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Effects of Seasonal Malaria Chemoprevention in Children between Three Months to Nine Years Old in Dass Community, Bauchi, Bauchi Sate, Nigeria

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Abstract: **Background: Seasonal Malaria Chemoprevention (SMC) is a preventive strategy used to reduce the incidence of malaria in areas with high seasonal transmission. It involves the administration of a full treatment course of antimalarial drugs (sulfadoxine-pyrimethamine and amodiaquine) to children under 5 years old, during the peak malaria transmission season. This study is aimed at evaluating the effects of SMC in the prevention and treatment of malaria in children aged 3 months to 9 years in Dass Community, Bauchi, Bauchi State, Nigeria.**

Methods: Descriptive survey research design was utilized for the study. The respondents consisted of three hundred and twenty (320) male and female children aged 3months to 9 years, seeking health care at Dass Town Maternity, who were conveniently and purposefully sampled. Their mean age was 4½ years and 62.5%% were females. Respondents' demographics, knowledge, and effects of SMC were collected using questionnaires developed through the literature review. Pearson chi-square test was used to investigate associations between outcome variables and $p<0.05$ was considered statistically significant at (95%) confidence level.

Results: (93.8%) and (90.9%) of the respondents had adequate knowledge of SMC and its protective effect against malaria respectively. There was a significant association between knowledge of SMC and respondents' educational status in the following areas 'prevents the development of malaria parasites in the bloodstream' ($p=0.0175$).

Conclusion: SMC remained quite effective in malaria management in children due to its success rate in parasitemia reduction. To reduce malaria socioeconomic burden, adequate enlightenment on the use of insecticide-treated bed nets should be advocated.

Keywords: **Malaria, Chemoprevention, Sulfadoxine-pyrimethamine, Amodiaquine, Seasonal.**

1. INTRODUCTION

Despite the availability of various preventive and therapeutic measures in combating malaria, its global burden particularly in Sub-Saharan Africa remained alarmingly high and constitute a major global cause of morbidity and mortality especially in children. World Health Organization (WHO) in 2020, estimated that the African continent accounts for 94% of the overall malaria burden [1]. Globally, in 2021, nearly 80% of the total deaths from malaria occurred in children under the age of five, thereby highlighting their vulnerability to the disease [2]. For effective prevention of malaria morbidity and mortality in children and to alleviate its burden, regular administration of antimalarial drugs during the transmission season has been advocated. While insecticide treated nets (ITNs) and prompt treatment

have been important in malaria control, they have not been sufficient to address the overall burden. The World Health Organization in 2012 recommended seasonal malaria chemoprevention (SMC) as a complementary strategy to existing malaria control measures such as insecticide-treated bed nets and indoor residual spraying (IRS) and an absence of sulfadoxine-pyrimethamine (SP) resistance in regions with highly seasonal transmission, particularly in the Sahel regions [3], [4]. According to the World malaria report 2022, there were an estimated 247 million malaria cases and 619,000 malaria deaths globally in 2021; and significant proportion of the death were in children under five years old [2]. Malaria control through seasonal malaria chemoprevention strategy has made significant impute in reducing the disease burden over the past 15 years; thanks to renewed global interest and significant increase in funding [3]. This has led to the scale-up of multiple control interventions such as appropriate and timely management of uncomplicated and severe cases, the provision of insecticide-treated nets, indoor residual spraying, intermittent preventive treatment for pregnant women (IPTp) and, lately, SMC in endemic countries.

Seasonal Malaria Chemoprevention is defined as a global public health preventive or treatment strategy aimed at reducing the incidence of malaria in areas with high seasonal transmission. It involves the administration of a full treatment course of antimalarial drugs (usually sulfadoxine-pyrimethamine and amodiaquine) to eligible individuals, usually children under 5 years old, during the peak malaria transmission season (usually during rainy season July to October). The objectives of SMC are to maintain therapeutic anti-malarial drug concentration in the blood throughout the period of the peak malaria transmission season thereby reducing malaria cases and hospitalization, decrease malaria-related morbidity and mortality, minimize the spread of malaria parasites, and protect vulnerable population (mainly children) [3]. Malaria, caused by the parasite plasmodium falciparum, continue to pose a significant threat to global health with devastating effects, and despite the success of SMC initiative, there is still significant pockets of malaria burden among children aged 5 years and below globally, and this has remained a major health issue particularly in many tropical African countries [4].

However, with the current World Health Organization (WHO) guidelines on malaria, restricting SMC to children under five years old, there is a need to consider expanding this age limit in regions with high seasonal malaria burden [5]. The drug of use for SMC is usually sulfadoxine-pyramethamine (SP) and amodiquine (AQ). However, it is also used for intermittent preventive treatment of complicated malaria. Various research conducted in some African countries such as Senegal, Mali, Ghana, and Tanzania had demonstrated that SMC is a cost-effective, safe, and practical strategy for preventing malaria in children living in regions with high seasonal malaria transmission. For instance, in Senegal, there was a significant decrease in malaria cases among children who received seasonal intermittent preventive treatment. In Mali, SMC showed a (67.5%) efficacy against clinical malaria episodes, while in Ghana, the study found (95.0%) efficacy in reducing malaria incidence, and a (96.0%) efficacy in reduction of malaria incidence was found in Tanzania respectively [5], [6]. Seasonal Malaria Chemoprevention works through a multidimensional mechanism to combat malaria in children such as killing existing malaria parasite, preventing new infection, reducing parasite transmission, reducing anaemia and malnutrition, as well as boosting immunity [7].

Furthermore, as stated earlier, SMC is aimed at preventing and treating malaria infections in young children especially those residing in the Sahel region of Africa. In this region, it involves administering antimalarial drug usually once per month during the transmission season, for a total of three or four cycles per year depending on the length of the rainy season mainly from July to October. However, in Nigeria, the peaks seasons are from April to September in the South, and July to October in the North, due to variation of yearly rainfall. This approach is aimed at treating both the existing infections and maintaining a protective drug concentration in the blood throughout the peak transmission season. The drug regimen recommended in West African countries is one single-dose of sulfadoxine-pyrimethamine (SP) and three daily doses of amodiaquine (3AQ) [8]. In many countries, distribution teams consist of pairs of health workers mainly Community Health Extension workers (CHEWs) that visits households to administer the drugs to children under five years old. In some arrears, such as part of Niger and Mali, distribution teams are stationed at fixed points with children and their parents or caregivers coming to them for the medication.

In Bauchi State, precisely Dass Local Government Area (LGA), it has been noted that there is a high incidence of malaria and malaria-related deaths particularly in children under the age of five during or immediately after the rainy season, typically from July to October. However, various strategies and interventions have been advocated and implemented to reduce the spread and impact of the disease such as the distribution of insecticide treated bed nets, indoor residual spraying, adequate environmental sanitation, and targeted interventions for vulnerable groups such as intermittent preventive treatment for pregnant women and SMC for children under 5 years old. SMC has been proven to effectively

reduce infections and clinical malaria cases in the Sahel region, and in Dass community of Bauchi State, where the malaria transmission season coincides with the start of the rainy season [9]. However, it appeared that there is a relative variation in the implementation of SMC in children particularly in relation to their age and educational level in the area. This forms the basis of the study.

Throughout the Sahel-region, majority of childhood malaria cases and deaths occur during the relatively short rainy season. Administering effective malaria treatment at intervals during this period has proven to prevent illness and death in children [10]. Since its endorsement by WHO in 2012, many countries have promptly integrated SMC into their malaria control strategic plans because of its effectiveness in combating malaria transmission and mortality [2]. Despite SMC being recommended for children aged 3-59 months in high seasonal transmission areas, there have been instances of high incidences of malaria cases and mortality among children aged 5-9 years of age (referred to as leakage) in Dass LGA of Bauchi State, Nigeria. This situation may be as a result of lack of appropriate administration of SMC prophylaxis treatment that will prevent malaria among children between 5 to 9 years old. This study is aimed at evaluating the effects of SMC in children within 3-59 months old with an extension to older ones between 5-9 years old in Dass LGA of Bauchi State, Nigeria. Specifically, it seeks to explore the level of respondents' knowledge and age influence on SMC in Dass LGA of Bauchi State, Nigeria. However, there seem to be significant association between knowledge of SMC, its effects, and educational status of the respondents which might enhance its utilization in combating malaria.

Understanding the significance of SMC in the community can aid in the reduction of malaria cases, decrease morbidity and mortality, and improve the quality of life of the people. Through this medium, community awareness of the season that transmission is high, those that are more vulnerable, and acceptance of SMC exercise whenever it is brought to their door-step is created. This will facilitate reduction in healthcare cost, lost productivity and economic burden associated with malaria. Furthermore, it will improve school attendance and educational outcome, enhance community productivity, and improve healthcare system efficiency by focusing on preventive rather than curative. Lastly, the crucial goal of WHO towards achievement of malaria elimination can be realised.

The high prevalence of malaria cases mostly among children in Dass community despite the many intervention strategies instituted prompted the uptake of this study to ascertain the true effect of SMC in curtailing the cases in the community. Children who are not eligible for SMC include those with severe acute illness or who are unstable to take oral medication, any children receiving a co-trimoxazole or any drug containing it, children who received a dose of either SP or AQ in the past 4 weeks, and children who are allergic to either drugs as well as children who are younger than 3 months, but may receive SMC if they turn 3 months during the SMC round [11].

The evaluation of the study outcome will help Government, Non-Governmental Organisations (NGOs), Educators, and Researchers, to obtain a baseline evidence to forecast future coverage of health promotion strategies that could effectively combat malaria transmission, morbidity and mortality. Therefore, healthcare practitioners should prioritize counselling and enlightenment to address some misconceptions concerning SMC strategy and promote informed decision-making about SMC acceptance to their client and the general public.

2. METHODOLOGY

Research Design

Descriptive survey research design was adopted, in order to achieve the purpose of the study.

Research Setting

The study was carried out in Town Maternity, Dass LGA, between July,1 and September, 30, 2023, to assess the effects of seasonal malaria chemoprevention in children less than 5 years old and in extension to those between 5-9 years old in Dass Community of Bauchi State, Nigeria. Town Maternity, Dass was the central health facility in the LGA sub serving other minor healthcare centres. It was chosen because it has well established and functional non-infectious disease unit, up-to-date clinical equipment, adequate man power and patients turn-out.

Study Population, Sample Size and Sampling Techniques

The study population consisted of 4,440 of the 6,540 patients (children) male and female aged between 3 months to 9 years old, accessing health care services at the Town Maternity, Dass, and had received SMC treatment for malaria treatment or prevention between 2021 and 2023; according to the Records and Health Information Unit of the health

centre [12]. The respondents' sample size was 320 determined using the Krejcie and Morgan table for research activities for a specific population. They were sampled through a multistage sampling procedure involving convenient and purposive sampling techniques, as not all patients accessing healthcare services at the healthcare centre had need for SMC treatment. The criteria for inclusion in the study were male and female patients aged 3 months to 9 years and had received SMC treatment for malaria treatment or prevention, as well as consent to participate in the study. A pretested, structured, self-administered questionnaire developed based on the literature review was utilised to collect quantitative data from the respondents. It was sectionally divided into (A, B, and C), that gathered information on respondents' demographics, knowledge of SMC, and effects of SMC on children 3 months to 9 years old during the peak transmission season respectively.

Validity and Reliability of the Instrument

Three research experts established the validity of the instrument. Their observations and corrections were used for the final draft of the instrument. The instrument's reliability was determined by test re-test method. It was administered twice within the interval of two weeks on sixty patients at the non-infectious disease unit of Primary Health Centre, State Low-cost, Bauchi, Bauchi State, who were not part of the study sample, but had the similar characteristics with the study population. The scores obtained on these two separate administrations were subjected to Pearson's Product Moment Correlation coefficient, which yielded a coefficient of 0.80 (r=0.80). However, Cronbach's alpha statistics was further utilised to ascertain the instrument's internal consistency which yielded a coefficient of 0.84. Both coefficient values were high enough and were considered reliable for used in the study.

Method of Data Collection

Research and Ethical Clearance was obtained from the Research and Ethics Committees, of the Dass Local Government Health Authority (DLGHA) Bauchi, Bauchi State, before the study commenced. Copies of the questionnaire (320 in number) were administered by the researcher and two assistants who were briefed on the modalities of the instrument's administration. Quantitative data were collected using the mothers or caregivers that brought their children to the maternity for treatment of malaria infection (or for preventive purpose) with SMC. The questionnaires were collected back the same day they were given as soon as the respondents were done answering them. The process continued until the required sample size was reached.

Method of Data Analysis

Statistical Package for the Social Sciences (SPSS) version 23 was utilised for the data analysis. The results were calculated in frequencies and percentages. Tables were used to present the results for easy appraisal. The proportion of the effects of SMC in children between 3 months and 9 years old in Dass community of Bauchi State, Nigeria, was computed using descriptive statistics. Pearson chi-square (X^2) test was used to assess the significant associations between the outcome variables and $P< 0.05$ was considered statistically significant at 95% confidence level.

Ethical Consideration

Permission for the study was obtained from the Ethics and Research Committee of the Dass Local Government Health Authority (DLGHA) Bauchi, Bauchi State. Informed consent was obtained from all the respondents (from their parents or caregivers) and the study aims explained to them before the study. Confidentiality and anonymity was ensured with records and the information collected from the respondents and they were used solely for the study purpose. The study was also performed in accordance with the tenets of the Declaration of Helsinki, 2013.

3. RESULTS

Respondents' Demographics

Table 1: Respondents' age and gender distribution (n=320)

Age (years)	Male f (%)	Female f (%)	Total f (%)
3 months ─ < 5	70 (21.9)	120 (37.5)	190 (59.4)
5 ─ 9	50 (15.6)	80 (25.0)	130 (40.6)
Total	**120 (37.5)**	**200 (62.5)**	**320 (100)**

Source: Researchers' questionnaire 2023.

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A total of three hundred and twenty (320) respondents participated in the study, with 120 males (37.5%) and 200 females (62.5%), aged between 3 months to 9 years (mean age 4½ years) The age and gender distribution of the respondents were presented in (Table 1) and the educational levels in (Table 2). The average ages of males and females were 3.1 and 3.0 years respectively. Majority of the respondents (59.4%), had formal education indicating a relatively educated population. The slight marginal imbalance in the male-to-female ratio (3:5) may be related to chance due to the convenient sampling method used.

Table 2. Respondents' educational status (n=320)

Education Level	Frequency (f)	Percentage (%)
Formal	190	59.4
Non- formal	130	40.6
Total	**320**	**100.0**

Source: Researchers' questionnaire 2023

Table 3. Knowledge of Seasonal Chemoprevention (SMC) in Dass community, Bauchi, Bauchi State. (n= 320), and the Pearson chi-square test results of hypothesis 1. df=1

	Educational status				
	Formal n=190	Non-formal n=130	Total (%)	X^2	*P*-value
Statement: Which of the following questions applied to you?					
Have you heard of SMC prophylaxis treatment before?					
Yes	180(56.3)	120(37.5)	93.8	3.84	0.0500
How did you come to know about SMC?					
Through health education by care givers in the clinics					
Yes	90(28.1)	40(12.5)	40.6	2.97	0.0848
Campaigns in the community					
Yes	70(21.9)	90(28.1)	50.0	5.60	0.0180
Community engagement by Volunteers visiting household					
Yes	30(9.4)	20(6.2)	15.6	0.10	0.3173
All of the above					
Yes	30(9.4)	40(12.5)	21.9	3.16	0.0754
The regular administration of SMC drugs provide protective, effect and prevents the development of malaria parasites in the bloodstream					
Yes	187(58.4)	104(32.5)	90.9	5.64	0.0175
Has your child been given SMC drugs before?					
Yes	177(55.3)	110(34.3)	89.6	2.62	0.1055
How many doses of SMC is your child supposed to have?					
1 dose					
Yes	0(0.0)	0(0.0)	0.0	0.00	1.0000
2 dose					
Yes	0(0.0)	0(0.0)	0.0	0.00	1.0000
3 doses					
Yes	40(12.5)	80(25.0)	37.5	7.30	0.0068
4 doses					
Yes	100(31.2)	110(34.2)	65.4	1.37	0.2418
Have your child ever suffer from malaria before the commencement of seasonal malaria chemoprevention (SMC)?					
Yes	170(53.1)	119 (37.1)	90.2	0.38	0.5376
How many times did your child have malaria episode after the treatment?					
Twice					
Yes	115(35.1)	80(25.0)	60.1	0.04	0.8414
Thrice					
Yes	30(9.4)	59(18.4)	27.8	33.54	6.9813
More					
Yes	24(7.5)	34(10.6)	18.1	9.44	0.0021
Grand value				**76.00**	**0.0000**

Source: Researchers' questionnaire 2023. Knowledge scale:0–49%, low, 50- 69% moderate, and 70-100% adequate. X^2_{cal} = 76.00; $X^2_{0.05(1)}$=3.841; p-value = 0.0000; Hypothesis rejected.

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There was adequate knowledge of seasonal malaria chemoprevention strategy among the respondents particularly in the areas of first-hand information of it (93.8%), its protective effect against malaria infestation (90.9%), and the children having received SMC drug before (89.6%). However, greater number of the respondents did not know the right dosage of SMC drug their children supposed to take to adequately effect protection against malaria attack (0.0% for 2 doses, 0.0% for 2 doses and 37.5% for 3 doses). On the other hand, moderate number of the respondents knew about SMC through community volunteer group (50.0%) while low number of them came to know through health care givers in the clinics (40.6%) (Table 3). Besides, despite the awareness of the SMC strategy in the community, good number of the children still came down with malaria attack after receiving SMC drug. This may likely indicate the incompletion of the required doses for effective protection as a result of apathy on the part of the parents or caregivers.

Table 4. Effects of SMC among children aged 3months to 9 years in Dass community, Bauchi, Bauchi State n=320), and the Pearson chi-square test results of hypothesis 2. df=1

	Age distribution of the respondents n=190n=130 3–59months f (%)	5-9years f(%)	Total (%)	X^2	*P*-value
Statement: Which of the following questions applied to you?					
SMC has been shown to reduce the incidence of malaria in children					
Yes	127(39.6)	120(37.5)	77.1	5.02	0.0250
How effective is the SMC prophylaxis treatment?					
Very effective					
Yes	99(30.9)	130(40.6)	71.5	9.32	0.0022
Not too effective					
Yes	4(1.25)	27(8.4)	9.65	5.64	0.0175
Effective					
Yes	20(6.3)	37(11.6)	17.9	4.14	0.0418
Not effective					
Yes	7(2.2)	0(0)	2.2	2.68	0.1016
Was there any change after taking the SMC prophylaxis treatment?					
Yes	119(37.1)	123(38.4)	75.5	6.50	0.0107
Which of the following changes did you noticed in your child after the SMC:					
Improved haemoglobin count					
Yes	90(28.1)	100(31.3)	59.4	5.20	0.0225
Reduced parasitemia (parasite in blood)					
Yes	80(25)	70(21.9)	46.9	3.64	0.0564
Reduced physical signs and symptoms					
Yes	183(57.1)	100(31.3)	69.7	5.64	0.0175
Which of the following side effect did you noticed on your child after the SMC?					
Fever					
Yes	76(23.7)	85(26.5)	50.2	4.41	0.0564
Diarrhoea					
Yes	30(9.3)	32(1.0)	10.3	1.89	0.1692
Vomiting					
Yes	100(31.3)	55(17.1)	48.4	1.73	0.1884
Drowsiness					
Yes	0(0)	0(0)	0.0	0.00	1.0000
Abdominal pain					
Yes	0(0)	3(0.9)	0.9	4.41	0.0564
Itching					
Yes	0(0)	13(4.0)	4.0	7.66	0.0056
What was the extent of malaria in your child before the SMC?					
Complicated malaria					
Yes	40(12.5)	40(12.5)	25.0	1.96	0.1615
Severe malaria					
Yes	70(21.8)	111(34.6)	56.4	8.30	0.0039
Uncomplicated malaria					
Yes	130(40.6)	121(37.8)	78.4	4.95	0.0260
How was your child treated during the malaria episode? with Artesunate-amodiquine					
Yes	30(9.3)	47(15.0)	25.0	4.18	0.0409
Herbal treatment					
Yes	30(9.3)	15(4.7)	14.0	7.80	0.0052
Artemether-lumefantrine (ACT)					
Yes	90(28.1)	130(50)	78.1	9.46	0.0021
Dihydroartemisin – piperaquine					
Yes	30(9.3)	32(1.0)	10.3	1.93	0.1647
Grand value				**104.57**	**0.0000**

Source: Researchers' questionnaire 2023. Effects scale (0– 49%) low, (50- 69%) moderate and (70-100%) adequate. X^2_{cal} = 104.57; $X^2_{0.05(1)}$ =3.841; p-value = 0.0000; Hypothesis rejected.

The study showed that there were adequate and moderate positive effects of SMC among the respondents in Dass community, Bauchi, Bauchi State. (75.5%) responded that there were significant changes after taking SMC prophylaxis treatment. (71.5%) responded that the strategy has been effective as a prophylaxis in malaria treatment and had aided significantly in the reduction of malaria incidences in children (77.1%). Besides, due to the effectiveness of the SMC drugs in tackling malaria incidence, there were equally improvement in the haemoglobin counts of the patients (59.4%), Reduced parasitemia (parasite in blood) (46.9%) and reduced physical signs and symptoms of malaria (69.7%). There were also relatively low side effects such as Diarrhoea (10.3%), vomiting (48.4%), and abdominal pain (0.9%) associated with the SMC drugs. However, Artemether-lumefantrine (ACT) (78.1%) has also proven to be effective in malaria treatment and can also be used as an alternate during the episode.

Hypothesis 1. Ho1. There is no significant association between knowledge of seasonal malaria chemoprevention and educational status of the respondents

Table 3 showed the grand calculated Pearson chi-square value of 76.00 with the corresponding table value of 3.841 and a p-value of 0.0000. The hypothesis was rejected because the X^2_{cal} = 76.00 > $X^2_{0.05(1)}$ =3.841, p-value = 0.0000. This implies that there was significant association between educational status of the respondents and knowledge of seasonal malaria chemoprevention in Dass community, Bauchi, Bauchi State. The table further showed the calculated Pearson chi-square values for the following components of knowledge of seasonal malaria chemoprevention and educational status of the respondents in Dass community, Bauchi, Bauchi State with their corresponding p-values that were significant: 'Campaigns in the community' (X^2=5.60, p-value=0.0180); 'The regular administration of SMC drugs provides protective effect and prevents the development of malaria parasites in the bloodstream' (X^2=5.64, p-value=0.0175); '3 doses' (X^2 =7.30, p-value=0.0068); and 'More' (X^2= 9.44, p-value=0.0021).

Hypothesis 2. Ho2. There is no significance association between the effects of seasonal malaria chemoprevention and the age of the respondents.

Table 4, showed the grand calculated Pearson chi-square value of 104.57 with the corresponding table value of 3.841 and a p-value of 0.0000. The hypothesis was rejected because the X^2_{cal} = 104.57 > $X^2_{0.05(1)}$ =3.841, p-value=0.0000. This implies that there was significance association between the age of the respondents and effects of seasonal malaria chemoprevention in Dass community, Bauchi, Bauchi State. The table further showed the calculated Pearson chi-square values for the following components of the effects of seasonal malaria chemoprevention and the age of the respondents in Dass community, Bauchi, Bauchi State, with their corresponding p-values that were significant: 'SMC has been shown to reduce the incidence of malaria in Children' (X^2=5.02, p-value=0.0250); 'Very effective' (X^2 =9.32, p-value=0.0022); 'Not too effective' (X^2=5.64, p-value=0.0175); 'Effective' (X^2 =4.14, p-value=0.041); 'Was there any change after taking the SMC prophylaxis treatment' (X^2=6.50, p-value=0.0107); 'Improved haemoglobin count' (X^2=5.20, p-value=0.0225); 'Reduced physical signs and symptoms' (X^2=5.64, p-values=0.0175); 'Fever' (X^2 =4.41, p-value =0.0564); 'Itching' (X^2=7.66, p-value=0.0056); 'Severe malaria' (X^2=8.30, p-value=0.0039); 'Uncomplicated malaria'(X^2=4.95, p-value=0.0260); 'Artesunate-amodiquine' (X^2=4.18, p-value=0.0409); 'Herbal treatment' (X^2=7.80, p-value=0.0052); and 'Artemether-lumefantrine (ACT)' (X^2=9.46, p-value =0.0021).

4. DISCUSSION

Respondents' Knowledge of Seasonal Chemoprevention (SMC)

Knowledge of common diseases (infectious and non-infectious), their effects and management approach plays a crucial role in motivating individuals to seek medical attention. The respondents had adequate knowledge of causative agent of malaria, its preventive and management options (in this case seasonal chemoprevention therapy). (Table 3). These findings were in tandem with the updated World Health Organisation's 2022 guidelines on malaria [11]. This in-depth cognition of SMC could be associated with the sound literacy level and enlightenment of the respondents. This implied that there is significant association between educational status and knowledge of SMC as similar studies conducted elsewhere earlier yielded corresponding results like the study carried out in Ghana [9]. Hence, the significance of education in transforming lives and communities cannot be overemphasized. Educating individuals on the modalities of SMC could feasibly improve healthcare access, motivate acceptance, and treatment adherence. Besides, through SMC education, individuals could gain a clear understanding of the causes, symptoms, and treatment strategies; facilitating proactive address to health issues and prevention of potential complications. This might be achieved through health

education by care givers in the clinics, community engagement and campaign by volunteers visiting household, and involvement of the community health extension workers(CHEWs). Moreover, a comprehensive understanding of SMC therapy would enable evidence-based policymaking by effective identification of societal needs thereby enabling optimal and strategical allocation of scarce resources to enhance productivity and mitigate the economic burden of malaria.

Influence of educational status of the respondents on knowledge of SMC

Pearson Chi-square analysis showed statistical significant association between educational status of the respondents and knowledge of SMC in Dass community, Bauchi, Bauchi State. To ascertain the effect of educational status of the respondents on knowledge of SMC, psychosocial statements were put across the 320 respondents; and the detailed results were as presented in Table 3. These four statements were statistically significant; with formal educational status showing more preponderance: 'Campaigns in the community' (X^2=5.60, p-value=0.0180); 'The regular administration of SMC drugs provides protective effect and prevents the development of malaria parasites in the bloodstream' (X^2=5.64, p-value=0.0175); '3 doses' (X^2 =7.30, p-value=0.0068); and 'More' (X^2= 9.44, p-value=0.0021).

The outcome of this study was in line with the study conducted in Northern Ghana and Mali respectively [13], [14]. The educational status of the respondents significantly influenced their knowledge of SMC. This is because educational status of an individual or a community tend to correlate with increase awareness, better access to information, improved health-seeking behaviour, community engagement, and enhanced positive critical thinking skills, as reflected by respondents with formal education in the study. Besides, previous studies have reported positive correlations between knowledge, attitude and practice of malaria preventive measures. It had also been reported that information and motivation, act through a mediator (behavioural skills), to cause a health behaviour change [7]. However, addressing educational disparity could be a key strategy in improving the acceptance and effectiveness of SMC in the community. Educational status could also play critical role in the understanding of the benefits and limitations of SMC therapy as well as other malaria treatment drugs and opens an avenue for informed decision on the best [7].

Influence of respondents' age on the effects of seasonal malaria chemoprevention.

Pearson Chi-square analysis showed statistical significant association between the effects of SMC and the respondents' age in Dass community, Bauchi, Bauchi State. To ascertain the influence of respondents' age on the effects of SMC, psychosocial statements were put across the 320 respondents; and the detailed results were as presented in Table 4. These fourteen statements were statistically significant; with age 5-9years showing greater preponderance: 'SMC has been shown to reduce the incidence of malaria in Children' (X^2=5.02, p-value=0.0250); 'Very effective' (X^2 =9.32, p-value=0.0022); 'Not too effective' (X^2=5.64, p-value=0.0175); 'Effective' (X^2 =4.14, p-value=0.041); 'Was there any change after taking the SMC prophylaxis treatment' (X^2=6.50, p-value=0.0107); 'Improved haemoglobin count' (X^2=5.20, p-value=0.0225); 'Reduced physical signs and symptoms' (X^2=5.64, p-values=0.0175); 'Itching' (X^2=7.66, p-value=0.0056); 'Severe malaria' (X^2=8.30, p-value=0.0039); 'Uncomplicated malaria'(X^2=4.95, p-value=0.0260); 'Artesunate-amodiquine' (X^2=4.18, p-value=0.0409); 'Herbal treatment' (X^2=7.80, p-value=0.0052); and 'Artemether-lumefantrine (ACT)' (X^2=9.46, p-value =0.0021).

This study result is in tandem with the study conducted in Kita and Bafoulabe districts, Mali [4]. There was a well-documented effectiveness of SMC in reducing severe malaria incidence especially in children under 5 years of age, as well as good adherence, well tolerance to SMC, and a significant reduction in the prevalence of malaria among children 60–120 month in the intervention district. Despite substantial gains in addressing malaria prevalence in the young children (under five years of age), few recommendations exist for antimalarial prevention therapies in children at least five years old. Routine surveillance data showed an almost three times higher prevalence of malaria cases in children 5 to 14 years 58.1% versus 19% in children 3–59 months old in the districts [4]. This means that extending SMC coverage to children 5-9 years will help in bringing the scourge of malaria especially during the peak transmission season to barest minimum. Besides, conducting comprehensive evaluation of SMC's efficacy is vital to informing data-driven decision-making and optimizing intervention strategies in targeted age groups.

In Senegal for instance, SMC had shown to be significantly effective among children 5–9 years of age for lowering the prevalence of parasitemia and anaemia [10]. Also, numerous epidemiological studies had revealed the epidemiological impact of SMC in school-aged children in clinical trials. It is found that the number of children 5 years of age and above with malaria parasites was higher in all seasons compared to 3–59 months in S´elingu´e, Mali due to malaria control

policies focused on children under five years old and pregnant women than children 5 years and above [15]. Over time, school-aged children have been neglected in malaria control efforts. The emphasis on malaria control among children under 5 years of age may impedes natural immunity development, thereby enhancing susceptibility to acute infection and malaria attack in older children once they have outgrown the age-specific control interventions targeted at children under 5 years old in malaria endemic areas [16]. Therefore, supplemental interventions are needed to safeguard children beyond standard SMC policy, necessitating expanded treatment and prevention initiatives in this age group (5-9years of age).

5. CONCLUSION

Generally, the study showed that SMC remained a popular and quite effective strategy in malaria prevention and treatment especially in children less than 5 years of age and by extension to those 5-9 years old due to its success rate in parasitemia reduction, improved haemoglobin count, reduced physical signs and symptoms, as well as low or non-associated complications. Education plays significant role towards knowledge of SMC and its optimal adherence and utilization by the respondents. And to reduce the global socioeconomic burden of malaria, adequate enlightenment on the use long-lasting insecticide-treated bed nets (LLINs), indoors and window spraying, proper environmental sanitation, and effective health education should be advocated.

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Authors Contributions

James, Iliya Kyamru designed the study and performed data analysis and interpretation. Collins Onyeahiri and Lami Madaki coordinated and carried out field activities as well as Performed the drafting and critical revision of the manuscript. All authors read and approved the final version of the manuscript.

Conflict of Interest

We hereby declare having no conflict of interest.

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