

Evidence on the Impact of Community Health Workers on Health Indicators in Congo: A Quasi-Experimental Temporal Study

Reiche Diauvani Massengo Nsongola^{1,2}, Gilbert Ndziessi³, Ange Clauvel Niama³, Joseph Axel Ngatse³, Jethro Massala³, Gerard Eloko Matangelo¹, Pascal Lutumba¹

¹Doctoral School, Higher Institute of Medical Techniques of Kinshasa, Kinshasa, Democratic Republic of the Congo

²Africa Centres for Disease Control and Prevention, African Union, Addis Ababa, Ethiopia

³Faculty of Health Sciences, Marien Ngouabi University, Brazzaville, Democratic Republic of the Congo

Email: reichemass@gmail.com, ndziessi@yahoo.fr, clauvelniama@gmail.com, josaxel@yahoo.fr, jethromassala@gmail.com, gerardeloko@yahoo.fr, pascal_lutumba@yahoo.fr

How to cite this paper: Massengo Nsongola, R.D., Ndziessi, G., Niama, A.C., Ngatse, J.A., Massala, J., Matangelo, G.E. and Lutumba, P. (2025) Evidence on the Impact of Community Health Workers on Health Indicators in Congo: A Quasi-Experimental Temporal Study. *Open Journal of Epidemiology*, 15, 712-726. <https://doi.org/10.4236/ojepi.2025.153046>

Received: July 23, 2025

Accepted: August 23, 2025

Published: August 26, 2025

Copyright © 2025 by author(s) and Scientific Research Publishing Inc. This work is licensed under the Creative Commons Attribution International License (CC BY 4.0).

<http://creativecommons.org/licenses/by/4.0/>



Open Access

Abstract

Introduction: Community Health Workers (CHWs) is considered a key strategy to improve access to primary health care in resource-limited countries. This study aimed to assess the impact of CHWs on district health indicators in Congo. **Methods:** Study used a pre-post design. Health indicators from six rural health districts were compared for the periods of 24 months before and 24 months after introduction of CHWs. Data were extracted from the national District Health Information System (DIHS2) platform. Indicator values were compared in terms of absolute differences, expressed in percentage points, using repeated measures analysis of variance (ANOVA). Mixed linear regression was used to assess the relationships between CHWs and health indicators. Statistical analyses were performed using R software (lme4 package). **Results:** CHWs led to a significant improvement for following indicators (percentage points: pp, p-value): CPN1 (+12.6 pp, $p < 0.001$); ANC4 (+5.6 pp, $p = 0.002$); HIV testing (+29.7 pp, $p < 0.001$); TPI2 (+10.6pp, $p = 0.008$); Pentavalent 1 (+28.9 pp, $p < 0.001$); Pentavalent 3 (+27.3 pp, $p < 0.001$); Vitamin A (+34.5 pp, $p < 0.001$); Curative consultations (+8.3 pp, $p = 0.004$). However, no significant variation was found for the rate of hospital admissions for malaria (-0.2 pp, $p = 0.957$) and HIV testing positive in pregnant women (+2.4 pp, $p = 0.188$). After adjustment, CHWs was associated with an increase of screening rate for ANC (+35.26 points; 95% CI: +18.55 - 51.96; $p = 0.0001$), HIV testing in ANC1 (+55.75; 95% CI: 33.72 - 77.78; $p < 0.0001$), vaccination coverage in Pentavalent 1 (+14.67; 95% CI: 5.57 - 23.78; $p = 0.0018$), vaccination coverage in pentavalent (+148.02; 95% CI: 106.52 - 189.52; $p < 0.0001$), vitamin A sup-

plementation (+197.96; 95% CI: 137.11 - 258.80; $p < 0.0001$), and curative consultations (+35.00; 95% CI: 21.48 - 48.52; $p < 0.0001$). In contrast, the effect on HIV positivity rate, IPT2 coverage, and malaria hospitalizations was positive but not statistically significant: (+6.74; 95% CI: (-7.51 -21.00; $p = 0.3511$), (+11.66; 95% CI: -14.23 - 37.56; $p = 0.3746$) and (+12.56; 95% CI: (-6.87 - 31.99; $p = 0.2034$), respectively. **Conclusion:** Study shows a positive impact of CHWs on several health indicators in health districts. Results are in favor of strengthening community health programs as levers to strengthen health indicators in health districts with a low ratio of health workers, to increase the chances of moving towards achieving the objectives of universal health coverage. In this regard, challenges related to governance and financing of national community health programs, as well as the training and motivation of CHWs, must be addressed in order to stimulate and maintain the benefits of care in local communities.

Keywords

Community Health Workers, Impact, Health Indicators, Health Districts, Congo

1. Introduction

Human resources for health are a fundamental lever for improving access to primary health care and achieving universal health coverage goals in developing countries. The World Health Organization (WHO) estimates that there will be an overall gap of 18 million qualified health professionals to be filled by 2030, a deficit that particularly affects sub-Saharan Africa [1]

In this context, a renewed interest in the use of community health workers (CHWs) is evolving in several countries globally [2]-[5]. CHWs are a category of frontline health workers who are usually members of the communities they serve, receiving minimal health training to provide basic services in their communities [6]-[8]. They connect health services and communities, providing culturally appropriate health information, support, and services [9]. Their role is central to access to care, especially in vulnerable and disadvantaged communities. They are involved in a variety of public health activities, such as awareness-raising, early prevention and detection of diseases, distribution of medicines, home visits, and referrals to health facilities.

In the Republic of Congo, the health system is structured at three levels: strategic or central, intermediate or regional and operational or peripheral. The peripheral level is represented by the health district, composed of a district referral hospital linked to a network and several Integrated Health Centres (IHCs) [10]. In Congo, each IHC serves a health area with between 5000 and 15,000 inhabitants in rural and urban areas respectively; a Health District (HD) covers between 30,000 and 100,000 inhabitants in rural areas, and up to 300,000 in urban areas

[11]. It should be noted that a health district is the area covered by a number of health centres. However, Congo experiences a persistent shortage of health workers, particularly in rural areas. The current density is about 1 health professional (doctor, nurse, midwife) per 1000 inhabitants, well below the WHO-recommended standard of 4.45 per 1000 inhabitants [12] [13]. This context limits the supply of health services and population access to healthcare. To address this issue, the Ministry of Health deployed a community health program since 2022 with 2652 CHWs, also known as community relays or associative agents [14]. These agents are trained to ensure the link between the population and the health facilities (FOSA) in health areas. It is expected that CHWs can help alleviate the shortage of health personnel, but it is crucial to verify whether their presence really translates into a significant improvement in the performance of health districts. In Congo, despite the expansion of the CHW program, we have not found any studies conducted to measure its real effect on the performance of health districts. This study was designed to fill this gap by documenting the impact of CHWs on key performance indicators of health services. It seeks to answer the following question: What is the impact of the introduction of community health workers on the performance of health districts in terms of access to and coverage of health services? To answer this question, the following hypothesis was formulated: the intervention of community health workers significantly improves the performance indicators of health districts such as vaccination coverage, antenatal consultations and antenatal follow-up. The results of this study will fill a gap in the existing literature regarding the real impact of CHWs on people's access to care, guide decisions based on scientific evidence and potentially revise the intervention strategies implemented.

2. Methods

2.1. Design and Setting

A quasi-experimental ecological study based on a pre-post comparison model over a period of 24 months without a control group was conducted. Two periods were compared: the pre-intervention phase (before) T0, from July 1, 2021 to June 30, 2022, and the post-intervention phase (after) T1, from July 1, 2022 to June 30, 2023. Indeed, the Ministry of Health of Congo had introduced CHWs in all health districts of the country in July 2022. The study was conducted in the Republic of Congo, in the health districts. During the study period, the country had 52 health districts divided into 12 Departments of Care and Health Services (DCHS). A total of six (06) health districts were randomly selected for this study. This selection has been adjusted for geographical diversity and data availability. Thus, 6 following health districts, spread over 6 DCHS, were selected for the study at the rate of one SD per DCHS. It is the DS of Oyo in the DCHS of the Cuvette, of Gamboma in the DCHS of the Plateaux, of Kinkala in the DCHS of Pool, of Madingou in the DCHS of Bouenza, of Dolisie in the DCHS of Niari and the DS of Hinda-Loango in the DCHS of Kouilou. The total population of these 6 six DCHS was 355,349.00

in 2023.

2.2. Databases

Data used for this study are from the National Health Information Management System DHIS2 (District Health Information Software, version 2), officially deployed and used by the Ministry of Health and the population of Congo, for routine data collection and monitoring at the national level. DHIS2 is a widely used open-source platform, supported by the University of Oslo, that enables the capture, validation, analysis, and visualization of aggregated health data [15]. In the DHIS2, data are monthly reports at the Integrated Health Centers (IHCs) level and compiled at the Health District (HD) level. The primary data used to calculate the indicators for the two study periods, namely 24 months before and 24 months after the introduction of CHWs, were extracted from DIHS2 by five trained investigators, using the following criteria: department, health district and covered population. These data were used to create a secondary database using KoboCollect Box app. Data validation process was used to check completeness, identify outliers, and ensure data reliability. In the event of an anomaly, checks were carried out from the paper registers of the health centres.

2.3. Indicators

The indicators explored in this study included:

1) Antenatal Care 1 (ANC 1) rate: ANC 1 is the first prenatal consultation a pregnant woman has with a healthcare professional, usually a doctor or midwife. Rate of ANC 1 was assessed as $\text{Number of pregnant women who had their first prenatal consultation} / \text{Number of expected pregnant women} \times 100$

2) HIV testing rate assessed as: $(\text{number of people tested for HIV} / \text{Target population to be tested}) \times 100$

3) HIV-positive women: assessed among pregnant women at ANC 1 as: $(\text{number (Number of pregnant women tested positive for HIV} / \text{Total number of pregnant women tested}) \times 100$

4) Intermittent Preventive Treatment 2 (IPT2) rate: Intermittent Preventive Treatment (IPT) for malaria is a malaria prevention strategy that involves administering antimalarial drugs at regular intervals to prevent infection. IPT2 rate was assessed as: $(\text{Number of pregnant women who received the 2nd dose of IPT2} / \text{Pregnant women expected or who received IPT1}) \times 100$

5) Antenatal care 2 (ANC 2) rate: $(\text{Number of women who have completed 4 or more ANC} / \text{Number of expected pregnant women}) \times 100$

6) vaccination coverage for pentavalent 1: $(\text{Number of children who have received the 1st dose of pentavalent vaccine} / \text{Number of children} < 1 \text{ year of age expected}) \times 100$

7) Vaccination coverage for pentavalent 3: $(\text{Number of children who have received the 3rd dose of pentavalent vaccine} / \text{Number of children} < 1 \text{ year of age expected}) \times 100$

8) Vitamin A supplementation coverage (Number of children 6 - 59 months who received vitamin A/Number of children 6 - 59 months expected) \times 100

9) Rate of curative consultations: (Total number of curative consultations carried out/Expected total population) \times 100

10) Rate of hospitalization for malaria: (Number of malaria hospitalizations/Total all-cause hospitalizations) \times 100

2.4. Statistical Analysis

A univariate analysis was first performed to assess whether CHWs had an impact on health indicators. Thus, each indicator was calculated and compared between the 24 months before and 24 months after the introduction of CHWs. All indicator values, expressed as percentages, were compared in terms of absolute differences in percentage points (simple difference between pre- and post-intervention proportions). These variations were assessed by repeated measures analysis of variance (ANOVA), appropriate for longitudinal data, to measure the degree of significance. Assumptions of normality were tested using the Shapiro-Wilk test, and the hypothesis of sphericity was tested using the Mauchly test. Secondly, to assess the real impact of CHWs on the health indicators, mixed effects linear regression was performed to control for potential confounding factors. The choice of this type of regression was justified, as each health district constitutes a geographical site where the data collected are hierarchical or correlated, *i.e.*, several observations are often from the same people within the health districts, with measures before and after intervention. In this case, the observations were not independent. On the contrary, simple regression models that assume that the residuals are independent were not applicable because the standard errors would be too small and p-values incorrect. Indeed, mixed-effects regression introduced random effects to model correlations and hierarchies, in order to control potential confounding effects. Ultimately, linear regression with mixed effects makes it possible to estimate the average effect of the intervention, *i.e.*, the introduction of CHWs, while integrating the unexplained variability between observation units through the introduction of random effects. The models were fitted using the restricted maximum likelihood (REML) method. Residual normality and homoscedasticity assumptions were verified by graphic inspection. The results are presented as estimated coefficients (β), with their 95% confidence intervals and corresponding p-values. Statistical analyses were performed using R software (lme4 package).

2.5. Variables

In this study, the variables included in the regression equation are as follows:

Dependent variables

The dependent variables consisted of the ten tracer indicators selected for the study, which were treated as continuous variables.

Primary variable of interest

The main variable of interest was time (before vs. after intervention), introduced

as a fixed effect.

Covariates

These included: 1) seasonality (rainy vs. dry), 2) presence of NGO-supported health projects, 3) flood occurrence (binary variable), and 4) CHW-to-population ratio, all treated as fixed effects. These covariates were selected as adjustment variables. For instance, if health districts with NGO support have both a higher number of CHWs and better health indicators, adjusting for this variable helps avoid overestimating the effect of CHWs. Similarly, because health indicators vary by season, including seasonality as a covariate allows for the assessment of temporal effects on health outcomes.

Random effect

A random effect was introduced for health districts, to account for within-group correlation and inter-unit variability.

The following equation represents a linear fixed-effects regression model used to estimate the impact of community health workers (CHWs) on a given health outcome:

$$Y_{it} = \beta_0 + \beta_1 \cdot ASC_{it} + \beta_2 \cdot ONG_{it} + \beta_3 \cdot Season_{it} + \beta_4 \cdot Flood_{it} + \beta_5 \cdot RatioCHW_{it} + u_i + \varepsilon_{it}$$

where:

- Y_{it} : The dependent variable, representing the health indicator measured for area i at time t . For example, this could be a consultation rate or morbidity indicator.

- β_0 : The intercept, representing the average value of YYY when all explanatory variables are zero.

- $\beta_1 \cdot ASC_{it}$: The effect associated with the variable ASC_{it} , which reflects the presence or activity of community health workers (CHWs) in area i at time t . The coefficient β_1 measures the average impact of this variable on YYY .

- $\beta_2 \cdot NGO_{it}$: The effect of NGO presence in area i at time t . This factor controls for parallel interventions that might influence health indicators.

- $\beta_3 \cdot Season_{it}$: The seasonal effect, for example distinguishing between dry and rainy seasons, which can affect health outcomes.

- $\beta_4 \cdot Flood_{it}$: The effect of flooding in area i at time t , considered an environmental shock that may impact population health.

- $\beta_5 \cdot RatioCHW_{it}$: The effect of the relative density of community health workers in area i at time t .

- u_i : The unobserved, area-specific effect, assumed to be constant over time (fixed effect).

- ε_{it} : Random error term specific to each observation, assumed to be independent of others and drawn from the same distribution with consistent properties.

2.6. Ethical Issues

The use of data from DHIS2 was within a framework legally authorized by the Ministry of Health and Population, which is responsible for the collection and management of routine health data. The data used in this study was aggregated and

anonymized, and did not contain any personally identifiable or individual information. A formal authorization for the use of the data has been obtained from the Minister of Health and Population. Data extraction was performed by the authorized agents of the Health Information Directorate of the Ministry of Health and Population), and the consolidated files were password-protected throughout the analysis process.

3. Results

3.1. Main Characteristics of Health Districts

Detailed data for each Health District (HD) are presented in **Table 1**. Data from six Health Districts (HDs) across six Departments of Care and Health Services (DCHS) were used, with one HD selected per DCHS. The total population was 1,122,580, with 62 Community Health Workers (CHWs), representing an average allocation of 10 CHWs per Health District (HD). Half of the health districts (50%) simultaneously benefited from health development support programs provided by Non-Governmental Organizations (NGOs).

Table 1. Description of the six health districts.

Department of care and health services	Health district	Number of CHWs	Average total population	NGOs health programs	Flooding	Dominant season
Kouilou	Hinda_Loango	10	100,187	None	Yes	winters
Bouenza	Madingou	8	254,402	None	Not	winters
Niari	Dolisie	17	323,717	Yes	Not	winters
Pool	Kinkala	5	102,866	None	Not	winters
Plateaux	Gamboma	14	224,593	Yes	Yes	winters
Cuvette	Oyo	8	116,815	Yes	Yes	winters

3.2. CHWs and Health Indicators

Table 2 shows the cumulative averages of the monthly values of the health indicators before and after the intervention of CHWs, as well as the level of performance for each indicator in percentage points (pp). Significant increases were observed after the introduction of CHWs for the following indicators: ANC1 (+12.6 pp, $p < 0.001$); HIV testing (+29.7pp, $p < 0.001$); ANC4 (+5.6 pp, $p = 0.002$); TPI2 (+10.6 pp, $p = 0.008$); Pentavalent 1 (+28.9 pp, $p < 0.001$); Pentavalent 3 (+27.3 pp, $p < 0.001$); Vitamin A (+34.5 pp, $p < 0.001$); Curative consultations (+8.3 pp, $p = 0.004$). However, no significant difference was observed for HIV positivity rate and malaria hospitalizations between the pre- and post-intervention periods involving CHWs.

3.3. Effect of Community Health Workers on Health Indicators

The results for each indicator are presented in **Table 3**. The effect of CHWs on

Table 2. Comparative summary of the evolution of health indicators.

Indicator	Average Front	Average After	Variation (Percentage points)	p-value
Coverage in CPN1	30.6	43.2	12.6	<0.001
HIV testing rates	48.2	77.9	29.7	<0.001
HIV positivity rate	2.8	5.2	2.4	0.188
Coverage in CPN4	17.6	23.2	5.6	0.002
TPI2 Coverage	71.7	82.3	10.6	0.008
Vaccination coverage Penta 1	66.5	95.4	28.9	<0.001
Penta 3 Immunization Coverage	61.7	89.0	27.3	<0.001
Vitamin A supplementation coverage	64.0	98.5	34.5	<0.001
Rate of use of curative consultations	19.3	27.6	8.3	0.004
Malaria hospitalization rate	53.7	53.5	-0.2	0.957

Table 3. Effects on health indicators, final linear mixed regression model.

Variables	CPN1 (β [95% IC])	P	HIV testing (β [95% CI])	P	HIV positivity rate (β [95% CI])	P	CPN4 (β [95% IC])	P	TPI2 (β [95% IC])	P
After (ASC)	+35.26 [18.55, 51.96]	<0.001	+55.75 [33.72, 77.78]	<0.001	+6.74 [-7.51, 21.00]	0.351	+14.67 [5.57, 23.78]	0.002	+11.66 [-14.23, 37.56]	0.375
Time	+2.97 [1.97, 3.98]	<0.001	+5.32 [3.71, 6.94]	<0.001	+0.46 [-0.26, 1.17]	0.209	+2.03 [1.47, 2.59]	<0.001	+2.39 [0.53, 4.25]	0.012
OS Program*	+16.75 [-39.43, 72.94]	0.328	+14.29 [-95.47, 124.05]	0.632	-4.71 [-30.67, 21.25]	0.517	+3.28 [-51.60, 58.16]	0.821	-3.22 [-28.39, 21.96]	0.712
TSF Program**	+44.28 [-11.91, 100.46]	0.077	-28.36 [-138.12, 81.40]	0.382	-1.07 [-27.03, 24.90]	0.876	+18.08 [-36.80, 72.96]	0.292	-16.28 [-36.18, 3.63]	0.080
Flooding (Yes)	+4.26 [-51.92, 60.45]	0.775	+25.29 [-84.47, 135.05]	0.426	-2.23 [-28.19, 23.73]	0.747	-1.26 [-56.14, 53.62]	0.930	-	-
Dry season	+6.50 [2.32, 10.68]	0.003	+1.69 [-3.83, 7.20]	0.546	+2.05 [-1.52, 5.62]	0.258	+1.53 [-0.75, 3.81]	0.188	+4.74 [-1.74, 11.23]	0.150
Period \times Time	-3.15 [-4.31, -1.99]	<0.001	-4.86 [-6.39, -3.33]	<0.001	-0.53 [-1.52, 0.46]	0.289	-1.81 [-2.44, -1.17]	<0.001	-1.61 [-3.41, 0.19]	0.079

Variables	Penta1 (β [95% CI])	P	Penta3 (β [95% CI])	P	Vitamins A (β [95% CI])	P	Consultation curative (β [IC 95%])	P	Malaria-related hospitalization (β [IC 95%])	P
After (CHWS)	+165.59 [116.76, 214.42]	<0.001	+148.02 [106.52, 189.52]	<0.001	+197.96 [137.11, 258.80]	<0.001	+34.99 [21.48, 48.52]	<0.001	+12.56 [-6.87, 31.99]	0.203
Time	+8.49 [6.04, 10.94]	<0.001	+7.77 [5.69, 9.85]	<0.001	+7.24 [4.19, 10.30]	<0.001	+3.05 [2.37, 3.73]	<0.001	+1.60 [0.62, 2.57]	0.001
OS Program*	+38.89 [-37.77, 115.55]	0.161	+22.83 [-57.22, 102.88]	0.345	+2.86 [-199.40, 205.11]	0.957	+9.16 [-89.41, 107.73]	0.728	+16.16 [-4.06, 36.38]	0.075

Continued

TSF Program**	-16.83 [-93.49, 59.83]	0.445	-17.79 [-97.84, 62.26]	0.440	-5.28 [-207.53, 196.98]	0.921	-5.17 [-103.74, 93.40]	0.842	+58.36 [38.14, 78.58]	0.006
Flooding (Yes)	+10.03 [-66.63, 86.69]	0.630	+9.90 [-70.15, 89.95]	0.648	-21.24 [-223.50, 181.01]	0.696	+2.72 [-95.85, 101.29]	0.916	-62.87 [-83.09, -42.65]	0.006
Dry season	+4.19 [-8.03, 16.42]	0.499	+2.05 [-8.34, 12.44]	0.697	+9.54 [-5.70, 24.77]	0.218	+3.93 [0.54, 7.31]	0.023	+0.36 [-4.51, 5.23]	0.884
Period × Time	-12.89 [-16.28, -9.50]	<0.001	-11.56 [-14.44, -8.68]	<0.001	-13.53 [-17.76, -9.31]	<0.001	-3.43 [-4.37, -2.49]	<0.001	-1.73 [-3.08, -0.38]	0.012

*Interventions of the World Health Organization (WHO) Operational Strategy at the Health District Level **Interventions of the Non-Governmental Organization Terre Sans Frontières (TSF) at the Health District Level.

each health indicator is described below:

Antenatal care 1 (ANC1) coverage

CHWs significantly increased the coverage of first antenatal care visits (ANC1) by 35.3 percentage points (95% CI: 18.6 - 52.0; $p < 0.001$). The time factor was also significant, showing an average positive trend of 3.0 percentage points per month (95% CI: 2.0 - 4.0; $p < 0.001$). In addition, the dry season was associated with a significant increase in coverage (+6.5 percentage points; $p = 0.003$). No significant effects were observed for the other adjusted variables, such as specific programs or flooding. However, the interaction between the post-intervention period and time was negative and significant, indicating a gradual loss of momentum in the effect of CHWs on this indicator over time (-3.2 percentage points per month; 95% CI: -4.3 to -2.0; $p < 0.001$).

HIV Testing at ANC1

CHWs significantly increased the rate of HIV testing at first antenatal care visits (ANC1) by 55.8% (95% CI: 33.7 - 77.8; $p < 0.0001$). The time factor was also significant ($p < 0.0001$; 95% CI: 3.7 - 6.9), indicating an overall positive trend. In contrast, the significant negative interaction (CI 95: -6.4 - -3.3; $p < 0.0001$) indicates that the effect of CHWs in this indicator decreases over time. No statistically significant effects were observed for the other factors examined, including associated programs, seasonality, and flooding.

HIV positivity rate among pregnant women (ANC1)

CHWs did not have a significant impact on the HIV positivity rate among pregnant women at the first antenatal visit (ANC1). No other factors included in the analysis (complementary programs, weather, floods, and dry season) also showed a statistically significant effect. These results suggest that the integration of CHW does not directly influence the HIV positivity rate.

Antenatal care 4 (ANC14) coverage

CHWs was associated with a significant improvement in ANC4 coverage, estimated at 14.7% (IC 95: 5.6 - 23.8; $p < 0.002$). The time factor also shows a significant positive effect (IC 95: 1.5 - 2.6; $p < 0.0001$). The term interaction is negative and significant (CI95: -2.4 - -1.2; $p < 0.0001$), reflecting a gradual weakening of

the effect of CHW on this indicator. The other variables, such as non-governmental organization health programmes and dry season or floods did not have a significant effect.

Intermittent preventive treatment (IPT2) regimens for malaria coverage

CHWs did not significantly influence the coverage of intermittent preventive treatment (IPT2), although a marginal trend towards a gradual decrease in its effect was observed (Period After \times Time interaction: $\beta = -1.61$; $p = 0.079$; IC 95: $-3.4 - 0.2$). However, an overall significant improvement in the indicator is found over time regardless of the intervention ($\beta = 2.39$; CI 95: $0.5 - 4.2$; $p = 0.012$). No other factors (complementary programs and seasonality) had a significant effect.

Penta 1 vaccination coverage

CHWs had a very significant effect on Pentavalent 1 vaccination coverage, with an estimated increase of 165.6% ($p < 0.0001$; IC 95: $116.8 - 214.4$). The time factor also reinforces this dynamic (IC 95: $6.0 - 10.9$; $p < 0.0001$). Nevertheless, the significant negative interaction ($p < 0.0001$) suggests a reduction in effect over time. None of the other factors (programmes, season, floods) were significantly influenced by this indicator.

Pentavalent 3 immunization Coverage

Similar to the first dose, Pentavalent 3 coverage increased significantly with CHWs intervention, with an estimated effect of 148% (IC 95: $106.5 - 189.5$; $p < 0.0001$). Time also plays a significant positive role ($p < 0.0001$; IC 95: $5.7 - 9.9$). The negative period \times time interaction is also significant (CI95: $-14.4 - -8.7$; $p < 0.0001$), indicating a gradual decrease in effect over time. No other variables analyzed showed a statistically significant effect.

Vitamin A supplementation coverage

CHWs were associated with a highly significant improvement in vitamin A supplementation coverage, estimated at 198% (95% CI: $137.1 - 258.8$; $p < 0.0001$). The time variable significantly contributed to the observed improvement ($p < 0.0001$; 95% CI: $4.2 - 10.3$). However, the interaction between period and time was negative and significant (95% CI: -17.8 to -9.3 ; $p < 0.0001$), suggesting a progressive reduction in the intervention effect over time. No other variables, such as associated programs, flooding, or dry season, showed statistically significant effects.

Use of services (Curative consultations)

CHWs had a significant positive impact on curative consultations, with an estimated increase of 35% ($p < 0.0001$; 95% CI: $21.5 - 48.5$). Time was also strongly associated with an increase in consultations (95% CI: $2.4 - 3.7$; $p < 0.0001$). The dry season showed a moderate but significant effect (95% CI: $0.5 - 7.3$; $p = 0.0233$), while the period-by-time interaction indicated a significant decrease in effect over time ($p < 0.0001$; 95% CI: -4.4 to -2.5). None of the other adjusted variables had a significant effect on this indicator.

Malaria-related hospitalization

In contrast, the time factor ($p = 0.0015$; 95% CI: $0.6 - 2.6$), TSF programs ($p = 0.0064$; 95% CI: $38.1 - 78.6$), flooding ($p = 0.0055$; 95% CI: -83.1 to -42.7), and

the interaction between period and time ($p = 0.0124$; 95% CI: -3.1 to -0.4) all exhibited statistically significant effects. These findings suggest that changes in hospitalization rates are more influenced by structural or environmental factors than by the community intervention itself.

4. Discussion

This study provides empirical evidence suggesting an improvement in several health district performance indicators after the introduction of Community Health Workers (CHWs). However, this relationship should be interpreted with caution. Overall, the introduction of CHWs appears to have contributed to a significant improvement in the majority of health performance indicators analyzed. This trend confirms observations in other African and international contexts, where CHWs have been shown to be effective vectors for expanding health care coverage [9] [16]-[18].

Significant improvements have been observed in indicators such as coverage of antenatal consultations (ANC1 and ANC4), vaccination (Pentavalent 1 and 3), vitamin A supplementation, and the rate of use of curative services. These results are consistent with the findings reported by Gilmore in a review of developing countries [19]. Moreover, Berini *et al.*, in a review conducted in the United States, concluded on the same effects [20].

These improvements suggest that CHWs have been a catalyst for access to care [20]. Their proximity to communities, their knowledge of the field, their ability to establish a relationship of trust with the population, and their role as relays between households and health facilities may be factors that have facilitated this increase in indicators. This contribution is all the more relevant in a context marked by the chronic shortage of qualified personnel and the difficulty of access to health facilities in rural or peri-urban areas [4]. Indeed, by providing a link between the community and health care structures, CHWs have made it possible to reduce geographical and cultural barriers [9].

The effectiveness of CHWs on immunization coverage and antenatal care indicators is consistent with the results of similar studies conducted in Ethiopia or Rwanda, where the structured integration of CHWs has resulted in a rapid and sustained increase in attendance at basic services [16] [21]. This dynamic reveals not only their ability to mobilize communities, but also their potential to support the achievement of universal health coverage [2].

However, certain indicators, such as HIV seroprevalence rates and malaria-related hospitalizations, did not show any significant change after the introduction of Community Health Workers (CHWs). This observation can be explained by the nature of these indicators, which depend not only on community mobilization but also on structural factors within the health system. More specifically, several obstacles may have limited the potential impact of CHWs on more complex clinical outcomes. These include the limited availability of diagnostic tools at the community level (e.g., rapid HIV tests, rapid malaria diagnostic tests), irregular supply of

medicines, particularly for antimalarial treatments, and insufficient capacity of referral facilities to manage severe or complicated cases. This suggests that, while CHWs play a vital role in detection, education and referral at the community level, their efforts alone are not sufficient to influence outcomes that depend on the functioning of higher levels of the healthcare system [3].

In addition, the analysis shows that the positive effect of Community Health Workers (CHWs) decreases over time across several indicators. The observed decline in CHW impact over time may be attributed to the weakening of key programmatic components necessary for sustaining their performance. Evidence from similar settings highlights the importance of continuous support mechanisms, including performance-based incentives, access to refresher training, and clearly defined career pathways [7] [22]. Without these structural supports, CHW motivation and service quality tend to deteriorate, ultimately reducing program effectiveness. These findings underscore the critical importance of ensuring long-term supervisory structures and support systems to preserve and build upon initial gains [3].

Finally, certain contextual variables (dry season, floods, parallel programs) also influenced the performance of the districts, reminding us that the action of the CHWs is part of a broader ecosystem, where several factors can potentiate or hinder the effects of their intervention.

This study is distinguished by its quasi-experimental before-and-after methodology, based on a longitudinal ecological design covering a period of 24 months without a control group. It is based on the use of routine data aggregated monthly, from the national health information system (DHIS2), and on adjusted statistical analyses taking into account several potentially confounding contextual factors.

However, several limitations should be acknowledged that may affect the robustness of the findings. First, the absence of a control group due to the nationwide simultaneous introduction of CHWs precluded the establishment of a valid comparison condition, thereby limiting the strength of causal inferences. Second, although the pre-intervention period spanned 12 months, allowing for the inclusion of a full seasonal cycle, challenges remain. A one-year baseline may be insufficient to fully capture long-term secular trends or interannual variability in health indicators. This limitation may compromise the stability of baseline trends and reduce the power of causal inference in interrupted time-series analyses. Longer pre-intervention periods would enable more robust trend estimation and improve the reliability of attributing observed changes to the intervention. Finally, while the model adjusts for key contextual and time-varying factors such as seasonality, presence of NGOs program, and CHWs density, residual confounding cannot be ruled out. Important contextual variables including socio-economic disparities and local variations in resource availability were not captured and may have influenced the outcomes. Therefore, the estimated effects of CHWs should be interpreted with caution, as they represent an approximation within a complex and heterogeneous real-world implementation context.

5. Conclusion

The study shows a positive impact of CHWs on several health indicators in health districts. Results are in favor of strengthening CHWs programs as levers to strengthen health indicators in health districts with a low ratio of health workers, to increase the chances of moving towards achieving the objectives of universal health coverage. In this regard, challenges related to governance and financing of national community health strategies, as well as the training and motivation of CHWs, must be addressed in order to stimulate and maintain the benefits of care in local communities.

Acknowledgements

We sincerely thank the Ministry of Health and Population of the Republic of Congo for granting access to the DHIS2 platform, which greatly facilitated data collection and analysis. We also wish to acknowledge all those who contributed to the completion of this work.

Author Contribution

D. R. N. M. and G. N. conceptualized the study and manuscript. D. R. N. M. conducted field data collection. D. R. N. M., J. A. N., and J. M. performed the statistical analyses. G. N., C. A. N., G. E. M., and P. L. contributed to supervision, database visualization, and manuscript review and editing. All authors read and approved the final version of the manuscript prior to submission.

Data Availability

The source data used in this study are available on the DHIS2 platform of the Ministry of Health and Population of the Republic of Congo, and can be obtained upon simple request addressed to the institution. However, the specific dataset used for the analysis and preparation of this manuscript is available from the corresponding author, R. D. M. N., upon reasonable request.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

- [1] WHO (2016) Global Strategy on Human Resources for Health: Workforce 2030. World Health Organization.
- [2] Afzal, M.M., Pariyo, G.W., Lassi, Z.S. and Perry, H.B. (2021) Community Health Workers at the Dawn of a New Era: 2. Planning, Coordination, and Partnerships. *Health Research Policy and Systems*, **19**, Article No. 103. <https://doi.org/10.1186/s12961-021-00753-7>
- [3] Asweto, C.O., Alzain, M.A., Andrea, S., Alexander, R. and Wang, W. (2016) Integration of Community Health Workers into Health Systems in Developing Countries: Opportunities and Challenges. *Family Medicine and Community Health*, **4**, 37-45.

- <https://doi.org/10.15212/fmch.2016.0102>
- [4] Ballard, M. and Montgomery, P. (2017) Risk of Bias in Overviews of Reviews: A Scoping Review of Methodological Guidance and Four-Item Checklist. *Research Synthesis Methods*, **8**, 92-108. <https://doi.org/10.1002/jrsm.1229>
- [5] Franklin, C.M., Bernhardt, J.M., Lopez, R.P., Long-Middleton, E.R. and Davis, S. (2015) Interprofessional Teamwork and Collaboration between Community Health Workers and Healthcare Teams: An Integrative Review. *Health Services Research and Managerial Epidemiology*, **2**. <https://doi.org/10.1177/2333392815573312>
- [6] Ignoffo, S., Gu, S., Ellyin, A. and Benjamins, M.R. (2023) A Review of Community Health Worker Integration in Health Departments. *Journal of Community Health*, **49**, 366-376. <https://doi.org/10.1007/s10900-023-01286-6>
- [7] Perry, H.B., Zulliger, R. and Rogers, M.M. (2014) Community Health Workers in Low-, Middle-, and High-Income Countries: An Overview of Their History, Recent Evolution, and Current Effectiveness. *Annual Review of Public Health*, **35**, 399-421. <https://doi.org/10.1146/annurev-publhealth-032013-182354>
- [8] Uta Lehmann, D.S. (2013) Community Health Workers: What Do We Know about Them? The State of the Evidence on Programmes, Activities, Costs and Impact on Health Outcomes of Using Community Health Workers. CHW Central. <https://chwcentral.org/resources/community-health-workers-what-do-we-know-about-them-the-state-of-the-evidence-on-programmes-activities-costs-and-impact-on-health-outcomes-of-using-community-health-workers/>
- [9] Knowles, M., Crowley, A.P., Vasan, A. and Kangovi, S. (2023) Community Health Worker Integration with and Effectiveness in Health Care and Public Health in the United States. *Annual Review of Public Health*, **44**, 363-381. <https://doi.org/10.1146/annurev-publhealth-071521-031648>
- [10] Ministère de la santé et de la population (2024) Plan national de développement sanitaire (PNDS) 2023-2026. <https://sante.gouv.cg/plan-national-de-developpement-sanitaire-2023-2026/>
- [11] République du Congo. Décret n° 2020-551 portant organisation et fonctionnement des organes de gestions du districts sanitaires.
- [12] Ministère de la santé et de la population (2016) Revue du secteur de la sante au Congo.
- [13] World Bank Open Data (2018). <https://data.worldbank.org>
- [14] Ministère de la Santé et de la Population (MSP) (2024) Rapport d'analyse de la maturité du système de santé communautaire. Brazzaville, Août.
- [15] Dehnavieh, R., Haghdoost, A., Khosravi, A., Hoseinabadi, F., Rahimi, H., Poursheikhali, A., et al. (2018) The District Health Information System (DHIS2): A Literature Review and Meta-Synthesis of Its Strengths and Operational Challenges Based on the Experiences of 11 Countries. *Health Information Management Journal*, **48**, 62-75. <https://doi.org/10.1177/1833358318777713>
- [16] Conley, T. (2017) Case Studies of Large-Scale Community Health Worker Programs: Examples from Afghanistan, Bangladesh, Brazil, Ethiopia, Niger, India, Indonesia, Iran, Nepal, Pakistan, Rwanda, Zambia, and Zimbabwe. <https://www.mcsprogram.org/wp-content/uploads/2017/01/CHW-CaseStudies-Globes.pdf>
- [17] High-Impact Practices in Family Planning (HIPs) (2015) Community Health Workers: Bringing Family Planning Services to Where People Live and Work. USAID. <https://www.fphighimpactpractices.org/briefs/community-health-workers/>
- [18] Scott, K., Beckham, S.W., Gross, M., Pariyo, G., Rao, K.D., Cometto, G., et al. (2018)

- What Do We Know about Community-Based Health Worker Programs? A Systematic Review of Existing Reviews on Community Health Workers. *Human Resources for Health*, **16**, Article No. 39. <https://doi.org/10.1186/s12960-018-0304-x>
- [19] Gilmore, B. and McAuliffe, E. (2013) Effectiveness of Community Health Workers Delivering Preventive Interventions for Maternal and Child Health in Low- and Middle-Income Countries: A Systematic Review. *BMC Public Health*, **13**, Article No. 847. <https://doi.org/10.1186/1471-2458-13-847>
- [20] Berini, C.R., Bonilha, H.S. and Simpson, A.N. (2021) Impact of Community Health Workers on Access to Care for Rural Populations in the United States: A Systematic Review. *Journal of Community Health*, **47**, 539-553. <https://doi.org/10.1007/s10900-021-01052-6>
- [21] Admassie, A., Abebaw, D. and Woldemichael, A.D. (2009) Impact Evaluation of the Ethiopian Health Services Extension Programme. *Journal of Development Effectiveness*, **1**, 430-449. <https://doi.org/10.1080/19439340903375724>
- [22] Ballard, M. and Montgomery, P. (2017) Systematic Review of Interventions for Improving the Performance of Community Health Workers in Low-Income and Middle-Income Countries. *BMJ Open*, **7**, e014216. <https://doi.org/10.1136/bmjopen-2016-014216>