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The Effect of Maternal Knowledge on Exclusive Breastfeeding, Anaemia, and Malaria Risk in Infants: A Cross-Sectional Study in Guéra Province, Chad

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Authors' contributions

This work was carried out in collaboration among all authors. Authors NMM, MB, BS and ASY were responsible for the conception and design of the study as well as project administration. Authors NMM, YMA, and WH participated in training investigators and collecting and processing data. Authors NMM, YMA, and WH were involved in the anaemia measurement and interpretation of results. Authors NMM and DSM, was responsible for statistical analysis. Authors NMM and DSM, wrote the original draft. All authors reviewed the first draft and approved the final version of the paper for submission authors MB, BS and ASY oversee all steps. All authors read and approved the final manuscript.

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ABSTRACT

Background: Malaria and anaemia are common and related health problems in poor countries. Exclusive breastfeeding (EBF) might contribute to prevent these diseases in infants, but research is unclear. This study aims to examine the connection between breastfeeding, anaemia, and malaria in Chad.
Methodology: This study randomized data from couple of mothers and infants in Mongo District, Guéra province, Chad, from June 2023 to July 2024. Researchers randomly selected households and gathered information about maternal knowledge on exclusive breastfeeding and infant health. Malaria in the infant was assessed by reviewing their medical records. Anaemia levels were measured using an auto-haematology analyser (HemoCue 301). Data analysis was performed using R statistical software version 4.4.1. Logistic regression analysis was used to identify factors associated with anaemia and malaria through univariate and multivariate models. Statistical significance was set at $p < 0.05$.
Results: The study involved 226 mother and child couple. EBF was more common among mothers who received information from health centres. EBF was also linked to lower healthcare costs and consistent use of Long-Lasting Insecticidal Nets (LLITNs). However, no significant association was found between EBF, anaemia, or malaria. Older infants (7-12 months) seemed more likely to have malaria, but this was not statistically significant. There was no difference in malaria risk based on gender ($p = 4.1$) or nutritional status ($p= 0.1$) according to logistic regression analysis.
Conclusion: Encouraging breastfeeding requires a multifaceted approach and more research to understand its full impact on child health, particularly in relation to anaemia and malaria.

Keywords: Breastfeeding; infant; malaria and anaemia.

ABBREVIATIONS

CI : Confidence Interval
EBF : Exclusive Breastfeeding
Hb : Haemoglobin
LLITNs : Long-Lasting Insecticidal Nets
NGO : Non-Governmental Organization
OPV : Oral Polio Vaccine
OR : Odds Ratio
PCV : Pneumococcal Conjugate Vaccine
VAR : Varicella Vaccine

1. INTRODUCTION

Chad grapples with a severe public health crisis characterized by the endemic prevalence of malaria and anaemia [1-3]. These two intertwined conditions disproportionately affect young children, exacerbating an already fragile healthcare system [4,5]. Malaria, particularly the deadly P. falciparum strain, claims thousands of lives annually, with children under five bearing the brunt of the disease in Chad [2]. Compounding this challenge, anaemia is widespread, stemming from a complex interplay of factors including iron deficiency, malnutrition, and infectious diseases like malaria [6,7].

Anaemia, a debilitating condition characterized by insufficient haemoglobin in the blood, poses a substantial global health challenge [8]. This deficiency hampers oxygen delivery to vital organs, leading to impaired physical and cognitive development. Children under five and

pregnant women are particularly susceptible to its adverse effects [8,9]. The burden of anaemia is especially pronounced in developing countries, where it contributes significantly to child and maternal morbidity and mortality [10].

The intricate relationship between anaemia, malnutrition, and malaria forms a vicious cycle that disproportionately affects young children in endemic regions [11]. Malnutrition weakens the immune system, increasing susceptibility to malaria, while malaria exacerbates nutritional deficiencies [12]. Exclusive breastfeeding (EBF), a protective factor against diarrheal diseases, may also influence, malnutrition, anaemia, malaria risk, though evidence is inconclusive [13].

Anaemia is a critical determinant of child health and development. In regions with high malaria prevalence, the combined effects of these two diseases can be devastating. Previous research has established a strong link between malnutrition, particularly stunting, and malaria in young children [6,10-12]. While the prevalence of anaemia among infants and young children in Chad has been few documented and the specific role of infant feeding practices in modulating anaemia and malaria risk remains understudied [4,14].

Chad socioeconomic landscape, marked by poverty, food insecurity, and limited access to essential services, amplifies the impact of malnutrition, anaemia and malaria in vulnerable rural populations, especially women and children [1,2,6,15,16]. By examining how breastfeeding affects child health, researchers hope to identify factors contributing to anaemia and malaria in this population. This study aims to understand the connection between Exclusive breastfeeding, anaemia, and malaria in infants in Chad.

2. METHODOLOGY

2.1 Study Areas

Chad is one of the vast territories located in the heart of the African continent, between the 8th and 24th degrees of north latitude and the 13th and 24th degrees of east longitude. It covers an area of 1,284,000 km². Completely landlocked, it is surrounded by Libya to the north, the Central African Republic to the south, Sudan to the east, and Cameroon, Niger, and Nigeria to the west. From the immense desert of the Sahara in the north to the wetlands of the south, passing through savannas and mountainous massifs, the country offers a range of landscapes as contrasting as they are fascinating. At the heart of this geographical mosaic lies the province of Guéra [17-19]. Bordered by the provinces of Batha, Salamat, Ouaddaï, Moyen-Chari, Chari-Baguirmi, and Hadjer-Lamis, the province of Guéra occupies a strategic geographical position. Its landscape, characterized by an alternation of plains, plateaus, and mountainous massifs, culminates at Mount Guéra, offering breathtaking panoramas. This geomorphological diversity is home to a remarkable biodiversity. As the cradle of numerous ethnic groups, each with its own cultural codes and languages, the province of Guéra is a veritable melting pot of traditions and know-how. This cultural richness is reflected in a highly diverse artistic and artisanal production. The province's subsoil contains significant mineral resources, while its fertile lands support prosperous agriculture [17,18]. Despite these undeniable assets, the province of Guéra faces significant challenges. Climate variability, such as recurrent droughts, compromises food security for the population. Access to basic services, including potable water, education, and healthcare, remains limited in some areas. Moreover, the degradation of ecosystems, caused by deforestation, overexploitation of natural resources, and pollution, poses a long-term threat to the environment [19].

2.2 Study Design, Duration and Definitions

A cross-sectional study was conducted from June 1, 2023, to July 31, 2024, encompassing the peak malaria transmission period (May-October) in the Guera province [20]. The study defined the rainy season as May to October and the dry season as November to April. To assess the historical incidence of malaria among children, we interviewed mothers about their child's history of malaria since birth. To corroborate this self-reported information, we systematically requested the presentation of health records or medical consultation reports. Only cases for which a medical document confirmed the diagnosis of malaria were included as children having had malaria. LLITN use was assessed by asking participants if their infants slept under a bed net. Only participants whose infants slept under a bed net in good physical condition were included in the study. Participants with damaged bed nets were excluded.

2.3 Study Participants

Participants were the couple mother and Child under 12 months, regardless breastfeeding status, and exclusively slept on mosquito bednet.

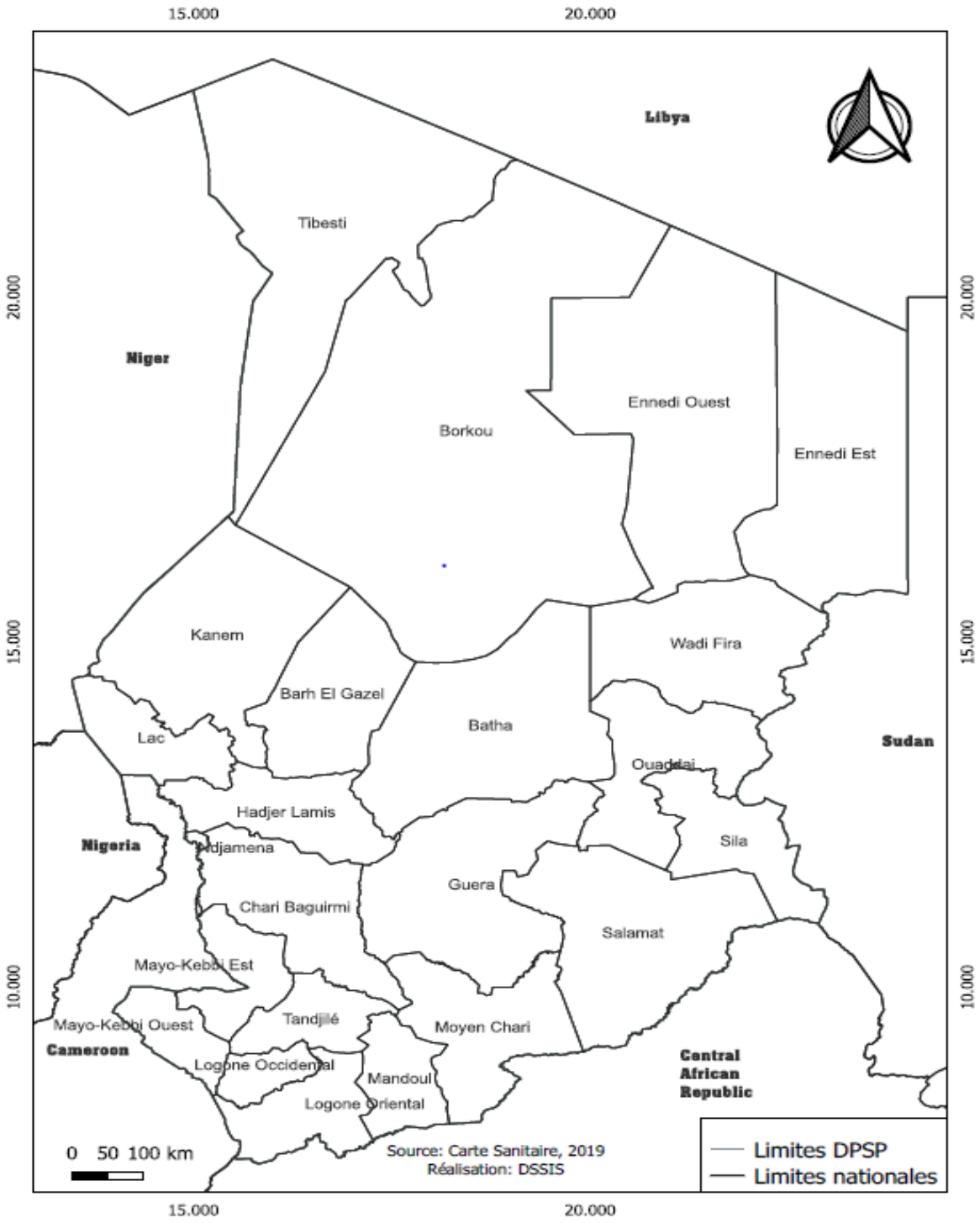

Fig. 1. A map of Chad with the province of Guéra emphasized [18]

2.4 Sample Size and Data Collection

The minimum number of samples required for the study was calculated using Cochran's sample size formula [21], $n = \frac{Z_{\alpha}^2 P (1-P)}{d^2}$ where n is the minimum sample size required; $Z_{(\alpha)}$ =1.96, Standard normal deviation which corresponds to 95% confidence interval; p = 5.5 % is Prevalence of malaria prevalence in Chad from previous studies [20]; and d = degree of accuracy/ precision expected = 0.03). A sample size calculation determined a minimum of 154 participants. To account for potential factors such

as multiple infants per house, sample loss due to blood clotting, and incomplete data, the sample size was increased by approximately 10% to 170.

Sampling was conducted in a sanitary district of Mongo. Eight villages were randomly selected for the study where the NGOs ("*Alliance Sahélienne de Recherche pour le Développement Durable"*; "*Action pour la Bonne Nutrition, la Promotion de Préscolaire et Protection de l'Environnement"*), had previously promoted exclusive breastfeeding and Ministry of Public Health through the "*Programme National de lutte contre le paludisme"* distributed LLITN. A complete list of households in each village was created, from which households were randomly chosen. Within each selected household, one mother-infant pair was included until the desired sample size was reached. Participants were provided with detailed information about the objectives of study, potential risks, and benefits. Subsequent to obtaining informed consent, investigators conducted interviews to gather data, which was captured using KoboToolbox software.

Data was collected through face-to-face interviews conducted by trained interviewers using a standardized questionnaire. Interviews were conducted with the mothers or primary caregivers of the infants. Information regarding infant diseases and vaccination history was primarily obtained from health cards. When health cards were unavailable, this information was collected through interviews.

2.5 Anaemia Measurement

Blood samples were collected from each infant for subsequent haemoglobin analysis. Haemoglobin (Hb) parameters level was assessed using an auto-haematology analyser (HemoCue 301) according to manufacturer's instructions. Anaemia status was determined based on WHO haemoglobin reference values for age and gender. Anaemia was defined as Hb <11.0 g/dL [8].

2.6 Data Analysis

Data were entered into Microsoft Excel (Microsoft Corporation, Redmond, Washington), figures were generated using Excel and we use R software, version 4.4.1 to perform univariate analysis for numeric variables (mean, standard deviation) and categorical variables (frequency, percentage). Univariate and multivariate logistic regression analyses were conducted to determine factors associated with anaemia or malaria. Data with missing values were excluded from the analysis. Statistical significance test was set at $p < 0.05$. All analyses were conducted using.

3. RESULTS

3.1 Characteristics of Participants

A total of N=226 couple of mothers and child pairs from eight villages were randomised surveyed. The distribution of participants by village and exclusive breastfeeding status was presented in Table 1. The median age of mothers was 25.00 years old (range: 15.00-45.00 years; mean: 25.23 ± 6.01 years). The majority of mothers sampled were aged between 21 and 30, comprising 49.11% of the total. This was followed by mothers aged 20 or younger, accounting for 34.07%. Mothers aged 31 or older represented the smallest group at 16.81% (Fig. 2). The median age of children was 7.00 months (range: 1.00-12.00 months; mean: 6.6 ± 3.51 months). The study population consisted of an equal proportion of male and female children (Fig. 3). According to practicing breastfeeding, 92 (41.4%) mothers practicing exclusive breastfeeding was identified as house housewives, while 130 (58.6%) mothers not practicing exclusive breastfeeding were also house housewives (Fig. 4).

Regarding maternal occupation, 92 (41.4%) mothers practicing exclusive breastfeeding was identified as house housewives, while 130 (58.6%) mothers not practicing exclusive breastfeeding were also house housewives. A significantly higher proportion of mothers who did not practice exclusive breastfeeding (42.5%) gave birth in a health centre compared to those who did (2.5%). Conversely, a greater percentage of mothers who practiced exclusive breastfeeding (54%) delivered at home than those who did not (64.7%). A small number of mothers in both groups reported other occupations, as detailed in Table 2.

Overall, according to vaccinations and exclusive breastfeeding (EBF) status, results showed suggest that timely completion of the recommended infant immunization schedule is associated with higher vaccination coverage for subsequent vaccines. Children who did not receive BCG+OPV at birth have a slightly lower vaccination coverage across all subsequent vaccines compared to those who did, but the

difference is not statistically significant (p = 0.804) (Table 3). Children who received the first dose of the pentavalent vaccine, OPV1, PCV1, and Rotaq1 vaccines at 1.5 months have a significantly higher vaccination coverage for all subsequent vaccines compared to those who did not (p = 0.013) (Table 3). There is a trend towards higher vaccination coverage among children who received the second dose of these vaccines at 2.5 months, but the difference is not statistically significant (p = 0.066) (Table 3). Children who received the second dose of these vaccines at 3.5 months have a significantly higher vaccination coverage for VAR and yellow fever vaccine compared to those who did not (p = 0.004). There is no statistically significant difference in vaccination coverage between children who received VAR and yellow fever vaccine at 9-11 months and those who did not (p = 0.543) (Table 3).

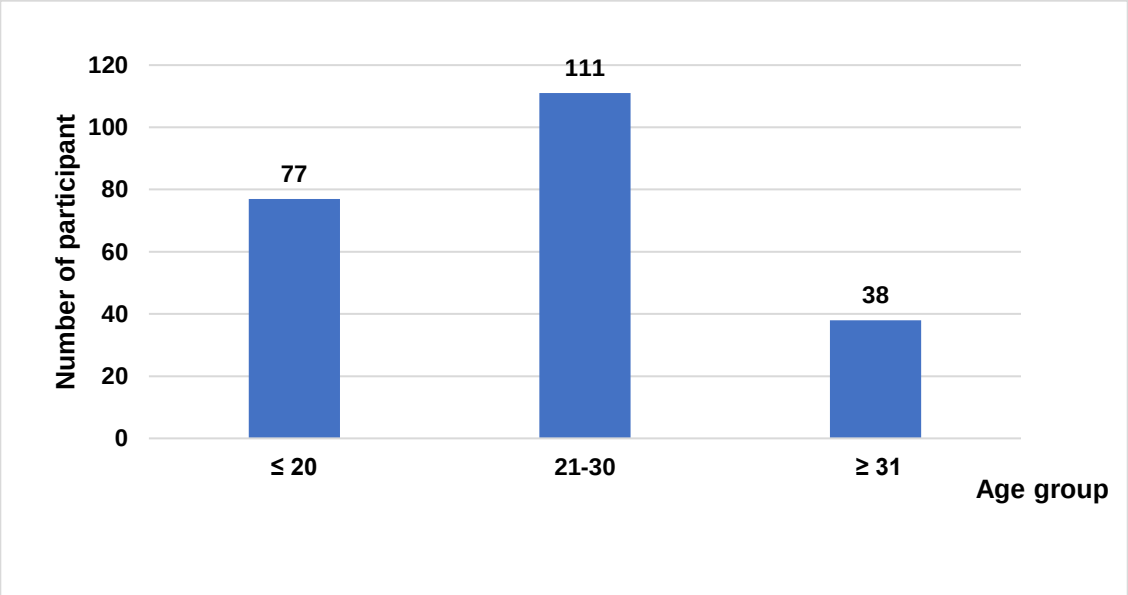

Fig. 2. Distribution of mothers by age group

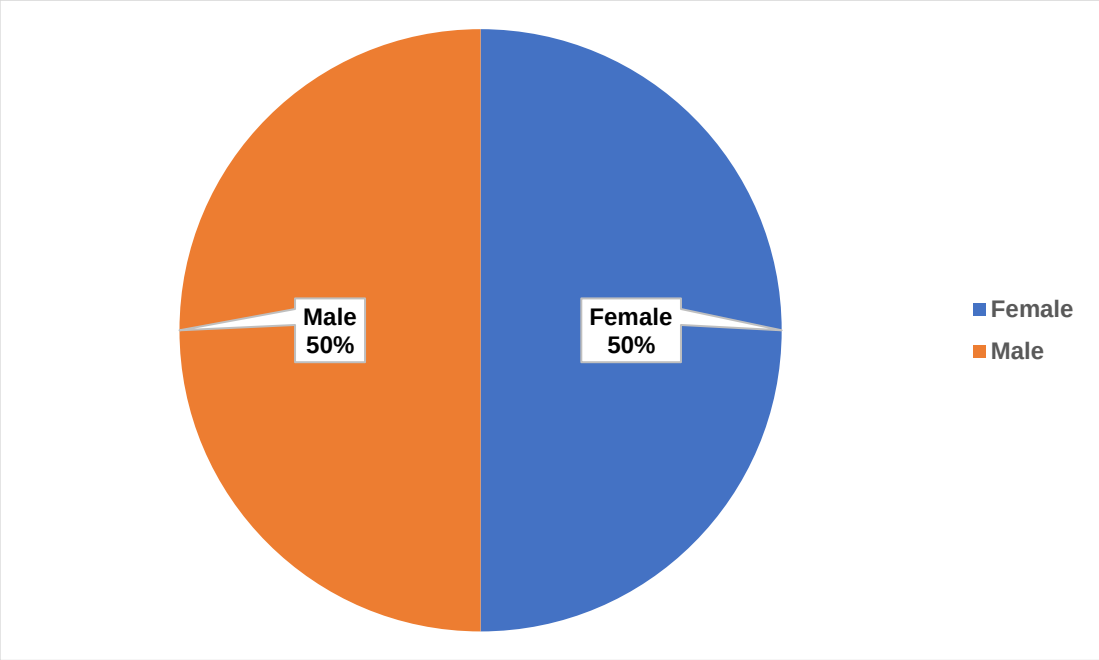

Fig. 3. Gender distribution of infant

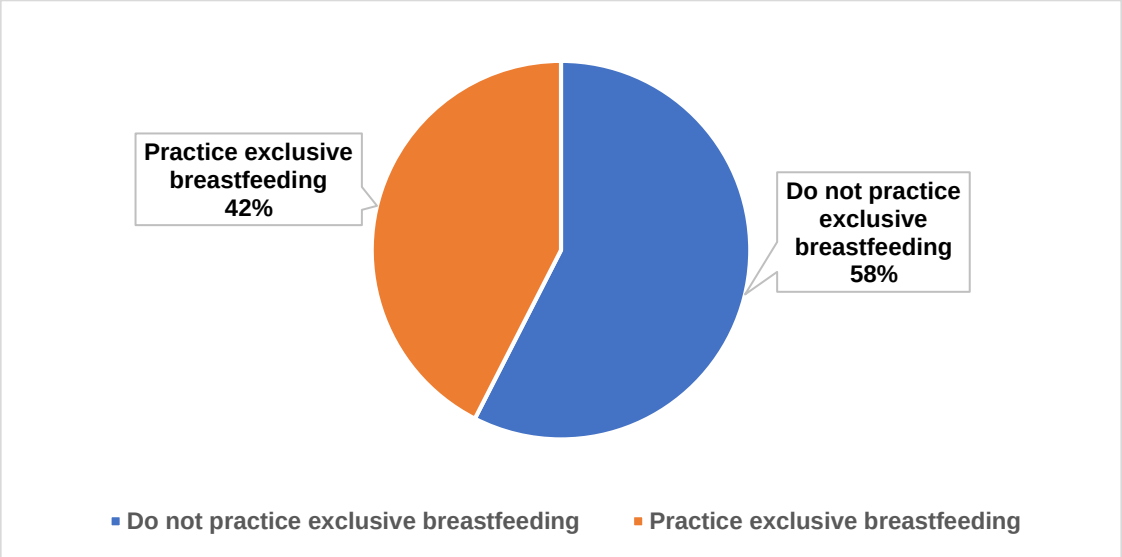

Fig. 4. Distribution of mothers according to exclusive breastfeeding

Table 1. Villages surveyed

	Mothers			Infants		
	Do not practice EBF n = 130	**Practice EBF n = 96**	**Total N= 226**	**Not under EBF n = 130**	**Under EBF n = 96**	**Total N= 226**
Villages surveyed						
Banda	48 (76.2)	15 (23.8)	63 (100)	48 (76.2)	15 (23.8)	63 (100)
Banda Dochon I	0 (0)	2 (100)	2 (100)	0 (0)	2 (100)	2 (100)
Banda Gourlia	0 (0)	1 (100)	1 (100)	0 (0)	1 (100)	1(100)
Bola Chari	0 (0)	13 (100)	13 (100)	0 (0)	13 (100)	13 (100)
Mondjino I	26 (78.8)	7 (21.2)	33 (100)	26 (78.8)	7 (21.2)	33 (100)
Mondjino II	40 (76.9)	12 (23.1)	52 (100)	40 (76.9)	12 (23.1)	52 (100)
Tchoffio	6 (20)	24 (80)	30 (100)	6 (20)	24 (80)	30 (100)
Zoubli	10 (31.2)	22 (68.8)	32 (100)	10 (31.2)	22 (68.8)	32 (100)

Exclusive Breastfeeding: EBF

3.2 Knowledge of Mothers Regarding Exclusive Breastfeeding

According to knowledge about EBF, mothers who obtained information about EBF from health centres were significantly more likely to practice EBF compared to those who learned about it at home (p=0.02) (Table 4). There is a strong association between receiving information about EBF from health centres and practicing EBF (p<0.0001) (Table 4). Mothers with no information about EBF exclusively belonged to the non-EBF group, indicating a strong relationship between information and EBF practice (Table 4).

Concerning practice of EBF, all mothers who practiced EBF had done so for all their children, with no exceptions (p<0.0001) (Table 4). This suggests that once mothers start EBF, they tend to continue it for subsequent children. Health workers were the primary source of encouragement for EBF practice, with no mothers reporting encouragement from neighbours (Table 4).

According to perceived benefits and difficulties of EBF, there is a strong association between recognizing the benefits of EBF (good health, well-being, intelligence, and no illness) and practicing EBF ($p<0.0001$) (Table 4). No differences were found in terms of perceived difficulties of EBF between the two groups (Table 4).

Table 2. Socio-demographic characteristics of the mothers surveyed

	Mothers			
	Do not practice EBF n = 130	**Practice EBF n = 96**	**Total N = 226**	**X-squared Test p**
Occupations				
Farmer	0 (0)	4 (100)	4 (100)	
Household	129 (58.6)	91 (41.4)	220 (100)	
Pupil	0 (0)	1 (100)	1 (100)	
Shopkeeper	1 (100)	0 (0)	1 (100)	**0.025**
Educational level				
Out of school	100 (62.5)	60 (37.5)	160 (100)	
Primary	24 (42.9)	32 (57.1)	56 (100)	
Secondary	5 (55.6)	4 (44.4)	9 (100)	
Tertiary	1 (100)	0 (0)	1 (100)	0.06
Place of delivery according to mother				
Health Centre	31 (42.5)	42 (57.5)	73 (100)	
Home	99 (64.7)	54 (35.3)	153 (100)	**0.002**
Husband profession				
Civil servant	5 (41.7)	7 (58.3)	12 (100)	
Farmer	83 (56.1)	65 (43.9)	148 (100)	
Trader	0 (0)	4 (100)	4 (100)	
Unemployed	42 (67.7)	20 (32.3)	62 (100)	**0.02**

EBF: Exclusive Breastfeeding;

Table 3. Vaccinal profile of the infants surveyed

	Infants			
	Not under EBF n =130	**Under EBF n = 96**	**Total n = 226**	**X-squared Test p**
BCG+OPV at birth				
No	15 (53.6)	13 (46.4)	28 (100)	
Yes	115 (58.1)	83 (41.9)	198 (100)	0.804
Penta1 + OPV1 + PCV1 + Rotaq1 at 1.5 months				
No	27 (43.5)	35 (56.5)	62 (100)	
Yes	103 (62.8)	61 (37.2)	164 (100)	**0.013**
Penta2 + OPV2 + PCV2 + Rotaq2 2.5 months				
No	39 (48.8)	41 (51.2)	80 (100)	
Yes	91 (62.3)	55 37.7 %	146 (100)	0.066
Penta2 + OPV2 + PCV2 + Rotaq2 3.5 months				
No	42 (45.7)	50 (54.3)	92 (100)	
Yes	88 (65.7)	46 (34.3)	134 (100)	**0.004**
VAR + yellow fever at 9 to 11 months				
No	79 (55.6)	63 (44.4)	142 (100)	
Yes	51 (60.7)	33 (39.3)	84 (100)	0.543

EBF: Exclusive Breastfeeding; OPV: Oral polio vaccine; PCV: pneumococcal conjugate vaccine VAR: Varicella vaccine

Table 4. Knowledge of mothers regarding exclusive breastfeeding

	Mothers			
	Do not practice EBF n= 130	**Practice EBF n = 96**	**Total n= 226**	**X-squared Test p**
knowledge about EBF				
Health Centre	31 (42.5)	42 (57.5)	73 (100)	
Home	99 (64.7)	54 (35.3)	153 (100)	**0.02**
Information about EBF				
Health centre	23 (39.7)	35 (60.3)	58 (100)	
None	9 (100)	0 (0)	9 (100)	
Radio	2 (100)	0 (0)	2 (100)	
Television	84 (71.2)	34 (28.8)	118 (100)	**<0.0001**
Third party	12 (30.8)	27 (69.2)	39 (100)	
How many infants have you practiced EBF?				
All my children	0 (0)	13 (100)	13 (100)	
First time	0 (0)	50 (100)	50 (100)	
I do not practice EBF	130 (100)	0 (0)	130 (100)	**<0.0001**
More than 2 children	0 (0)	33 (100)	33 (100)	
Who encourage you to pratice EBF?				
Health worker	0 (0)	90 (100)	90 (100)	
Neigborhood	0(0)	6 (100)	6 (100)	NA
Benefits of EBF				
Good Health and well being	0 (0)	16 (100)	16 (100)	
I do not know	130 (96.3)	5 (3.7)	135 (100)	
Intelligence	0 (0)	6 (100)	6 (100)	
No illness	0 (0)	69 (100)	69 (100)	**<0.0001**
Difficulties of EBF				
Difficult	0 (0)	9 (100)	9 (100)	
No difficulties	0 (0)	83 (100)	83 (100)	NA

EBF: Exclusive Breastfeeding; NA: Not Applicable

3.3 Malaria Characteristics and Preventive Methods According to Mothers Surveyed

Overall, there were no statistically significant differences in the prevalence of diarrhoea, vomiting, or fever between mothers who practiced EBF and those who did not. Concerning malaria: A statistically significant difference was found in the prevalence of malaria between the two groups (p=0.029) (Table 5). Mothers who did not practice EBF were more likely to report malaria in their children compared to those who practiced EBF. According to infant health costs, a statistically significant difference was found in infant healthcare costs between the two groups (p=0.004) (Table 5). Mothers who did not practice EBF were more likely to report higher healthcare costs compared to those who practiced EBF. According to LLITN Use, a statistically significant difference was found in LLITN use between the two groups (p=0.001) (Table 5). Mothers who practiced EBF were more likely to use LLITNs consistently compared to those who did not (Table 5).

3.4 Association between Nutritional Status and Anaemia, Malaria

3.4.1 Univariate analysis examining the association between several factors with anaemia and malaria

Table 6 presents the results of a univariate analysis examining the association between several factors with anaemia and malaria.

Table 5. Malaria characteristic, cost and preventive methods

	Mothers			
	Do not practice EBF n = 130	**Practice EBF n = 96**	**Total N = 226**	**X-squared Test p**
Diarrhea				
No	106 (57)	80 (43)	186 (100)	0.862
Yes	24 (60)	16 (40)	40 (100)	
Vomiting				
No	110 (58.2)	79 (41.8)	189 (100)	
Yes	20 (54.1)	17 (45.9)	37 (100)	0.775
Fever				
No	93 (56.7)	71 (43.3)	164 (100)	
Yes	37 (59.7)	25 (40.3)	62 (100)	0.8
Malaria				
No	86 (55.1)	70 (44.9)	156 (100)	
Medical examination confirmed	17 (48.6)	18 (51.4)	35 (100)	
Medical examination unconfirmed	27 (77.1)	8 (22.9)	35 (100)	**0.029**
Infant health cost XAF				
0	50 (46.3)	58 (53.7)	108 (100)	
]1000-5000]	54 (68.4)	25 (31.6)	79 (100)	
]5000-10000]	7 (46.7)	8 (53.3)	15 (100)	
]10000-20000]	11 (84.6)	2 (15.4)	13 (100)	
]20000-50000]	8 (72.7)	3 (27.3)	11 (100)	**0.004**
Period of LLITN use				
I don't use LLITNs every night	3 (17.6)	14 (82.4)	17 (100)	**0.001**
Only while the child is sleeping	127 (60.8)	82 (39.2)	209 (100)	

EBF: Exclusive Breastfeeding; LLITN: Long-Lasting Insecticidal Net

Table 6. Factors associated with anaemia or malaria identified using univariate logistic regression

	Anaemia			Malaria		
	OR	**95%CI**	**p**	**OR**	**95%CI**	**p**
Factors						
Age (months)						
7 - 12	1.02	-50.4-54.6	0.9	4.14	80-208	1.3
Gender						
Male	1.5	-60.2-99.2	0.08	0.7	-81.8-31.5	0.3
Nutritional status						
EBF	0.89	- 63.6- 42.2	0.6	0.7	-90.6-25.3	0.2
Mosquitos in house						
Female anopheles	1.05	-85- 19.8	0.2	1.8	6.8-121	2.9
Malaria						
Positive	0.97	-83.5- 30.3	0.36			
Anaemia						
Positive				0.7	-83.5-30.3	0.3

OR: Ajusted Odds Ratio; CI: Confidence Interval

Anaemia: According to age (7-12 months), there is no significant association between age (7-12 months) and anaemia (OR = 1.02 [-50.4-54.6] 95% confidence intervals (95% CI); p = 0.9) (Table 6). Nutritional status (Infant under EBF), there is no significant association between infants under exclusive breastfeeding and anaemia (OR = 0.89 [- 63.6- 42.2] 95% CI; p = 0.6) (Table 6). Mosquitos in house (Female anopheles) there is no significant association between the presence of female anopheles in the house and anaemia (OR = 1.05 [-85- 19.8] 95% CI; p = 0.2) (Table 6). Concerning malaria (Positive exam), there is no significant association between a positive malaria exam and anaemia (OR = 0.97 [-83.5- 30.3] 95% CI; p = 0.36) (Table 6). Based on the provided data, none of the examined factors (age, nutritional status, mosquito presence, or malaria) were significantly associated with anaemia (Table 6).

Malaria: According to age, infants aged (7-12 months) were at a higher risk, 4 time must importantly risk of malaria compared to younger infants (OR: 4.14 [80-208] 95% CI; p-value: 1.3) (Table 6). This association was not statistically significant. Concerning gender, there was no significant difference in malaria risk between male and female infants (OR: 0.7 [-81.8-31.5] 95% CI; p-value: 0.3) (Table 6). When analyse nutritional status, EBF show a protective effect against malaria (OR: 0.7 [-90.6-25.3] 95% CI; p-value: 0.2) (Table 6). But this effect was not statistically significant. When analyse mosquitos in house, as expected, the presence of female anopheles in the house increased the risk of malaria (OR: 1.8 [6.8-121] 95% CI; p-value: 2.9) (Table 6). But the risk was not statistically significant. According to anaemia, (OR: 0.7 [-83.5-30.3] 95% CI; p-value: 2.9) (Table 6) indicates that individuals with anaemia are less likely to have malaria compared to those without anaemia whit not statistically significant risk (Table 6).

3.4.2 Multivariate analysis examining the association between several factors with anaemia and malaria

Table 7 presents the results of a multivariate analysis examining the association between several factors with anaemia and malaria.

Anaemia: The odds ratios for age (7-12 months), gender (male), nutritional status (EBF), presence of mosquitos in the house, and malaria (positive) were calculated to assess their association with anaemia. None of these factors demonstrated a statistically significant association with anaemia. For all factors, the 95% confidence intervals (CI) included 1, indicating no significant difference in odds. The p-values for age, gender, nutritional status, mosquitos, and malaria were 0.70, 0.07, 0.40, 0.20, and 0.40, respectively and the OR were 1.1 [-47.1-69.5]; 1.6 [-4.1-102.6]; 0.7 [-90.6-18.7]; 0.8[-82.7-39.2] at 95% CI respectively (Table 7).

Table 7. Factors associated with anaemia or malaria identified using multivariate logistic regression

	Anaemia			Malaria		
	OR	**95%CI**	**p**	**OR**	**95%CI**	**p**
Factors						
Age (months)						
7 - 12	1.1	-47.1-69.5	0.7	4.3	80.1-217.5	4.1
Gender						
Male	1.6	-4.1-102.6	0.07	0.7	-84.1-37.8	0.7
Nutritional status						
EBF	0.8	-77.0-36.4	0.4	1.05	59.7-69.6	0.1
Mosquitos in house						
Female anopheles	0.7	-90.6-18.7	0.2	2.4	10.4-33.8	2.2
Malaria						
Positive	0.8	-82.7-39.2	0.4			
Anaemia						
Positive				0.7	-85.1-37.3	0.7

OR: Ajusted Odds Ratio; CI: Confidence Interval

Malaria: Infants aged 7-12 months exhibited 4.3 times [80.1-217.5] IC 95% higher likelihood of malaria compared to the reference group. However, this difference was not statistically significant (p=1.3). While males were less likely to develop malaria than females (odds ratio 0.7 [-84.1-37.8] 95% CI), this disparity was also not significant (p=0.7) (Table 7). Exclusive breastfeeding showed a negligible increase in malaria risk (odds ratio 1.05 [59.7-69.6] 95% CI, p=0.1) (Table 7). The presence of female Anopheles mosquitoes in the house was associated with 2.4 times [10.4-33.8] 95% CI higher odds of malaria but lacked statistical significance (p=2.2) (Table 7). Similarly, infants with anaemia were less likely to develop malaria (odds ratio 0.7 [-85.1-37.3] 95% CI), but this finding was not statistically significant (p=0.7) (Table 7).

4. DISCUSSION

The study population primarily focussed on young women, many of them were housewives, and their infants. While the majority of mothers in both EBF and non-EBF groups were housewives, a notable disparity was observed in place of delivery. Mothers who practice EBF were more likely to deliver in a health facility, potentially indicating a link between institutional delivery and upper EBF rates. Our findings corroborate the meta-analysis conducted by Alebel et al., which demonstrated a statistically significant positive correlation between institutional delive ry and exclusive breastfeeding practices across multiple studies. The authors concluded that enhancing accessibility to institutional delivery services could serve as a strategic intervention to promote exclusive breastfeeding [22]. According to several factors, including exposure to infant formula promotion in healthcare settings or adequate breastfeeding support during hospitalization [23,24].

The findings underscore the importance of timely immunization for achieving optimal vaccine coverage. Early administration of pentavalent, OPV, PCV, and Rotaq vaccines is strongly linked to higher overall vaccination rates. This suggests that encouraging timely immunization can significantly boost vaccination coverage across the board [25,26]. It is encouraging that vaccination coverage is similar for both boys and girls, suggesting equal access to immunization services [26,27]. However, further research is needed to identify potential barriers that may hinder early vaccinations for both sexes.

These findings emphasize the need for comprehensive interventions to promote both EBF and timely immunization. Efforts should focus on improving maternal knowledge and attitudes towards breastfeeding, especially among women who deliver at home [28,29]. Strengthening immunization services, particularly at the primary healthcare level, is essential for ensuring timely vaccine administration. Addressing challenges related to geographic accessibility and vaccine availability is vital to achieving optimal vaccination coverage [30].

Future research should explore the factors influencing the relationship between EBF and place of delivery in more detail. Longitudinal studies are needed to establish causal relationships between EBF, immunization coverage, and child health outcomes. A strong association was found between access to information about EBF from health centres and the practice of EBF. Our results may be support by several authors which collectively provide evidence that supports the association between access to information about breastfeeding from health centers and higher rates of exclusive breastfeeding [31-33]. This suggests that investing in healthcare infrastructure and training healthcare providers to provide breastfeeding information can be an effective way to improve breastfeeding practices in communities. The absence of EBF among mothers with no information underscores the necessity of reaching all women with accurate and comprehensive breastfeeding information [31,34]. The consistent practice of EBF among mothers who had previously breastfed all their children suggests a strong positive influence of early breastfeeding experiences. Additionally, the dominant role of health workers as sources of encouragement highlights the importance of healthcare providers in supporting and promoting EBF [35].

The link between recognizing the benefits of EBF and actually practicing it highlights the importance of continuing educating mothers about advantages of breastfeeding. Interestingly, the relatively low number of mothers reporting difficulties with EBF suggests that addressing misconceptions

and providing practical support could significantly improve breastfeeding rates [36].

These findings underscore the need for targeted interventions to improve EBF rates. Health systems should prioritize providing accurate and accessible information about EBF to all mothers, regardless of their socioeconomic status. Furthermore, strengthening the role of healthcare providers in counselling LLITNs and supporting breastfeeding mothers is essential. Community-based support groups and peer counselling LLITNs programs can also play a vital role in promoting EBF [34,37,38].

EBF has been shown to significantly protect infants from malaria. Infants whose mothers exclusively breastfed were notably less likely to contract the disease compared to those who were not breastfed. These findings align with previous research indicating that breastfeeding enhances infant immunity, potentially offering protection against infections like malaria [39-41]. Additionally, mothers who exclusively breastfed were more likely to consistently use LLITNs. This suggests a possible combined protective effect when EBF is coupled with LLITN use in reducing malaria risk [37,42].

The study also revealed a substantial economic impact of EBF on infant healthcare costs. Mothers who did not practice EBF reported significantly higher healthcare costs. This finding underscores the economic benefits of breastfeeding, as it can reduce healthcare expenditures associated with common childhood illnesses [43,44].

Surprisingly, no significant differences were observed in the prevalence of diarrhoea, vomiting, or fever between infants of mothers who practiced EBF and those who did not. While EBF is known to protect against various infections, these results suggest that other factors might be more influential in determining the occurrence of these specific illnesses in the study population [45,46]. Further research is needed to explore these factors. Overall, the results of this study contribute to the growing body of evidence supporting the benefits of EBF for child health and well-being.

The findings of this study are contrary to what to expectations, no significant associations were found between anaemia and age, nutritional status (exclusive breastfeeding), exposure to female Anopheles mosquitoes, or malaria. Our findings align with three studies exploring the link between undernutrition and malaria. In India, Stauder and Thein found no correlation between age and anemia among children [47]. Meinzen-Derr et al, working in Tanzania, observed that exclusive breastfeeding did not lower the risk of anemia in infants [48]. Additionally, Nicholas White's research in an African malaria-endemic region revealed a weak association between malaria prevalence and anemia [9]. These findings suggest that the determinants of anaemia in this population may be more complex than initially hypothesized. It is possible that other factors not assessed in this study, such as dietary diversity, micronutrient deficiencies, or underlying chronic infections, might be influencing anaemia prevalence [49]. Additionally, the relatively small sample size and cross-sectional design may have limited the study's power to detect significant associations.

The results indicate a non-significant trend towards a higher risk of malaria in older infants (7-12 months). While this finding did not reach statistical significance, it aligns with previous studies suggesting increased malaria risk in this age group [50,51]. The lack of significant associations between malaria and gender, exclusive breastfeeding, or anaemia is unexpected and warrants further investigation.

The lack of a significant association between malaria and the presence of female Anopheles mosquitoes is unexpected. This result may be partially attributed to the study's limited sample size and design, which could have reduced its power to detect such an association. However, a more in-depth exploration is necessary to fully explain this discrepancy. Factors such as insecticide resistance, indoor residual spraying, and other environmental influences on mosquito-human contact may provide valuable insights [52,53].

This study has limitations that should be considered. Its cross-sectional design prevents establishing direct cause-and-effect relationships between variables. Additionally, relying on mothers' memories for breastfeeding and immunization details may introduce bias.

Exclusive breastfeeding is crucial for infant health and development. The study found links between exclusive breastfeeding and reduced rates of anaemia and malaria, which could lead

to significant healthcare cost savings. However, more research is needed to fully understand the protective effects of breastfeeding against malaria and to identify other factors influencing child health in the studied population. The unexpected findings on anaemia and malaria require further investigation to uncover the complex relationship between these factors. To improve future research, studies with long-term follow-ups and objective measurements of child health and feeding practices are recommended.

5. CONCLUSION

This study emphasizes the complex factors influencing exclusive breastfeeding and Child health. Promoting breastfeeding requires a comprehensive approach, and further research is needed to fully understand its impact and the factors affecting child health outcomes, such as anaemia and malaria.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Authors hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The study was approved by the Chad Ministry of Public Health and Prevention (approval number N°6010/PT/PM/MSPP/SE/SG/DGSP/DANA/202). Informed consent was obtained from all parents or caregivers of participating infants. Participants were provided with written and/or verbal explanations of the study, and their consent was documented. Participation was entirely voluntary, and caregivers had the right to withdraw their child from the study at any time.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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