rate for acute respiratory infections (pneumonia and/or cough/cold) by ASC by year and by region.*

Regions	Kayes	Koulikoro	Sikasso	Segou	Mopti	Average
2016	2.00	0.00	9.00	2.00	3.00	3.00
2017	11.00	5.00	23.00	39.00	25.00	21.00
2018	23.00	26.00	31.00	30.00	31.00	28.00
2019	29.00	46.00	54.00	37.00	38.00	42.00
2020	26.00	48.00	44.00	39.00	42.00	40.00
2021	10.00	24.00	21.00	24.00	27.00	21.00
2022	14.00	33.00	30.00	33.00	37.00	30.00
2023	11.00	32.00	31.00	34.00	47.00	31.00

Regions	Kayes	Koulikoro	Sikasso	Segou	Mopti	Average
2024	11.00	35.00	29.00	44.00	53.00	35.00
Average	15.22	27.67	30.22	31.33	33.67	27.89

3.4.3. Diarrhea Target Coverage Rates Achieved by Community Health Workers

Performance of ASCs in achieving the ASC site diarrhea target objectives in the study regions from 2016 to 2024.

Over the entire period, average coverage was 24.14%. A continuous and significant growth dynamic was observed: 1) Start-up (2016): Coverage was marginal, with only 3% of the target achieved. 2) Expansion (2017-2020): A steady increase in coverage brought the average to 31% in 2019. 3) Peak in 2021: 2021 was an exceptional year, with coverage reaching its peak at an average of 47%, driven by record performance in the Mopti and Segou regions. 4) Stabilization (2022-2024): After a correction in 2022, coverage stabilized at around 26%, confirming the integration of the intervention into community healthcare routines.

Regarding regional performance, Table 11 highlights significant geographical heterogeneity in healthcare provision: The Mopti region exhibits the strongest performance with an average of 36.28%. It stands out particularly in 2021 with a rate of 73% and ends the period with nearly one in two children covered (48.52% in 2024). The Segou region followed with an average of 30.12%, also reaching its peak in 2021 (56%). The Sikasso (22.16%) and Koulikoro (19.35%) regions showed intermediate and stable coverage. The Kayes region recorded the weakest performance with an average of 12.28%. A sharp decline is noted at the end of the period, with the rate falling to 7.48% in 2024.

Summary of findings: The analysis showed that in high-intensity areas (Mopti and Segou), community health workers (CHWs) manage to cover between one-third and one-half of the diarrhea care needs. The overall average of 24.14% demonstrates the capacity of the CHW network to be a major lever for reducing mortality related to diarrheal diseases in Mali. (Table 11).

Table 11. *The evolution of coverage rates of diarrhea management by ASCs in the study regions from 2016 to 2024.*

Year	Kayes	Koulikoro	Sikasso	Segou	Mopti	Average
2016	2.00	0.00	7.00	2.00	3.00	3.00
2017	7.00	2.00	10.00	28.00	20.00	13.00
2018	16.00	17.00	19.00	27.00	31.00	22.00
2019	22.00	29.00	34.00	32.00	36.00	31.00
2020	15.00	22.00	25.00	27.00	31.00	24.00
2021	22.00	41.00	41.00	56.00	73.00	47.00
2022	11.00	20.00	22.00	31.00	38.00	25.00
2023	8.00	21.00	23.00	32.00	46.00	26.00
2024	7.48	22.12	18.47	36.04	48.52	26.27
Money	12.28	19.35	22.16	30.12	36.28	24.14

3.4.4. Analysis of Regional Heterogeneity (2010-2024)

Regarding the volume of cases managed and the effectiveness (coverage) of community health workers (CHWs), the cross-sectional analysis of our data reveals a clear hierarchy of performance by pathology:

Malaria, the driving force of activity: With an average target coverage of 75.09%, this was the area where CHWs performed best. However, the actual proportion of cases managed (12.03%) suggests either saturation or preferential referral of severe cases to referral facilities.

The lag in Acute Respiratory Infections (ARIs) and Diarrhea: These two pathologies showed significantly lower coverage rates (27.89% for ARIs and 24.14% for diarrhea). The volume of cases managed for ARIs is particularly low (6.89%), which constitutes a bottleneck for child survival. Regional Disparities: The North-South/West Gradient High-Performance Hub (Mopti and Ségou): These regions demonstrated the best performance, with malaria coverage rates exceeding 100% at the end of the period. This reflects strong community integration and perhaps improved oversight by technical partners.

The Kayes Gap: The Kayes region consistently lags behind for all three diseases (Average Malaria Coverage: 5.64%; Acute Respiratory Infections: 3.22%). This performance gap necessitates an analysis of geographical factors and the supply chain.

4. Discussion

4.1. Limitations

The main limitation of this study lies in the incompleteness of the routine data extracted from DHIS2. Although the program began in 2010, the systematic integration of community health workers' activities into the digital platform was only effective from 2016 onwards. Furthermore, disparities remain in the regularity and completeness of the monthly reports submitted by field agents.

4.2. Socio-demographic Characteristics of ASCs

The profile of Community Health Workers (CHWs) identified in this study, characterized by a female predominance (68.0%) and a mature age (57.8% between 28 and 38 years old), constitutes a major strategic lever. These results corroborate the World Health Organization guidelines that advocate the recruitment of women to increase the social acceptability of maternal and child health care [17].

Regarding gender and acceptability, our results align with the work of Kok et al. (2015), which demonstrates that female ASCs have easier access to the intimacy of homes and promote better communication with mothers on Essential Newborn Care [18].

The fact that 68.0% of our community health workers had prior experience (midwives or nursing assistants) strengthens the network's technical credibility. This "pre-qualification" significantly reduces the learning curve for community-based IMCI. This observation aligns with the analysis by Davis et al. (2024), highlighting that prior experience is a predictor of quality of care and worker retention [19].

The very low rate of site non-operation (3.1%) in 2024 demonstrates exceptional resilience, especially in the Malian context. This result surpasses the standards observed in other sub-Saharan contexts where site allocation and inactivity are often linked to funding instability. This sustainability is an indicator of the effectiveness of the Malian institutional framework, particularly following the 2022 reforms and the support provided by development partners.

A striking finding of our study is the low rate of community health workers (CHWs) native to their intervention villages (10.0%), contrasting with WHO recommendations that favor exclusively local recruitment to ensure social acceptance and retention [17]. This discrepancy can be explained by three interdependent factors specific to the Malian context: 1) The requirement for technical qualifications: Mali has opted for a complex package of interventions (iCM, neonatal care, family planning) requiring a secondary education level, which 68% of our sample possessed. In many rural areas, the scarcity of local candidates meeting these academic criteria forces municipalities and community health organizations to recruit qualified candidates from neighboring villages or urban centers. 2) The retraining of health workers: our study shows that 68% of CHWs were previously midwives or nursing assistants. These agents, although not natives of the specific village where they are deployed, possess a professional legitimacy that sometimes overrides residential legitimacy. This professional "local migration" facilitates better application of clinical protocols [19]. 3) The impact of insecurity and displacement: the period 2010-2024 was marked by population displacements. The recruitment of non-native agents demonstrates a certain flexibility within the SEC network to maintain healthcare services in areas where the local social fabric has been weakened.

While non-nativism can theoretically hinder integration, the fact that 80% of ASCs are married and that 56.7% of users still obtain their medication suggests that social integration has occurred through the performance and family stability of the agent, rather than through their place of birth.

4.3. Satisfaction and Accessibility of Services

Analysis of beneficiaries' perceptions of services highlights an overall positive assessment of affordability and availability. A large majority of respondents consider community health costs acceptable, both for consultation fees (81.1%) and for the price of medications (86.9%). Financial acceptability is a decisive factor in access to healthcare in rural Africa [20, 21]. The results, indicating that more users consider the costs of community health worker (CHW) services acceptable, confirm that the SEC program's funding model (often based on a nominal fee or a working capital fund managed by the CHWs) is effective in reducing economic barriers.

Community health centers' (CHCs) ability to dispense necessary medications is superior to the stock shortages often encountered by central community health centers (CHCs). This rate, while improvable, positions CHCs as a local solution that ensures logistical continuity. This financial and logistical accessibility partly explains the massive increase in demand for curative and preventive care observed.

In contrast, a certain neutrality was observed regarding other services, for which more than a third of respondents (36.8%) did not express an opinion. Regarding supplies, more than half of users (56.7%) stated that they had always obtained the medications they needed from community health workers.

Among those implementing the program, satisfaction is high: two-thirds of the managers surveyed (66%) said they were "very satisfied" with the performance of the community health workers. This perception is reinforced by the observations of the community health workers themselves, nearly two-thirds of whom reported that children under five were the primary focus of their interventions.

4.4. Volume of Activities and Coverage Rates of Key Interventions

4.4.1. Malaria Cases Managed by Community Health Workers

The rise in power and the effect of professionalization: The doubling of the volume of cases treated between 2016 and 2024 demonstrates increased public trust in community health workers (CHWs). This dynamic coincides with the professionalization reforms of CHWs in Mali, suggesting that securing the status of these workers positively impacts the provision of care. This result is consistent with the findings of Perry et al. (2014), who stated that the formal integration of CHWs into the health system is the main driver of increased healthcare utilization [22]. The predominant role of CHWs in the management of uncomplicated malaria allows for early and rapid treatment with Artemisinin Combination Therapy (ACT), a critical factor in preventing progression to severe malaria. The literature is unanimous: iCCM reduces the time to treatment and, consequently, reduces infant and child mortality in areas where access to community health centers (CHCs) is difficult [23].

The resilience of the Mopti region: Mopti's performance (17.85% coverage) is paradoxical given the deteriorating security context. This "health resilience" is explained by the fact that, in areas where fixed facilities (CSComs) are difficult to access or closed, community health workers (ASCs) become the only recourse. The literature emphasizes that in conflict zones, ASCs ensure continuity of service that formal structures cannot maintain [21].

The "decline" in the Kayes region: The low rate of 5.64% in Kayes, falling below 4% since 2021, is a cause for concern. Several hypotheses can be put forward: 1) Stock shortages: The supply of Rapid Diagnostic Tests (RDTs) and Artemisinin-based Combination Therapies (ACTs) is often the bottleneck in remote areas. 2) Reporting bias: Underreporting of data via DHIS2. 3) Therapeutic competition: Increased reliance on self-medication or the private sector [24].

The observed regional disparities, with Mopti and Segou having the highest proportions of managed cases, are consistent with their epidemiological profile. Mopti is an area of high endemicity and increased nutritional vulnerability, which justifies the intensity of the intervention and the greater morbidity burden managed by community health workers in these regions.

4.4.2. Cases of Acute Respiratory Infections (ARI) PEC by ASCs

The increased management of pneumonia: The dramatic jump observed between 2016 and 2019 (from 1% to 8% coverage) marks the effective implementation of Integrated Community-Based Childhood Illness Management (ICCM-c). This development demonstrates that the use of respiratory counts and amoxicillin by community health workers is increasingly accepted by parents. This result aligns with the work of Das et al. (2013), who highlight that integrated Community Case Management (iCCM) reduces barriers to access for respiratory infections in areas where health centers are remote [15, 25].

Regional disparities and bottlenecks: The superior performance of the Mopti and Segou regions (reaching 14% in 2024) can be interpreted as a response by the community system to the inaccessibility of fixed facilities. In Mopti, in particular, community health workers compensate for the fragility of health centers impacted by the security situation. Conversely, the low rate in Kayes (3.22%) could be linked to stockouts of amoxicillin or a preference for self-medication (purchasing syrups from private pharmacies), as observed in other Sahelian contexts [24].

Coverage stability (2019-2024): The stabilization of the average around 8-9% suggests that the program has reached a "performance plateau" with current resources. To cross this threshold, intensified supervision and securing the antibiotic supply chain are essential. According to the WHO (2018), the quality of diagnosis (respiratory rate counting) remains the major challenge in maintaining user confidence in the treatment of acute respiratory infections (ARIs) by community health workers [17].

This average coverage rate of nearly 28% (reaching over 50% in some areas) is a key factor in explaining the health impact of your study. In research, 20% coverage for ARIs by community health workers is often considered the threshold at which a significant reduction in pneumonia mortality is observed.

4.4.3. Cases of Diarrhea: Management by Community Health Workers

The effectiveness of the ORS/Zinc strategy at the community level: The volume of 325,316 cases treated confirms that community health workers (CHWs) have become essential players in the fight against dehydration, the second leading cause of infant mortality. The stabilization of Figures since 2018 (around 40,000 cases annually) suggests a well-established care routine. This result is consistent with the WHO

recommendations (2018) which position community distribution of ORS and zinc as one of the most cost-effective interventions for reducing diarrhea-related mortality [17].

Contrasting geographical resilience: The strong contribution observed in Mopti and Segou (reaching 25% coverage in 2024) illustrates the crucial role of community health workers (CHWs) in areas where geographical access to health centers is limited or disrupted. Conversely, the low coverage rate in Kayes (4.93% in 2024) poses an equity challenge. This low utilization could be explained by recurring stockouts of treatment kits or a low perception of the severity of diarrhea among mothers in this region, necessitating an intensification of home visits.

These Figures are a direct manifestation of the success of the Community-Based IMCI (iCCM) strategy, which allows community health workers to treat the main causes of death in children under five.

4.4.4. Analysis of Regional Heterogeneity (2010-2024)

The Predominance of Malaria

Our results corroborate the trends observed in sub-Saharan Africa, where malaria remains the primary entry point for community healthcare. A systematic review by Coldiron et al. (2014) shows that community health workers (CHWs) are often perceived by communities as "malaria specialists," sometimes neglecting respiratory symptoms [26].

Challenges in the Management of Acute Respiratory Infections (ARIs)

The low rate of ARI management (6.89%) in your study is a recurring finding. Identifying signs of pneumonia by CHWs remains a major technical challenge. Druetz et al. (2015), in their work in Burkina Faso, showed that while malaria coverage is high, pneumonia coverage often stagnates due to the complexity of diagnosis (respiratory rate counting) [27].

The Impact of Free Access and Availability of Inputs

The peak performance observed in our data around 2019–2021 (particularly for target coverage) often coincides with periods of increased funding from the Global Fund and other partners. Experience in Rwanda shows that the effectiveness of Community Health Workers (CHWs) is directly correlated with the absence of stockouts of inputs (RDTs, ACTs, Amoxicillin, ORS/Zinc) described in the study by Condo et al. (2014) [28].

Coverage rates exceeding 100% (such as in Mopti for malaria in 2024) likely stem from outdated census data for the target population or significant internal migration due to the security situation.

4.4.5. Community Health Worker Performance and Child Survival (2010-2024)

Comparative Analysis of Work Volume vs. Effectiveness: The study revealed a striking contrast between community engagement and the actual impact on morbidity, as demonstrated in the work of Aichata et al. (2022) [29]:

Malaria (Domination of the Care Package): This is the flagship activity with an average target coverage of 75.09%. This strong performance is correlated with the historical reduction in infant and child mortality in Mali, where the possession of mosquito nets and treatment with ACT were the main factors in survival. This result corroborates that of Diawara et al. (2021) [30].

The Gap in Acute Respiratory Infections (ARIs) and Diarrhea: Despite a target coverage of 27.89% (ARIs) and 24.14% (diarrhea), the actual proportion of cases treated remained marginal (6.89% and 14.19%, respectively). This low workload indicates that a vast majority of children suffering from respiratory infections or dehydration still fall outside the reach of community health workers (CHWs). Our result is consistent with the findings of Sidibé et al. in 2014 [31].

Correlation with Mortality (Focus 2021-2022): The 2021-2022 period was marked by a worrying stagnation in treatment indicators, which can be attributed to security challenges and the post-COVID-19 pandemic [32].

Mortality Inflection Point: While the under-five mortality rate fell from 101 per 1,000 in 2018 to approximately 87 per 1,000 in 2023, the slowdown in progress coincides with the reduced effectiveness of community health workers (CHWs) in some areas [33].

Link to the EDSM-VI: The EDSM highlights that respiratory infections (19%), malaria (16%), and diarrhea (15%) remain the leading causes of death. Our results show that the decline in community health care performance in 2021–2022 leaves these illnesses without an immediate response at the community level, increasing the risk of death at home [34, 35].

Regional Heterogeneity and Disparities in Survival: Heterogeneous performance creates an unequal "geography of survival" in Mali [31, 34]:

Success Areas (Mopti/Ségou): Coverage rates exceeding 100% for malaria suggest strong resilience and successful community integration, contributing to the local decline in mortality.

Vulnerability Areas (Kayes): With a catchment rate for acute respiratory infections (ARIs) capped at 3.22%, this region illustrates the challenge of delayed access to care. The poor performance of community health workers (CHWs) is a direct contributing factor to rural infant and child mortality.

5. Conclusions

The performance evaluation of Community Health Workers (CHWs) in Mali, through the management of malaria, acute respiratory infections (ARIs), and diarrhea, confirms the effectiveness and relevance of the Essential Community Care (ECC/ iCCM) strategy. CHWs have demonstrated their ability to reduce the burden of childhood morbidity by ensuring access to primary care, particularly in geographically disadvantaged regions such as Mopti and Segou, where their contribution is vital for equitable access.

However, the average proportions of care for ARI, malaria and

diarrhea indicate that the program has not yet reached its maximum potential (regional standards 18% to 20%) and remains vulnerable to operational challenges that limit full coverage.

At the conclusion of this study, several avenues of research warrant exploration to consolidate the achievements of the SEC strategy. Future work should focus on an in-depth analysis of the resilience of community healthcare in conflict zones, as well as on innovative financing models to ensure the sustainability of community health workers. Finally, the integration of digital tools (mHealth) could provide a major technological response to the logistical challenges and supply disruptions identified in our research.

Abbreviations

ASC	Community Health Workers
ACT	Artemisinin-based Combination Therapy
AIDS	Acquired Immunodeficiency Syndrome
ARIs	Acute Respiratory Infections
ASACO	Community Health Association
CBHC	community-based Healthcare
CERB	Ethics Committee for Biomedical Research
CHIs	Community Health Initiatives
CHS	Community Health Services
CHWs	Community Health Workers (International Standard Term for CHW)
CNRST	National Center for Scientific and Technological Research
CSCOM	Community Health Center
CSLS-TBH	Sectoral Unit for the Fight Against HIV/AIDS, Tuberculosis and Viral Hepatitis
CURC	University Clinical Research Center
DERSP	Department of Teaching and Research in Public Health and Specialties
DGSHP	Directorate General of Health and Public Hygiene
DHIS2	District Health Information Software Version 2
DRY	Essential Care in the Community
ECC	Essential Community Care
FMOS	Faculty of Medicine and Odonto-Stomatology
HIV	Human Immunodeficiency Virus
iCCM	Integrated Community Case Management (Technical term for PCIME-C/SEC)
IMCI	Integrated Management of Childhood Illness
LHIS	Local Health Information System
PCIME	Integrated Care for Childhood Illnesses
PCIME-C	Integrated Care for Childhood Illnesses at the Community Level
PTFs	Technical and Financial Partners
SDESR	Sub-Directorate of Healthcare Facilities and Regulations
SDG	Sustainable Development Goals
SENE	Essential Newborn and Child Care
SLIS	Local Health Information System
SPSS	Statistical Package for the Social Sciences
SRO	Oral Rehydration Salts
TCR	Therapeutic Coverage Rate
TFPs	Technical and Financial Partners
UNICEF	United Nations Children's Fund
USTTB	University of Sciences, Techniques and Technologies of Bamako
WHO	World Health Organization

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Author Contributions

Borodjan Diarra: Conceptualization, Formal Analysis, Writing – original draft

Oumar Sangho: Project administration, Resources, Supervision, Validation

Cheick Abou Coulibaly: Conceptualization, Formal Analysis, Validation, Writing – review & editing

Bakary Diarra: Writing – review & editing

Abdoul Salam Diarra: Writing – review & editing

Abou Sogodogo: Writing – review & editing

Nouhoum Telly: Writing – review & editing

Hamadoun Sangho: Project administration, Validation

Data Availability Statement

The data supporting the outcome of this research work has been reported in this manuscript.

Conflicts of Interest

The authors declare no conflicts of interest.

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Biography

Borodjan Diarra is a physician, PhD candidate in public health, and expert at the Directorate General of Health and Public Hygiene (DGSHP) of Mali. A lecturer and researcher at the DERSP (USTTB), he specializes in community health interventions. Having completed his doctoral studies in 2026 at EDSTM, he participates in numerous international research projects and serves on the editorial boards of several scientific publications.

Research Field

Borodjan Diarra: Malaria Control, Maternal and Child Health, Health Systems and Health Coverage, Nutrition and Food Security, Emerging and Re-emerging Communicable Diseases, Digital Health (e-Health/Telemedicine), Socio-cultural and Behavioral Factors, Health Economics, School Health and Parasitosis, Human Resources Management in Health (HRM)

Oumar Sangho: Epidemiology, prevention and treatment of malaria, Epidemiology, prevention and treatment of HIV, Epidemiology, prevention and treatment of tuberculosis, Epidemiology, prevention and treatment of nutrition, Epidemiology, prevention and control of maternal health, Health promotion

Cheick Abou Coulibaly: Tuberculosis, HIV, COVID-19, Maternal Health, Child Health, cardiovascular disease

Bakary Diarra: Malaria control, maternal and child health, health systems and health coverage, emerging and re-emerging communicable diseases, quality of care, socio-cultural and behavioral factors, health policy and system, health human resource management (HRM)

Abdoul Salam Diarra: Cervical cancer, epidemiology and prevention strategies; Breast cancer, epidemiology and prevention strategies; Diabetes, epidemiology and prevention strategies; Malnutrition, epidemiology and prevention strategies; Sleep disorders; Malaria control

Abou Sogodogo: Epidemiology; Public Health; Statistics; Geospatial Modeling; One Health; Implementation Research

Nouhoum Telly: Diabetes, epidemiology and prevention strategies, Malnutrition, epidemiology and prevention strategies, Epidemiology and prevention of malaria, Cervical cancer, epidemiology and prevention strategies, Breast cancer, epidemiology and prevention strategies

Hamadoun Sangho: Maternal and Child Health, health system evaluation, neglected tropical diseases (NTDs), quality of care, health information systems (HIS), and university pedagogy