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Explanatory Factors of Poor Performance in the Routine Distribution of Insecticide-Treated Nets through Immunization Services in the Democratic Republic of Congo

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Abstract

Background: The coverage obtained after mass distribution of insecticide-treated nets (ITNs) requires continuous distribution, particularly through antenatal care (ANC) and Expanded Programme for Immunizations (EPI) channels, to achieve the expected impact in terms of mortality and morbidity reduction. The aim of this study was to identify the factors explaining the poor performance of continuous ITN distribution in public healthcare facilities (PHFs) through EPIs in the Democratic Republic of the Congo (DRC). **Methods:** An analytical cross-sectional study was carried out in the PHFs of the DRC's 7 Provincial Health Divisions (PHDs). Data on socio-demographic characteristics, ITN distribution, and the first measles vaccination dose from January to June 2023 were collected. Data was collected through ODK Collect tools, then transferred to SPSS for Windows version 26 for analysis. Logistic regression was used to identify factors associated with poor ITN distribution performance. **Results:** Overall, 66.9% of health areas demonstrated poor ITN distribution performance through EPI services. A 34% gap was observed between children receiving measles vaccination and those receiving ITNs. Independent predictors of poor performance included low maternal education (adjusted odds ratio [aOR]: 8.22; 95% CI: 5.59 - 12.09), low household income (aOR: 5.00; 95% CI: 3.40 - 7.35), incomplete child immunization (aOR: 4.49; 95% CI: 2.06 - 9.80), and lack of community sensitization by health workers (aOR: 3.03; 95% CI: 2.02 - 4.56). Providers cited unequal prioritization of ITNs for pregnant women, lack of ITNs at outreach sites, and weak community engagement as key barriers. **Conclusion:** ITN distribution through EPI services in the DRC is suboptimal and inequitable. Addressing socioeconomic disparities, strengthening community health worker engagement, and ensuring ITN availability at all service delivery points are critical to improving coverage among children under five.

Keywords

Insecticide-Treated Mosquito Nets, Preschool Preventive Health Services, Antenatal Care, Performance, Democratic Republic of Congo

1. Introduction

Globally, in 2023, the number of malaria cases was estimated at 263 million, with an incidence of 60.4 cases per 1000 population at risk [1]. The WHO African Region continues to carry the heaviest burden of the disease, accounting for an estimated 94% of malaria cases worldwide in 2023 [1]. Five countries—Nigeria (25.9%), the Democratic Republic of the Congo (DRC) (12.6%), Uganda (4.8%), Ethiopia (3.6%), and Mozambique (3.5%)—accounted for just over half of all cases [1].

Malaria is a major public health concern in the Democratic Republic of Congo (DRC). The latest demographic and health survey, conducted in 2023-2024, showed that 20% of children under 5 had a fever in the two weeks preceding the interview [2]. For 51% of them, advice or treatment was sought. Just over a third of children (35%) were diagnosed with malaria. Malaria remains one of the most prevalent diseases in the DRC, contributing to a high infant mortality rate estimated at 93 deaths per 1000 live births [2].

Vector control with insecticide-treated nets (ITNs) is one of the key strategies for malaria prevention and has contributed to a decrease in malaria worldwide [3] [4]. The use of LLINs has risen sharply in sub-Saharan Africa over the last two decades, leading to a significant drop in malaria morbidity and mortality [5]-[8].

To tackle malaria endemic in DRC, the National Malaria Control Program (NMCP) has developed a National Malaria Control Strategic Plan 2024-2028 (NSP 2024-2028) aligned with the Global Technical Malaria Control Strategy 20216-2030 (GTS 2016-2030) [9]. In this NSP, the specific expected vector control outcome is to reach 80% of the population using ITNs [9]. To achieve this, two main categories of ITN distribution are advocated in the strategic plan, namely successive mass campaign distribution and continuous distribution during antenatal care (ANC), Expanded Programme for Immunizations (EPI) services for children under one year of age, as well as school distribution in selected provinces [9].

The expected results of distribution through these different channels is a rapid increase in coverage after mass ITN distribution campaigns, with coverage maintained between campaigns that are spaced no more than three years apart according to WHO recommendations [10]. With 4% of the population represented by pregnant women expected at ANC and around 3.6% of surviving infants expected at EPI services, anticipating recoveries of children with delayed completion of the immunization schedule, the NMCP expects to deploy ITNs equivalent to around 7.6% of the population each year [9]. This makes an annual coverage potential of 15.2% of the population if we consider the WHO standard of one ITN for every two people [11]. However, the successive results of Malaria Performance Reviews (MPR) repeatedly show that in the DRC, there is non-compliance with ITN renewal intervals by campaigns, with delays of up to 5 years, making the need for optimal continuous distribution crucial [12].

Yet the results obtained from these distributions remain inadequate, especially in distribution through ANC and EPI, with 66% and 55% performance, respectively [13]. The disparity in ITN coverage between pregnant women attending ANC and infants at EPI services is evident across most health zones, even when ITNs are adequately available. One contributing factor is that pregnant women who miss ITNs due to stock shortages are often compensated later, whereas infants who miss ITNs during EPI visits rarely recover.

These findings prompt a critical question: What factors contribute to the poor performance of ITN distribution through EPI services in the affected health zones? Identifying these determinants is essential to inform targeted interventions and improve implementation quality. This study aimed to investigate the underlying causes of suboptimal ITN distribution in public health facilities across the Democratic Republic of Congo.

2. Materials and Methods

2.1. Study Design and Population

We conducted a cross-sectional analytical study to assess the performance of insecticide-treated net (ITN) distribution through routine Expanded Programme on Immunization (EPI) services in public health facilities across seven Provincial Health Divisions (PHDs) in the Democratic Republic of Congo (DRC).

Only public health facilities supported by the Global Fund through SANRU were included in the sampling frame. The Global Fund, through SANRU, implements continuous ITN distribution activities in 17 provinces of the DRC. The Global Fund, through SANRU as principal recipient, implements continuous ITN distribution activities in 17 provinces of the DRC.

The study population consisted of all children aged 6 to 23 months received at the EPI and all pregnant women received at the ANC services; mothers or child keepers of children aged 6 to 23 months for the household side of the survey.

2.2. Sample Size Calculation

The sample size for the quantitative component was calculated using the formula for estimating a proportion in a population:

$$n = \left(Z^2 \cdot p \cdot (1-p)\right) / d^2$$

where: i) n is the required sample size, ii) Z is the Z-score corresponding to the desired confidence level (1.96 for 95%), iii) p is the estimated prevalence of poor ITN distribution performance (assumed at 50% to maximize sample size), and iv) d is the margin of error (set at 5%).

Based on these assumptions, the minimum sample size required was 384 households. To account for design effect due to cluster sampling and potential non-response, the sample size was increased by a factor of 3.25, resulting in a final target of approximately 1247 households. This adjustment ensures adequate statistical power and reliability of the findings. The calculation was performed manually and cross-validated using Epi Info software version 7.2.

2.3. Sampling Procedures

A multi-stage cluster sampling approach was used to select study participants. Among the 17 Provincial Health Divisions (PHDs) supported by the Global Fund through SANRU, seven were purposively selected based on the degree of discrepancy observed between ITN distribution at ANC and EPI services, as reported in the national DHIS2 database. This included three PHDs with lower discrepancies and four with higher discrepancies. Based on this rationale, we selected Kinshasa, Kongo Central, Kwilu, Nord Kivu, Tshopo, Sud Ubangi, and Equateur (**Figure 1**).

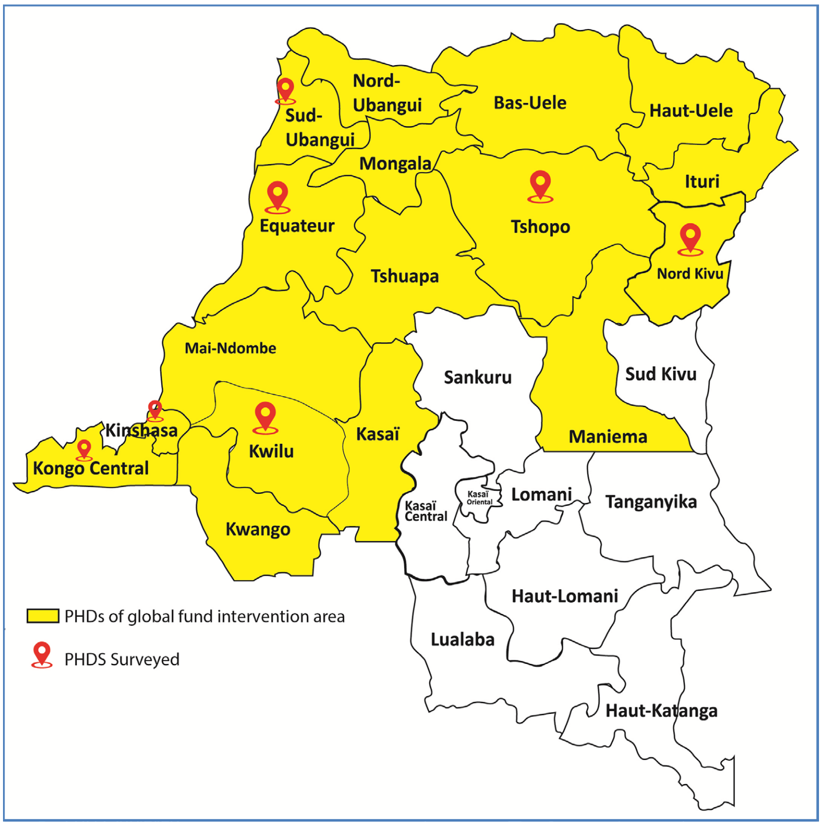

Figure 1. Mapping of the provincial health division sampled for the survey.

Within each selected PHD, three health zones (HZs) were randomly chosen, except for Kinshasa, where eight HZs were included due to its larger population and greater observed disparity. In total, 26 HZs were surveyed, representing 8.1% of all HZs in the country.

In each HZ, six health areas (HAs) were randomly selected using the cluster Lot Quality Assurance Sampling (cLQAS) method. Within each HA, ten villages were randomly selected, and one household per village was chosen through segment sampling. Households were visited sequentially until one with an eligible child aged 6 to 23 months was identified, based on the assumption—derived from the 2017-2018 MICS survey—that 60% of households include at least one child under five [14].

This sampling strategy was designed to ensure geographic diversity and representation of both urban and rural settings, while maintaining feasibility within logistical constraints.

For the household survey, the following inclusion and exclusion criteria were used:

Inclusion Criteria:

- Households with at least one child aged 6 to 23 months.
- Mothers or primary caregivers who were present and consented to participate.
- Children who had received at least one routine immunization during the study period (January-June 2023).

Exclusion Criteria

- Households without children in the target age group.
- Caregivers who declined to participate or were unavailable during the survey visit.
- Children who had not received any routine immunization during the study period.

In parallel, institutional visits were conducted in the selected health areas to assess ITN distribution practices at the facility level. At this level, the following inclusion and exclusion criteria were used:

Inclusion Criteria

- Health workers are directly involved in ITN distribution through EPI services (e.g., nurses and vaccinators).
- Staff members of the health zone management team (HZMT) are responsible for supervision and logistics.
- Providers present at the time of the survey and willing to participate.

Exclusion Criteria

- Providers not involved in ITN distribution or EPI service delivery.
- Staff unavailable or unwilling to participate during the survey period.

2.4. Data Collection

Data were collected between January and June 2023 using structured questionnaires administered to mothers or primary caregivers of children aged 6 to 23 months in selected households. The questionnaires captured information on socio-demographic characteristics, child immunization status, and receipt of insecticide-treated nets (ITNs) through EPI services.

Data collection was conducted electronically using the ODK Collect mobile application. Trained field investigators visited each selected household and obtained written informed consent prior to administering the survey. For each eligible child, data were cross-verified with vaccination cards and facility registers when available.

In parallel, institutional data were extracted from health facility records in the selected health areas. This included monthly tallies of ITNs received and distributed through ANC and EPI services, as well as the number of children vaccinated with the first dose of measles vaccine. Registers reviewed included EPI service logs, ANC attendance records, stock cards, and essential drug registers.

All data were transferred to SPSS version 26 for cleaning and analysis. Quality control procedures included daily review of submissions, validation checks, and supervision by the central research coordination team.

The household questionnaire was developed by the SANRU's Operational Research Unit in collaboration with experts from the Ministry of Health. It was designed to capture key variables related to ITN distribution performance, including child immunization status, ITN receipt, socio-demographic characteristics of caregivers, and exposure to community sensitization activities.

The initial draft of the questionnaire was reviewed by a panel of public health specialists and field supervisors to ensure content validity and contextual relevance. The tool was then pre-tested in two non-sampled health zones to assess clarity, flow, and respondent comprehension. Feedback from the pilot was used to refine question wording, response options, and skip logic.

The final version of the questionnaire was digitized using the ODK Collect platform, with built-in validation rules to minimize data entry errors and ensure consistency across interviews. Enumerators received standardized training on questionnaire administration and ethical procedures prior to field deployment.

2.5. Data Analysis

All quantitative data were exported from the ODK Collect platform and analyzed using SPSS version 26. Descriptive statistics were used to summarize socio-demographic characteristics and ITN distribution indicators. Categorical variables were presented as frequencies and percentages, while continuous variables were summarized using means and standard deviations or medians and interquartile ranges, depending on the distribution.

The primary outcome was poor ITN distribution performance, defined as a positive difference between the number of ITNs distributed through ANC services and those distributed through EPI services within the same health facility. Bivariate analysis was conducted using the chi-square test to assess associations between independent variables and the outcome.

Multivariate analysis was performed using logistic regression to identify independent predictors of poor ITN distribution performance. Adjusted odds ratios (aORs) and 95% confidence intervals (CIs) were calculated. Statistical significance was set at a p-value < 0.05.

2.6. Ethical Considerations

This study was conducted with the formal authorization of the Ministry of Public Health of the Democratic Republic of Congo. Prior to data collection, institutional approval was obtained from provincial health authorities and relevant program managers overseeing malaria control and immunization services.

All participants were informed of the study's objectives, procedures, and their rights as respondents. Written informed consent was obtained from literate participants before administering the questionnaire. For participants who were illiterate, verbal consent was obtained following a standardized explanation of the study in the local language, in the presence of a neutral witness who confirmed the participant's understanding and voluntary agreement to participate.

Participation was entirely voluntary, and respondents were informed of their right to decline or withdraw at any time without any consequences. No personal identifiers were collected, and all data were anonymized to ensure confidentiality and privacy.

3. Results

3.1. Socio-Demographic Characteristics of Mothers and Children

Table 1 shows the characteristics of the surveys according to whether they had already been vaccinated or not.

Table 1. Socio-demographic characteristics of mothers and children.

Variables	Numbers (n = 1247)	%
Age of mothers, in years[a]	28.4	(±6.6)
Number of children in household[b]	2	(1 - 3)
Age of the last child, in months[a]	15.0	(±4.3)
Age at receipt of measles vaccine, in months[a]	9.4	(±1.1)
9 months	1087	87.2
10 - 12 months	118	9.5
13 - 15 months	42	3.4
Place of receipt of measles vaccine		
Health center	1247	100
Advanced activity in the community	0	0

Continued

Sensitisation of mothers by CHWs		
Yes	981	78.7
No	266	21.3
Mother's marital status		
Married	965	77.4
Single	229	18.4
Divorced	28	2.2
Widowed	25	2.0
Mother's education level		
Primary and unschooled	253	20.3
Secondary	763	61.2
Higher	167	13.4
University	64	5.1
Mother's occupation		
Housekeeper	470	37.7
Civil servant	172	13.8
Liberal	355	28.5
No profession	250	20.0
Monthly income		
Low level	683	54.8
Medium level	346	27.7
High level	218	17.5
Type of dwelling		
Shanty	93	7.5
House made of durable materials	508	40.7
House made of earth	646	51.8

a: x ± SD; b: median (EIQ).

Table 1 shows that the age of the mothers interviewed was 28.4 years, with a median of 2 children at home. The average age of the last child was 15 months. Most of these children (87.2%) received the measles vaccine at 9 months of age during vaccination sessions at the health center. Most mothers (78.7%) had been sensitized by community health workers (CHWs). Most of the mothers were married, had a secondary education, were housewives, had a low level of education, and lived in mud houses.

3.2. Results of ITN Distribution in EPI and ANC Services

Table 2 presents the results obtained from the continuous distribution of ITNs to children under one year of age during the EPI services and to pregnant women during the ANC services.

Table 2. Summary table of children received in CPS, MIIs received, MIIs distributed, and measles vaccine dose (VAR).

Month	Children received	ITN* received	ITN distributed	ITN distributed in ANC[£]	ITN distributed in EPI	Number of measles vaccine doses	Gap measles vaccine-ITN[a]	% difference[b]
January	59,949	10,472	13,250	6696	6554	7188	634	8.8%
February	28,853	9953	11,630	6649	4981	7559	2578	34.1%
March	30,412	15,459	13,513	8258	5255	8471	3216	38.0%
April	30,818	15,536	14,470	8458	6012	8041	2029	25.2%
May	33,833	12,632	13,267	7550	5717	12460	6743	54.1%
June	31,711	19,188	14,539	8351	6188	8674	2486	28.7%
Total	215,576	83,240	80,669	45,962	34,707	52,393	17,686	33.8%

ITN*: Insecticide-Treated Bed Net; ANC[£]: Antenatal Care; Gap measles vaccine-ITN[a]: Number of children vaccinated with measles vaccine minus number of children receiving insecticide-treated bed nets. % difference[b]: Gap measles vaccine-ITN divided by number of children vaccinated with the measles vaccine.

Of the total number of ITNs distributed (80,669), 43.0% (34,707) concerned children in SPC and 57% (45,962) concerned pregnant women in ANC. The difference between children who received the first dose of the measles vaccine (MV1) and those who received ITNs was 34%, with monthly peaks of up to 54%. There was a 34% difference between children who received MV1 and those who received ITNs, with monthly peaks of up to 54% (Table 2).

Figure 2 shows that of all ITNs received, 55.2% were distributed to pregnant women and 41.7% to children at the EPI services. This figure shows that the gap between ITN distribution at the EPI and MV1 vaccination was almost constant every month.

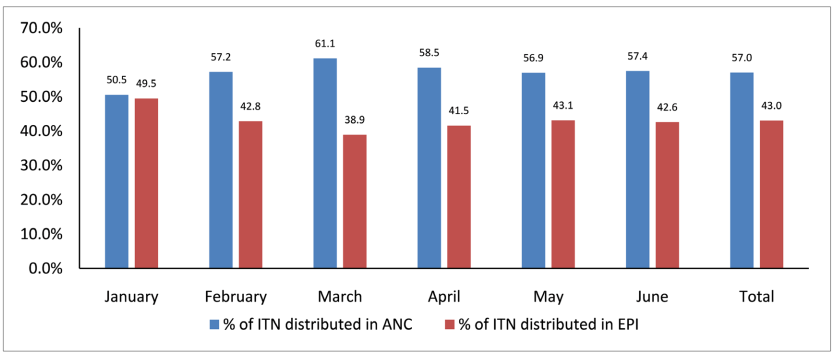

Figure 2. Proportion of ITNs distributed in ANC and EPI services.

This figure shows that of all ITNs distributed, 57% were distributed to pregnant women in ANC services and 43% to children in EPI services. This more frequent distribution to pregnant women at ANC compared with children at EPI services was constant almost every month.

Of the 151 HAs surveyed, 101 showed poor performance of MIIs distribution in EPI services, *i.e.*, a frequency of 66.9% (Figure 3).

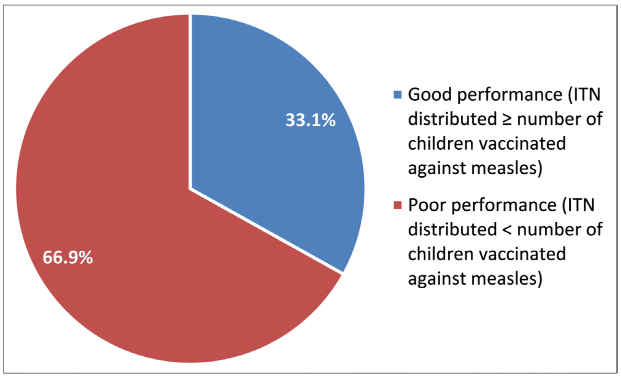

Figure 3. Overall frequency of poor performance in all PHDs surveyed.

3.3. Factors Associated with the Poor Performance of ITNs Distribution in EPI Services

Table 3 shows the factors associated with poor performance, based on data from the household survey.

Table 3. Factors associated with the poor performance of ITNs distribution in EPI services.

Variables	n	Good performance	Poor performance	OR (CI 95%)	ORa (CI 95%)
Marital status					
Living with spouse	965	323 (32.4)	652 (67.6)	1.15 (0.87 - 1.51)	-
Living without spouse	282	100 (35.5)	182 (64.5)	1	
Education					
Low	1016	230 (22.6)	786 (77.4)	3.03 (2.80 - 4.92)	8.22 (5.59 - 12.09)
High	231	183 (79.2)	48 (20.8)	1	1
Mother's occupation					
Housemaid	470	149 (31.7)	321 (68.3)	1.25 (0.91 - 1.73)	-
Public employee	172	55 (32.0)	117 (68.0)	1.24 (0.82 - 1.87)	-
Self-employed	355	117 (33.0)	238 (67.0)	1.18 (0.84 - 1.66)	-
No profession	250	92 (36.8)	158 (63.2)	1	
Monthly income					
Low	1028	248 (24.1)	780 (75.9)	9.61 (6.85 - 13.49)	5.00 (3.40 - 7.35)
High	219	165 (75.3)	54 (24.7)	1	1

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Type of dwelling					
Shanty	93	30 (32.3)	63 (67.7)	0.90 (0.56 - 1.44)	-
Earthen house	646	207 (32.0)	439 (68.0)	1.01 (0.63 - 1.61)	-
House of durable material	508	176 (34.6)	332 (65.4)	1	
Children fully vaccinated					
Yes	101	9 (8.9)	92 (91.1)	5.57 (2.78 - 11.15)	4.49 (2.06 - 9.80)
No	1146	404 (35.3)	742 (64.7)	1	1
Sensitization by CHW on ITN use					
Yes	266	42 (15.8)	224 (84.2)	3.24 (2.28 - 4.62)	3.03 (2.02 - 4.56)
No	981	371 (37.8)	610 (62.2)	1	1

In both univariate and multivariate analyses, the mother's low level of education, low level of income, complete immunization of the child, and mother/caregiver sensitization by CHWs were the determinants significantly associated with poor performance of ITN distribution in EPI services.

3.4. Explanatory Factors for Poor Performance in ITN Distribution at EPI Services

The factors explaining the poor performance of ITN distribution at EPI, according to the opinions of the players involved in the ITN distribution service chain for children at EPI services, are presented in **Table 4**.

Table 4. Factors associated with poor ITN distribution performance in EPI service

Explanatory factors	Numbers	%
Inequality of ITN delivery between pregnant women, who are more numerous, and children	40	33.1
Advanced sites not supported with ITNs*	28	23.1
Low involvement of CHWs[£] in sensitizing mothers to respond to the RDV[¥]	20	16.5
Weakness of mothers to bring children if they have completed all vaccines	16	13.2
Pregnant women are preferred over children if ITNs are insufficient	14	11.6
Mothers' disinterest in attending the RDV	2	1.7
ITNs are only given to children who have completed all vaccines	1	0.8

ITN*: Insecticide-Treated Bed Net; CHWs[£]: Community Health Workers; RDV[¥]: Rendez-vous.

The first 3 explanatory factors mentioned were: the influx of more pregnant women to ANC than children for vaccination (33.1%), advanced sites not supported by ITNs (23.1%), and the low involvement of CHWs in making mothers aware of the need to attend the next appointment.

4. Discussion

This study explored the determinants of poor performance in the distribution of insecticide-treated mosquito nets (ITNs) through routine Expanded Programme on Immunization (EPI) services in the Democratic Republic of the Congo (DRC). The findings revealed a concerning level of underperformance, with 66.9% of health areas failing to achieve adequate ITN coverage for children under five. A substantial 34% gap was observed between children who received the first dose of the measles vaccine and those who received ITN, highlighting missed opportunities in service integration.

4.1. Socio-Demographic Characteristics of Mothers and Children

This discrepancy was attributed to both demand-side and supply-side factors, including low maternal education, low household income, incomplete child immunization, and limited community sensitization by CHWs.

In Ghana, Nigeria, and Kenya, studies have consistently shown that maternal education and household wealth are strong predictors of ITN ownership and use. For instance, Konlan *et al*. (2022) found that high literacy levels, female-headed households, and antenatal clinic attendance were positively associated with ITN utilization among children under five [15]. Similarly, in Uganda, mothers with secondary or higher education were significantly more likely to use ITNs for their children.

The DRC findings reinforce this pattern, with low maternal education and low household income emerging as the most influential predictors of poor ITN coverage through EPI. Mothers with limited education were eight times more likely (aOR = 8.22) to miss ITN distribution, while low-income households had a five-fold increased risk (aOR = 5.00). These findings align with studies from Ghana, Uganda, and Kenya, which consistently demonstrate that maternal education and economic status are critical determinants of ITN use and access among children under five. Inadequate sensitization by community health workers (CHWs) also significantly contributed to poor coverage (aOR = 3.03), underscoring the vital role of CHWs in demand creation.

4.2. Results of ITN Distribution in EPI and ANC

The findings reveal a significant disparity in ITN coverage between pregnant women attending antenatal care (ANC) and children under five attending EPI services, with only 43% of ITNs reaching children compared to 57% for pregnant women. This discrepancy persisted despite similar service delivery platforms, suggesting systemic inefficiencies in the EPI distribution channel.

This study highlights a significant gap in the continuous distribution of ITNs to children under five years of age through EPI in the DRC. Despite the strategic integration of ITN distribution with routine immunization services, only 43% of

ITNs were distributed to children, compared to 57% to pregnant women attending antenatal care (ANC). The overall poor performance rate of 66.9% in health areas surveyed underscores systemic inefficiencies in the EPI delivery channel.

These findings differ from general regional trends. A recent multi-country review of ITN routine distribution data across seven sub-Saharan African countries—including Ghana, Senegal, Zambia, and Uganda—reported median ITN issuing rates of 64% at ANC and 78% at Expanded Programme on Immunization (EPI) clinics, with country-specific ranges from 31% to 93% at ANC and 39% to 92% at EPI [16]. Compared to these benchmarks, the DRC's performance through EPI is notably lower, particularly in the EPI distribution channel.

The overall poor performance rate of 66.9% in health areas surveyed aligns with previous reports from the National Malaria Control Program (NMCP), which highlighted suboptimal ITN coverage in routine services despite adequate stock availability [12]. The observed 34% gap between measles vaccination and ITN receipt among children further underscores missed opportunities for integrated service delivery.

4.3. Factors Associated with the Poor Performance of ITNs Distribution in EPI

Multivariate analysis identified four key factors significantly associated with poor ITN distribution performance: low maternal education, low household income, incomplete child immunization, and lack of sensitization by community health workers (CHWs). These findings are consistent with earlier studies in sub-Saharan Africa, which have demonstrated that maternal education and socioeconomic status are critical determinants of health service utilization and adherence to preventive interventions [5] [8].

The role of CHWs emerged as particularly salient. Mothers who were not sensitized by CHWs were three times more likely to miss ITN distribution opportunities. In the DRC, lack of sensitization by CHWs (ORa = 3.03) was a key barrier. This finding reinforces the importance of community-based health promotion and the integration of CHWs into routine immunization and malaria prevention programs [6]. This is consistent with findings from Sierra Leone and Rwanda, where active CHW engagement significantly improved ITN coverage and adherence.

Behavioral factors such as perceived malaria risk, seasonal variation, and cultural beliefs also influence ITN use. In Ghana, for example, hot weather, net odor, and lack of visible mosquitoes were cited as reasons for non-use [15]—factors not explicitly explored in the DRC study but potentially relevant.

The DRC study highlighted inequitable ITN allocation, with a bias toward pregnant women at ANC over children at EPI services. This mirrors findings from Tanzania and Mozambique, where stock-outs, logistical bottlenecks, and prioritization of ANC over child health services have led to similar disparities.

Moreover, advanced outreach sites in the DRC were often not supplied with

ITNs, a challenge also reported in Ethiopia and Malawi, where remote or mobile clinics frequently lack essential malaria commodities.

4.4. Explanatory Factors for Poor Performance in ITN Distribution at EPI Services

Healthcare providers' opinions corroborated these findings, citing unequal prioritization of ITNs in favor of pregnant women, lack of ITN support at outreach sites, and weak community mobilization as major barriers. These systemic issues reflect gaps in policy implementation and resource allocation, which may undermine the goals of the National Strategic Plan for Malaria Control 2024-2028 [9].

4.5. Policy and Programmatic Implications

The findings of this study have important implications for malaria control policy and program implementation in the Democratic Republic of Congo. The persistent underperformance of ITN distribution through EPI services—despite adequate stock availability—highlights systemic inefficiencies in routine service delivery and missed opportunities for integrated child health interventions.

To improve ITN coverage among children under five, national and provincial health authorities should consider the following programmatic actions:

1) Strengthen Equity in ITN Allocation

Current distribution practices favor pregnant women attending ANC services, often at the expense of children at EPI clinics. Policy adjustments are needed to ensure equitable allocation of ITNs across both target groups, particularly in settings with limited stock.

2) Enhance Community Engagement through CHWs

The lack of sensitization by community health workers (CHWs) was a significant predictor of poor ITN uptake. Reinforcing CHW-led outreach and education campaigns can improve caregiver awareness and increase demand for ITNs during immunization visits.

3) Integrate ITN Distribution with Immunization Tracking Systems

Linking ITN distribution to child immunization records—such as measles vaccine administration—can help monitor coverage gaps and ensure that eligible children are not missed.

4) Ensure ITN Availability at All Service Delivery Points

Stock-outs at outreach sites and peripheral health facilities contribute to unequal access. Strengthening supply chain management and forecasting tools is essential to maintain consistent ITN availability, especially in remote areas.

5) Monitor Performance through Routine Data Systems

The use of DHIS2 data to identify discrepancies between ANC and EPI distribution should be institutionalized as part of routine performance monitoring. This can guide targeted supervision and corrective actions at the health zone level.

By addressing these gaps, the DRC can move closer to achieving the objectives outlined in its National Malaria Control Strategic Plan (2024-2028), particularly the goal of reaching 80% ITN coverage among vulnerable populations. This is necessary to optimize the contribution of the EPI, which covers 3.4% of the population, in addition to the PNT, which covers 4% of the population, enabling coverage of nearly 15% of the additional population each year following mass distribution, based on one person sleeping under each ITN. Programmatic reforms should prioritize equity, integration, and accountability to maximize the impact of routine ITN distribution.

4.6. Study Limitations

This study has several limitations that should be considered when interpreting the findings. First, the analysis was restricted to public health facilities supported by the Global Fund through SANRU, excluding private and non-partnered facilities. This may limit the generalizability of the results to the broader health system in the Democratic Republic of Congo.

Second, although the sampling strategy was designed to ensure geographic diversity, the selection of seven Provincial Health Divisions was purposive and based on observed discrepancies in ITN distribution. As such, the sample may not fully represent provinces with more balanced performance or different operational contexts.

Third, the study did not include a qualitative component, which could have provided deeper insights into operational challenges, provider behaviors, and community perceptions influencing ITN distribution. The absence of this perspective limits the ability to explore contextual and systemic factors beyond those captured quantitatively.

Finally, the cross-sectional design precludes causal inference. While associations between socio-demographic factors and poor ITN distribution performance were identified, longitudinal studies would be needed to confirm causality and assess the impact of targeted interventions over time.

Despite these limitations, the study provides valuable evidence on the structural and behavioral determinants of ITN distribution gaps in routine immunization services and offers actionable insights for program improvement.

5. Conclusion

The Democratic Republic of the Congo faces challenges in ensuring equitable and effective distribution of insecticide-treated nets (ITNs) through routine EPI services. The findings from this study underscore the importance of addressing both structural and behavioral barriers, including socioeconomic disparities, weak CHW involvement, and logistical gaps, particularly in outreach services. To reduce malaria morbidity and mortality among children under five, national strategies must prioritize integrated, equity-driven interventions. This includes balancing ITN allocation between ANC and EPI, enhancing CHW-led community engagement, improving ITN availability at all service delivery points, and reinforcing demand through culturally sensitive behavior change communication. The success of the

National Malaria Control Strategic Plan (2024-2028) will depend on bridging the gap between policy and practice through data-driven, community-informed solutions.

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Authors' Contributions

FBP conceptualized the research topic, JLL and ANN drafted the protocol, prepared the submission for institutional review board approval, GI, NB, BMB, JRNM, PMM, MNB, JK, AKN, LNMK, ANK, and PNL reviewed the manuscript. ANN provided guidance for the statistical analysis. FBP provided content oversight for the manuscript. All authors read and approved the final manuscript.

Availability of Data and Materials

The datasets analyzed during this study are available from the corresponding author on reasonable request.

Conflicts of Interest

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

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