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A Phytochemical Study of Common Plant Dietary Sources in Relevance to Inhabitants Malarial Tolerance of Kamrup Metropolitan District of Assam, India.

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Abstract

Malaria prevalence in the tropics is characterized by their typical symptoms as well as asymptomatic phase. Despite the availability of various therapies, many traditional medicines used whole plant or crude plant extracts which shows greater antiplasmodial activity. This research was carried out for determining the phytochemicals and physiochemical properties of such different varieties of plant species consumed by the community in malaria endemic and malaria tolerance zone of Kamrup Metro District, Assam. Results showed evidence of several types of plant species, which are reported to be used in the different geographical location in the world. Their extracts contain many useful phytochemicals and secondary metabolites which may contain multi-drug inhibitor or may have immunomodulatory effect as well as antiplasmodial activity. The study indicates potential inhibition factors for malaria tolerance in the community of the study area.

Keywords: *Phytochemicals, asymptomatic, antiplasmodial,immunomodulatory, tolerance.*

1. Introduction

Malaria is a fatal infectious disease which affects people of all ages in developing countries with tropical and sub-tropical climates around the world. As per World Health Organization (WHO) record reports approximately 40% of the world population lives in malaria-endemic areas, with around 300-500 million clinical cases and about 1.5-2.7 million deaths per year globally.

Human malaria is caused by five protozoan species namely *P. falciparum*, *P. vivax*, *P. ovale*, *P. malariae*, *P.Knowlesi* and *P. falciparum*, which has become an increasingly important clinical issue in malaria chemotherapy worldwide (Dinio *et al.*, Sashidhara *et al.*, 2012). Traditional medicines have been playing important role in the treatment of diseases including malaria since ancient time (Rudrapal, 2017). A modern chemotherapeutic form of malaria treatment started with the discovery of quinine (QN) from cinchona bark (Rudrapal, 2017). As per earlier studies, plants and/or plant-based traditional medicines are believed as the most reliable and alternative means for the discovery of new antimalarial molecules (Rudrapal, 2017). Polyphenolic flavonoids are abundant in dietary or medicinal plants, which have been identified to possess good *in vitro* and *in vivo* antimalarial activities(Al-Adhroey *et al.*,2011, Lehane *et al.*, 2008).

Plants produce many phytochemicals as secondary metabolites in their various parts. These phytochemicals play various biochemical and pharmacological role when ingested by animals (Trease, 1989). Flavonoids are the most diversified groups of phenolic compounds found in plants various parts, which impart a variety of colors such as yellow, orange, purple, blue etc. to flower petals, fruit peels, vegetables and certain grains (Rudrapal, 2017). Because of their widespread distribution in dietary plants such as fruits and vegetables, flavonoids form an integral part of human diet. Flavonoids consumed through diet as raw forms, processed products or cooked preparations contribute beneficial effects to human health (Rudrapal,2017). Flavonoids from *Artemisia annua* as antioxidants and their potential synergism with Artemisinin against malaria and cancer (Jorge *et al.*, 2010).

The purpose of the study is to analyse the food diets frequently eaten in the study village where asymptomatic malaria cases were detected and to

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find if there are any role in malaria tolerance with the view (1) To establish relationship common dietary ingredients with malaria tolerance and (2) To comparative quantify the phytochemicals present in the food diets in study and control villages. The result of the study will contribute towards the potential use and sources of food materials of a defined geographical location where it is cultivated and may be used as common dietary resources by the population of a defined forest area and their coexistence of malaria parasite in their blood, remaining asymptomatic in nature. It will also help health care system to help to formulate different phytochemical derivatives as medicines and can promote awareness in the community to traditional uses of food which can play role in malaria tolerance.

2. Materials and Methods

2.1 Research design and setting

The present study is based on cross-sectional research design. The present study has been carried out in Hazongbari sub-center under Sonapur block. The research area is selected since annual parasitic incidence is very high in the district and malaria is the major health problem in these areas due to the ecological and poor livelihood of the population. Four urban villages have been selected as a control, a total 3283 population (747 households), which are 1KM away from Panikhaity railway station and a test study area of three rural villages of 359 populations (65 households), around 10 KM away from Panikhaity railway station, Kamrup Metropolitan District, Assam. The study villages consisted of the natural reservoir of malaria transmission throughout the year. Hilly forest areas with natural pools, poor environmental sanitation with standing water bodies, foothills, paddy fields. Occupation and living habits of villagers which boasts a natural ecosystem for malaria transmission. The communities are developing resistant to malaria and mostly all are asymptomatic in nature. They are predominantly farmers mainly producing rice, grains, and vegetables consume in their diets, thus receive carbohydrate and proteins. On the other hand, the control villages are situated in plain as well as hilly areas, adjacent to hills. District administration is better and also, they are economically sound. They are basically farmers, volunteers and private sector workers. The villages are malaria endemic to the district. The households of all these villages are well trained for the all the preventive measures of malaria prevention and use of long-lasting insecticidal nets (LLIN). To evaluate the effect of intervention, fever survey and mass blood survey have been done regularly for detection and treatment of malaria.

2.2 Sample size

This study was preceded by initial visits to the study area to establish a relationship and to understand dietary habits of the communities and to seek for permissions from local leaders to conduct the research in the area. Questionnaires were given to the women group, which included about the food materials they eat and the methods of preparations. Out of 100 households, about 25 food materials, main ingredients and preparations were collected. And 10 samples were taken for phytochemical analysis which was locally cultivated and frequently used by the community of study village. Same numbers of samples were collected from the control village to define a conclusion.

Pharmacognostic and phytochemical studies were carried out in State Drug Testing Laboratory, AYUSH, Govt. Ayurvedic College and Hospital, Guwahati-14.

2.3 Extraction:

300gm of powdered was extracted successively with solvents like petroleum ether, benzene, chloroform, acetone, methanol respectively in a Soxhlet apparatus(Wallis, 1967). Each solvent extract was then concentrated by distilling off the solvent under reduced pressure.

2.4 Photochemical Screening

The aqueous and methanolic extracts along with other solvent extracts of plant materials were studied for various phytochemicals like alkaloids, flavonoids, phenols, tannins, and terpenoids by using precipitation and coloration reactions (Trease, 1996).[1]

2.5 Statistical Analysis

Data for the phytochemical analysis for both control and study villages were recoded for 3 independent biological replicates and were analyzed statistically by Kruskal–Wallis test with Dunn's post-test [10] to compare three or more unmatched groups using GraphPad Prism (version 5.03 for Windows; CA, U.S.A.). For all statistical analyses, significance was set to * = $0.01 \leq p \leq 0.05$, ** = $0.001 \leq p \leq 0.01$, and ***/ΔΔΔ = $p \leq 0.001$ throughout the experiments and accordingly plotted in the tables for clear understanding.

3. Result and Discussion

Herein in this study, we found out that in the study village, the common diets included locally grown plants such as, *Carica papaya, Manihot esculentum, Aka colocasia, Musa paradisiaca* L, families of Zingiberaceae, families of Poaceae, Capsicum and the many other green vegetables

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like, neem, bitter guard, drumstick, other wild vegetables.

Table 1 show that there are many plants which are considered and studied as medicinal plants used for malaria therapy in Nigeria, Cameroon, and Ghana. Its use against malaria is justified by the presence of high concentrations of active compounds which has a minimal antimalarial activity and a minimal toxicity.

Table 1: Reported Plant materials used for treatment of malaria.

Sl. No	Plant materials	References
1	*Carica papaya*	Omosun G *et al*., 2013, Betti *et al*., 2013, Saotoing *et al*., 2011, Idowu *et al*., 2010.
2	*Manihot esculentum*	Betti *et al*., 2013, Omosun G *et al*., 2013.
3	*Momordica charantia*	Marles and Farnsworth, 1995, Ethan *et al*., 2003.
		Munoz *et al*., 2000, and Inga *et al*., 2002, Singh *et al*., 2006, Balogun *et al*., 2012.
4	*Capsicum frutescens L*.,	Mojab *et al*., 2003, Betti *et al*., 2013.
5	*Capsicum annum L*	Betti *et al*., 2013, Mojab *et al*., 2003.
6	*Curcuma longa*	Rasoanaivo *et al*., 2011.
7	*Aka colacasia*	Williams *et al*., 1981.
8	*Zingiber officinale*	Betti *et al*. 2013, Rasoanaivo *et al*., 2011, Titanji *et al*., 2008.
9	*Oryza sativa*	Betti *et al*., 2013.
10	*Colocasia esculata*	Pravakar Padhial, 2011.

The qualitative and quantities analysis (Table 2 & Table 3) showed the presence of higher amount of phytochemicals in the study. The presence of the phenolic content, total flavonoid content, alkaloid was observed most of the species. Similarly, tannin was present in *Carica papaya*, *Oryza sativa*. Terpenoid and carotenoid were present in *Capsicum frutescens*, *Capsicum annum*.

Table 2: Phytochemical analysis of plant materials of Study village.

The values in the table indicate the mean values of 3 biological replicates +/-SEM. The level of significance in indicated by *, wherever applicable.

Plant Material	Total Phenolic content (g/100g)	Total Flavonoid Content	Alkaloid	Tannin	Terpenoid	Carotenoid
Manihot esculantum	0.98 ± 0.003	0.86* ± 0.001	Present	-	-	-
Aka colacasia	22.33 ± 0.003	2.54*± 0.001	Present		-	-
Capsicum frutescens L	0.759 ± 0.003	0.306 ± 0.001	Present		Present	1.2
Capsicum annum L	0.988 ± 0.003	0.556* ± .001	Present	-	Present	1.88
Colacasia esculanta	33.33 ± 0.003	22.54 ± 0.001	Absent	-	-	-
Carica papaya	Present	-	-	Present	-	-
Zingiber officinale	-	Present	Present	-	-	-
Momordica charantia	-	Present	Present	-	-	-
Curcuma longa	-	Present	Present	-	-	-
Oryza sativa	-	Absent	Present	Present	-	-

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Table. 3: Phytochemical analysis of plant materials of Control village.

The values in the table indicate the mean values of 3 biological replicates +/-SEM. The level of significance in indicated by *, wherever applicable.

Plant Material	Total Phenolic content(g/100g)	Total Flavonoid Content	Alkaloid	Tannin	Terpenoid	Carotenoid
Manihot esculantum	0.65 ± 0.003	0.55 ± 0.001	Present	-	-	-
Aka colacasia	20.11 ± 0.003	1.99 ± 0.001	Present	-	-	-
Capsicum frutescens L.	0.754 ± 0.003	0.298 ± .001	Present	-	Present	0.6
Capsicum annum L	0.858 ± 0.003	0.458 ± .001	Present	-	Present	1.22
Colacasia esculanta	35.33 ± 0.003	23.56± .001	Absent	-	-	-
Carica papaya	Present	-	-	Present	-	-
Zingiber officinale	-	Present	Present	-	-	-
Momordica charantia	-	Present	Present	-	-	-
Curcuma longa	-	Present	Present	-	-	-
Oryza sativa	-	Absent	Present	Present	-	-

The comparative analysis of phytochemicals from food diets of study and control villages (Table 2 and 3) shows that flavonoids levels of diet constituents were significant at ($0.01 \leq p \leq 0.05$) compared to control village. This high content of flavonoids in study village diet may have contributed to anti-malarial response, which have been reported earlier (Inga *et al.,* 2002). It is also well documented that many plant secondary metabolites are increasingly synthesized under heat and drought stress, including flavonoids(Kaplan *et al.,* 2004, Wang, 2005). The Savanna monkey diets include a large quantity of flavonoid-rich leaves and bitter fruits as *Balanitesaegyptiaca.* So there are possibilities that these dietary compounds led to the reduction or elimination of simian malaria(Maranz, 2012). The human endothelial system at normal dietary plasma concentrations showed the strong effect by flavonoid in many traditional African malaria therapies and it suggests the potential for reducing the severity of malaria infections and facilitating parasite clearance via immune response(Maranz, 2010).

Moreover alkaloids, saponins, and flavonoids have been implicated to be responsible for antimalarial activity(Ettebong *et al.,* 2015) as these secondary metabolites elicit bioactivity wholly or in combination with other plants(Shigemori *et al.,*). Malaria parasites by wreaking havoc synthesize protein and produce free radicals in the human body. These vices are corrected in the presence of alkaloids which block protein-synthesis of *Plasmodium* species, and flavonoid, saponin, and tannin which are involved in primary anti-oxidation of free radicals and other reactive oxygen species(David *et al.,* 2004) In many plants, antiplasmodial activity is associated with the presence of total polyphenols, flavonoids, and alkaloids. [23] For instance, alkaloids occur in plants in association with characteristic acid(Evans, 2002) and are known to have anti-cancer, anti-aging and antiviral properties with marked physiological actions on man and animals(Ibukunoluwa,(Ibukunoluwa, 2017).

Studies show that the presence of alkaloids and terpenoids might be responsible for the antimalarial activity exhibited by *Artemisia maciverae* and *Artemisia maritime* (Ibukunoluwa, 2017). The present study shows that all the plant species daily use as diet by the community shows the presence of alkaloids and tannin (*Capsicum*) might be responsible for the antiplasmodialactivity.

The presence of higher amount of terpenoids in *Capsicum* species in the study village than the control village. Earlier research displayed various vital pharmacological activities i.e., anti-inflammatory, anticancer, anti-malarial, inhibition of cholesterol synthesis, anti-viral and anti-bacterial activities(Mojab *et al.,* 2003).

From all the plants which are locally available and frequently consumed by the communities in the study area, which possesses an antimalarial capacity and may have indirectly provided tolerance to the malaria parasite. The survey also shows that good numbers of respondents still rely on traditional different plant species herbal remedies. The study identified 10 different plant species during the period of house visits to the

study areas and found different households usually consume either raw or cooked form. Species of *Araceae* traditionally used for malaria, fevers, headaches, and liver disorders are reviewed. [15] Relevant literature that reveals the antimalarial potential of extracts and isolated compounds including median inhibitory concentrations (IC50) against *Plasmodium falciparum*(Frausin *et al*., 2015).

4. Conclusion

This study indicates that in the study village, regular use of flavonoid-rich common dietary sources, which have the higher amount of phytochemicals than usual food sources, may have a high potential for the production of compounds for the development of anti-modulatory and antiplasmodial activity. It is reinstated in this study that the villager's diets include a large quantity of flavonoid-rich and other phytochemical-rich plant species and is comparatively higher amounts that these dietary compounds could play a role in reducing or eliminating malaria parasites possess significant suppressive effects on the human body for the developing characteristics of malaria symptoms. Further in-depth study on the efficacy of phytochemicals on malaria may lead to a new direction on research.

Conflict of Interest

No conflicting interest.

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NUTRITIONAL EVALUATION OF DISHES CONSUMED IN MALARIA ENDEMIC ZONES OF KAMRUP METROPOLITAN DISTRICT, ASSAM

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Abstract : This study describes the determination of nutritional potential of dishes consumed by communities living in a forest area, which is a high prevalence of asymptomatic malaria endemic zone called Suali Lukua Hills and also another control village in the plain area adjacent hill which is malaria endemic but shows symptomatic malaria zone called Hazongbari Village. Moisture, ash, proteins, fat, and carbohydrates were determined by Food Safety and Standards Act (FSSAI).The results obtained are expressed in percentage f.w for moisture and percentage d.w for ash, proteins, fats, and carbohydrates. This study revealed that a higher consumption of dishes made from tubers, fermented fish, green leafy vegetables in the study village which have more anti-malarial properties and tolerant to malaria parasite.

Index Terms **- Nutritional evaluation, asymptomatic, endemic, macronutrient, fermented.**

I. INTRODUCTION

Malaria is caused by protozoans of the genus *Plasmodium* that is transmitted to humans by the bite of infected, female *Anopheles* mosquitos. Malaria symptoms include fevers, headaches, vomiting and chills that appear 10-15 days after infection [64]. The exponential human population growth demands an accelerated availability for growing food crops and vegetables [21]. To meet the food demands, cultivable and wild vegetables are regarded as a cheap source of food for the marginal communities as alternatives [21]. There are about 840 million undernourished people in 1998–2000, out of whom 799 million are in the developing countries, 11 million in the industrialized countries and 30 million in the countries in transition [10 11 18 54]. The interest on exploitation, quantification, and utilization of food plants, especially the vegetables has been centralized to apprehend the situation [10]. The major portion of the human diet is vegetables, which are a rich source of carbohydrates, fats and proteins, and are the cheaper source of energy [57 36 30]. Earlier studies on importance of biochemical's and the moisture, fibre, ash content and the energy values of individual vegetable and plant species was carried out by various scientists [5 7 21 22 23 28 63].

There are a number of rural community groups who make a living by horticulture, hunting, fishing and sell their products in the marketplace for fulfilling their other needs. But still, there are a number of groups who are self-sufficient in food production. They have their diets to be traditional. Their diets define in terms of ecological variables, food resources characteristics, and use [8]. In a mass survey, it was seen that the prevalence of asymptomatic malaria among the vulnerable groups, was found to be high in the malnourished population. It is seen that well-nourished people have better immunity to fight against malaria and other tropical endemic diseases [12]. In fact, previous studies like those of in Tanzania [58], Madagascar, in Central Africa [59], showed that protein–calorie malnutrition favours the evolution of malaria [49].

To fight against any disease, the knowledge of the nutritional value of prepared dishes that are ready for consumption is necessary. This study was therefore carried out for determination of contents of moisture, ash, protein, fat, and carbohydrate in 25 dishes/items among the dishes consumed in the hilly area.

2. MATERIALS AND METHODS:

A set of questionnaires were prepared for the women group, which included the staple food used in the study as well as control villages. The main motto of this study is to 1) Elicit the methods and composition of food items consumed by the community, 2) to evaluate macronutrients of food items. The food groups chosen for the study include staple food, vegetables, leaves, fruits, nut/pulses, meat, fish, and other foods used as medicinal items. Twenty-five (25) families were chosen at random in the area, the study village which falls in a malaria endemic zone located in a hilltop area about 10 KM away from Panikhaity Railway station of Kamrup Metropolitan District. On the other hand, the control village is situated in plain as well as hilly areas,

about 2 K.M. away from Panikhaity railway station, adjacent to hills. District administration is better and also they are economically sound. The villages are malaria endemic to the district and show all the malaria symptoms. The households of all these villages are well trained for the all the preventive measures of malaria prevention and use of long-lasting insecticidal nets (LLIN). They usually buy food from the local market available nearby and few they cultivate.

After frequent field visits and questionnaires, the survey of cooking methods and consumption of dishes was carried out in the year 2016-2017. The collected dishes were refrigerated overnight or until the time of analysis. The sample analysis part was outsourced to State Public Health Laboratory, Bamunimaidam, Assam. Each type of dish/item was analyzed separately.

The experiment was carried out during 2016-2017 at State Public Health Laboratory, Guwahati, Assam, India. The moisture content and chemical analysis were carried out by the Food Safety and Standards Act (FSSAI).

2.1 Statistical analysis

Data were calculated using Microsoft Excell 2010 software. All experiments were performed three times and data represent the mean and standard deviation (Mean ± SD) from the three replicates of a representative experiment.

3. RESULT & DISCUSSION

The Table 1 & 2 shows the list of food consumed by the study and control villages. The results of the analysis are shown in Table 3 & 4, study & control village respectively. This gives the contents in moisture, ash, proteins, carbohydrates, fats and of dishes expressed in grams per 100 g of dry weight (% d.w) except the moisture content which is expressed in grams per 100 g of fresh weight (% f.w). The energy derived from the food varieties are reflected as Kcal per 100 gm. The results presented here are average values for each variety. Three replications were done per sample. The results are given in the form: mean ± standard deviation.

Table: 1 List of food consumed in the study village

No	Name	Form of food	Main ingredients
1	MeskaTenga (Roselle)	Gravy	Meaka Tenga+ Green Chillies+Salt+Dry Fish
2	Papaya Flower	Gravy	Papaya Flower + Green Chillies+Salt+Dry Fish+Soda
3	Brinjal+Colocasia Sabji	Gravy	Colocasia Stem+Brinjal+Ginger+Salt+Soda+Dry Fish
4	Salad	Dry	Banana Flower+Ginger+Onion+Burnt Dry Fish+Salt
5	Papaya Flower	Gravy	PapayaFlower+Maan Dhania+Ginger+Garlic+Green Chillies+Salt+Soda
6	Colocasia leaves	Gravy	ColocasiaLeaves+Maan Dhania+Ginger_Garlic+ Raw Turmeric+Salt+Chillies
7	Hridal(FermentesFish)	Dry	Sun dried fish+Mustard oil+Soda+Salt
8	Kol Jabra	Gravy	Kol Jabra Plant+Hridal+Chillies+Salt+Soda
9	Papaya Curry	Gravy	Papaya+Fermrnted fish(Hridal)+Chillies+Sat+Soda
10	Pork curry	Thick	Pork+Brassica Leaves+Ginger+Garlic+Rice flour+Salt
11	Rice	Grain	Rice + Water
12	Green chillies	Piece	Spice
13	Bitter guard		Vegetables
14	Taro	Piece	Root
15	Ginger	Piece	Tuber
16	Banana Flower	Whole fruit	Vegetable
17	Riped Banana	Piece	Fruit
18	Cassava	Piece	Tuber
19	Taro	Piece	Tuber
20	Bean	Piece	Vegetable
21	Tumeric	Piece	Tuber
22	Sesame	Grain	Seed
23	Mosundari(Heart leaf)	Leaves	Leave
24	Salad	Dry	Gon Kosu+Ginger+Garlic+Chiilies+Burnt dry fish+Salt
25	Jute Leaves	Gravy	Dry leaves+Ginger+garlic+Salt+khar+Small fish fry+boil

Table:2 List of food consumed in the control village

No.	Name	Formof food	Main ingredients
1	Green Leaves	Gravy	Mustard greens (Lye Saak)+ Chinese Mellow (Lofa)_+Soda+Turmeric powder+Chillies+Salt
2	Sojina(Drumstick)	Gravy	Drumstick+Potato+Raw Banana+Salt+Chillies+Turmeric powder
3	Green Leaves	Gravy	Mustard greens+Chinese Mellow+Soda+Turmeric powder+Chillies+Salt
4	Dal(Lentil)	Liqid	RedLentil+Ginger+Garlic+Turmeric powder+Onion+Mustard Oil
5	Mix Veg	Solid	MustardGreen+WhiteGoosefoot(Lofa)+Beans+Dry fish+Soda+Salt+Chillies+Mastard Oil
6	Rice	Grain	Rice + water
7	Pork	Gravy	Pork+ Jute leaves(Hukuta)+ Banana leave ashes(Kol Khar)+Rice Flour+Salt+Chillies+water
8	Chicken	Gravy	Chicken+Yam(KathAlu)+Potato+Meatmasala+Turmeric+Salt
9	TitaFul(Phlogacanthus)	Gravy	Bahaka ful+Kol Khar+Salt+Chillies
10	Pork	Gravy	Pork+Cauliflower+MasalaPowder+turmeric powder+ Chillies+Salt+Mastard oil
11	Pork	Gravy	Pork+Potato+Curryleaves+Turmeric powder+Salt+Chillies+Turmeric Powder+Masrad oil
12	Lentil	Gravy	Lentil+Elephant fruit+salt
13	Pork	Curry	Pork+Potato+Tomato+Ginger+Garlic+Chillies+Turmeric Powder+Salt+Mustard oil
14	Pork	Curry	Pork+DombaruLeaves+Curry leaves+Fern+Ginger+Garlic+Chillies+Salt
15	Hridal(Fermented fish)	Gravy	Hridal+Kol Khar+Ginger+Garlic+Sat
16	Mustard Green	Dry	Peas+Mustard leaves+Bali Botua Leaves+Onion+Potato+Chillies+Turmeric powder+Salt+Mustard oil
17	Fish	Gravy	Fresh Fish+Colocasia Stem+Elephant Fruit+Ginger+Garlic+Chillies+Salt+Mustard Oil
18	Black Gram	Gravy	Black Gram+Papaya+Ginger+Garlic+Onion+chillies+Sambar Masala+Mustard oil
19	Green leafy vegetables	Gravy	Mustard Green+Radish shoot(Mula Saak)+Soda+Chillies+salt
20	Pork	Gravy	Jute leaves+Soda +Pork+Onion+Ginger+Garlic+Chillies+Salt+Fish
21	Colocasia+Fermented fish	Piece	Dry Fish + Colocasia stem
22	Ginger	Piece	Tuber
23	Banana Flower	Dry	BananaFlower+Potato+Onion+Garlic+Salt+ Chillies +Mustard oil
24	Green chillies	Piece	Spice
25	Gon Kosu	Piece	Stem

In the study village (Table 3), it is seen the moisture content ranges from 7.83% (sesame) to 92.4% (Colacasia stem with fermented fish). The high moisture content in these dishes is due to the vegetable used and water added to the dishes during cooking. The highest moisture content found in the green vegetables, banana flower, tubers, legumes, fermented fish (Hridal) and the curry prepared from these items. The ash level ranges from 0.38% (Bean) to 16.33% (Fermented fish). The higher ash and protein content found in fermented fish, green chilies, ginger, pork gravy with green leaves and rice flour and more abundantly in black sesame (36.95%). The highest carbohydrate found in 73.74% (Rice), Taro, 30.75% (sesame) and food items prepared by it.

Table: 3 Nutrient Contents of Study village

Food item	Moisture (g/100g f.w)	Ash(g/ 100g d.w)	Protein (g/100g d.w)	Carbohydrate(g/ 100g d.w)	Fats(g/ 100g d.w.)	Total Energy (Kcal /100g)
1	277.2±0.03	2.7±0.04	1.41±0.04	3.42±0.08	0.25±0.19	22.4
2	86.49±0.22	3.99±0.04	2.79±0.03	6.65±0.12	0.25±0.19	38.25
3	92.30±0.04	3.20±0.03	2.10±0.04	2.23±0.01	0.06±0.005	17.95
4	85.02±0.08	4.90±0.04	3.31±0.04	6.66±0.11	0.09±0.01	40.78
5	75.46±0.13	5.89±0.03	5.49±0.03	19.25±0.01	1.007±0.04	79.61
6	71.11±0.09	4.35±0.05	4.39±0.03	19.25±0.01	0.88±0.03	102.52

7	41.65±0.16	16.33±0.06	35.01±3.13	1.42±0.01	3.57±0.03	185.9
8	91.17±0.31	2.25±0.07	2.56±0.06	3.87±0.13	0.12±0.02	26.8
9	75.66±0.07	2.22±0.04	2.37±0.10	19.46±0.009	0.17±0.03	88.97
10	72.16±3.40	1.48±0.04	10.53±0.09	15±1	2.81±0.03	127.37
11	22.99±0.12	1.28±0.14	1.65±0.08	73.62±0.43	0.31±0.02	304.56
12	78.70±0.23	5.63±0.11	3.18±0.04	9.1±.1	3.37±0.04	79.53
13	89.09±0.06	1.08±0.05	2.4±0.04	7.28±0.07	0.12±0.02	39.8
14	67.15±0.07	2.08±0.04	2.39±0.03	28.24±0.03	0.086±0.01	123.46
15	85.09±0.23	8.10±0.04	2.12±0.03	2.31±0.46	2.36±0.04	39
16	86.57±0.20	1.81±0.04	1.06±0.03	9.82±0.21	2.79±3.64	49.98
17	85.19±0.07	1.21±0.03	0.99±0.03	12.54±0.80	0.04±0.005	54.61
18	87.53±0.25	1.09±0.04	3.7±0.03	7.7±0.17	0.02±0.005	45.87
19	89.27±0.03	1.29±0.03	3.7±0.03	5.71±0.21	0.01±0	37.73
20	88.56±0.23	0.38±0.02	4.22±0.04	6.73±0.08	0.09±0.02	44.7
21	85.65±0.39	10.38±0.03	1.94±0.18	1.5±0.16	0.53±0.08	18.57
`22	7.83±0.07	5.06±0.07	19.4±0.02	30.75±2.57	36.93±0.07	533.15
23	87.57±0.05	0.79±0.02	4.94±0.038	6.55±0.32	0.11±0.01	46.95
24	29.55±0.03	5.96±0.08	8.55±0.01	53.72±1.86	2.20±0.11	268.97
25	82.97±0.04	0.31±0.01	6.61±0.06	9.43±0.53	0.67±0.23	70.2

Similarly, in the control village (Table 4), tuber, green chilies, Khar, ginger and green vegetables carry more amounts of carbohydrate and ashes, fat content ranges from 0.04% (Colocasia stem) to 36.26% (Pork gravy with different vegetables/rice flour). All higher amounts of protein are derived from fish and pork gravy. Carbohydrate ranges from 1.33% (Black gram gravy) to 72.3% (Aijong Rice). The moisture content ranges from 22.56% (Fermented fish) to 92.93% (Black gram gravy); ash 0.45% (mix green vegetables) to 5.56 % (ginger); proteins, 0.03% (Colocasia stem) to 51.98 % (Fermented fish).

Table: 4 Nutrient Contents of Control Dishes

Food item	Moisture (g/100g f.w)	Ash(g/100g d.w)	Protein(g/ 100g d.w)	Carbohydrate (g/100g d.w)	Fats(g/ 100g d.w)	Total Energy (Kcal /100g)
1	92.74 ±0.07	2.73 ±0.03	2.29 ±0.04	1.38 ±0.02	0.24±0.02	19.32
2	80.93 ±0.29	2.06 ±0.04	3.19 ±0.06	8.45 ±0.28	5.16±0.04	93.84
3	42.4 ±0.57	0.79 ±0.02	1.9 ±0.02	54.64 ±0.60	0.49±0.015	45.14
4	74.23 ±0.47	1.28 ±0.05	5.6 ±0.07	18.56 ±0.08	0.49±0.015	231.02
5	46.77 ±0.24	0.45 ±0.03	2.02 ±0.07	50.4 ±0.01	0.30±0.025	99.46
6	25.51 ±0.08	0.69 ±0.02	1.19 ±0.03	72.3 ±0.2	0.30±0.025	212.56
7	36.43 ±0.16	1.02 ±0.07	10.73 ±0.08	15.56 ±0.16	36.2±0.37	296.70
8	64.51 ±0.04	0.53 ±0.03	2.77 ±0.02	31.91 ±0.14	0.27±0.02	431.51
9	70.20 ±0.06	1.15 ±0.04	2.22 ±0.04	26.02 ±0.05	0.38±0.02	141.2
10	51.4 ±0.03	0.79 ±0.04	1.3 ±0.02	43.28 ±0.20	3.22±0.02	116.46
11	44.28 ±0.07	0.77 ±0.03	9.36 ±0.33	12.81 ±0.03	32.78±0.02	207.30
12	90.37 ±0.13	1.13 ±1.13	2.64 ±0.15	5.3 ±0.12	0.47±0.03	383.70
13	60.23 ±0.10	1.90 ±0.04	14.43 ±0.7	7.61 ±0.02	15.82±0.07	36.31
14	65.17 ±0.07	2.09 ±0.04	15.1 ±0.04	0.83 ±0.01	16.80±0.04	230.58
15	84.61 ±0.24	0.61 ±0.04	3.54 ±0.07	10.53 ±0.25	0.69±0.05	214.92
16	66.66 ±0.07	1.10 ±0.06	2.63 ±0.09	26.85 ±0.14	2.74±0.06	62.58
17	71.53 ±0.08	2.18 ±0.04	6.74 ±0.06	15.74 ±0.03	3.81±0.04	124.21
18	92.93 ±0.11	1.56 ±0.03	4.06 ±0.03	1.33 ±0.01	0.1±0	22.5
19	92.12 ±0.31	2.5 ±0.04	3.28 ±0.06	1.94 ±0.04	0.14±0.02	22.22
20	57.73 ±0.06	2.04 ±0.05	16.16 ±0.03	7.75 ±0.26	16.30±0.03	242.28
21	22.56 ±0.03	5.28 ±0.05	51.98 ±0.32	16.51 ±0.08	3.67±0.02	307
`22	74.03 ±0.09	5.56 ±0.02	3.1 ±0.04	16.73 ±0.01	0.56±0.03	84.36
23	76.47 ±0.22	2.85 ±0.02	4.40 ±0.03	14.8 ±0.01	1.46±0.03	90
24	83.61 ±0.05	4.8 ±0.04	0.29 ±0.01	8.13 ±0.01	0.29±0.01	47.86
25	90.36 ±0.14	1.8 ±0.06	0.03 ±0.005	5.89 ±0.06	0.03±0.005	31.6

The present study indicates that in the study village, villagers consumed the vegetables which were ecologically available that includes plants like the families of Araceae, papaya, taro, cassava as their staple food. These green vegetables have the higher amount of moisture as well as ash and the lesser amount of carbohydrate, fat, and protein, which is supported by the

literature. The study also indicates that the villagers of study area consume more amounts of moisture and ash contents and the lesser amount of protein, fats, and energy derived from them(Figure 1).

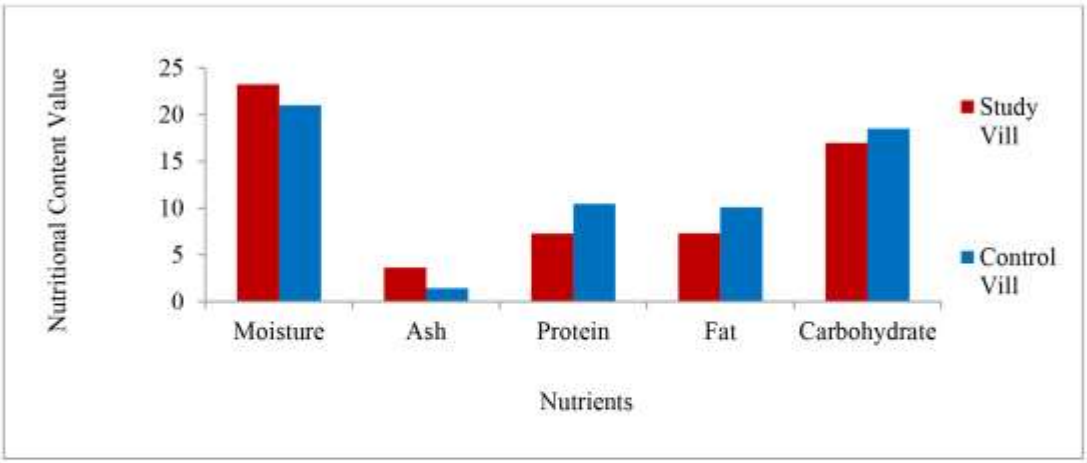

Fig 1: Comparison of Nutritional contents of Study and Control villages

It also supports having antimalarial properties of these foods (Table 5). On the other hand in the control village, people tend to modernize, and eat foods which are available in the market. They consume more animal protein than vegetables. The vegetable leaves are very high in moisture which is in agreement with the range values reported for fresh vegetables [24] and are generally the poor source of protein [60]. They are low in carbohydrate and gross energy, but fairly high in crude fiber and ash [1]. The low gross energy values of the leaves could have resulted from their low crude protein, lipid and carbohydrate contents.

Figure 1 show comparative nutritional evaluation and Table 5 shows that the earlier studies on various plants for malaria therapy and medicinal purpose. Such plants are frequently consumed either raw or cooked by the people of the study village. These foods are used by the people either raw as salad or cooked on daily basis and are self-cultivated, which may help to tolerate parasitic disease like malaria and remain in a latent period without showing proper symptoms.

Table 5: Reported Plant materials used for treatment of malaria

Sl. No	Plant materials	References
1	Species of Araceae, Colocasia esculata	Frautin, G. 2015, Pedralli, 2002, Milliken et al. 1997a, 1997b; Kvist et al., 2006; López et al., 2006, Adepoju et.al.2008
2	Carica papaya	Bergonio et.al., 2015, Wright 1990, Gasquet M, 1993, K. Kovendan 2012, Ahmad, N., 2011, Goel et al., 2001
3	Manihot esculentum	Melo et al., 2009; Punthanara et al., 2009, Velayutham, K. et al., 2016.
4	Fish	Per Fevang, 1995, Orville A, 1995, Block et.al. 1991, Herbas et al. 2010, Field et al. 2002, Levander et al. 1989,Maria, S. et al., 2006, Alves, M.F.A., et. al. 2006
5	Curcuma longa	Reddy, R.C., 2005, Rasoanaiv et al, 2011
6	Zingiber officinale	Coe, F.G., 1996, Shankar 1999, Singh 1994, Vongo 1999
7	Momordica charantia	Day et al., 1990, Elased et al. 1995, Mohapatra 2001.
8	Chameleon	K.Luong, 2012.
9	Capsicum sp.	Mathur, A., 2015.
10	Musa sp.	Sanyal et al., 1963, Lewis et al., 1999, Pari and Maheswari,1999

The ash and moisture content is found to be comparatively lower in control village than study village and protein, fats and carbohydrate is higher than study village. Though the control village shows the higher amount of energy derived from dishes, the amount of nutrients needed for human health to resist a disease is less, due to use of the higher amount of animal proteins and the lesser amount of green vegetables and derivatives. This may indicate that consumption of the lesser amount of green vegetables, cassava, tubers, dry fish etc which contain the higher amount of moisture and ash content and which have more antiplasmodial activities may be the major factor for tolerance to malaria parasite in people living in the study village.

In the study village, it is seen that the moisture content ranges from 7.83 %(sesame) to 92.4& %(Colocasia stem with fermented fish). The high moisture content in these dishes is due to the vegetable used and water added to the dishes during cooking. The highest moisture content was found in the green vegetables, banana flower, tubers, legumes, fermented fish and the curry prepared from this items .The ash level ranges from 0.38% (Bean) to 16.33% (Fermented fish). The higher ash and protein content was found in fermented fish, green chilies, ginger, pork gravy with green leaves and rice flour and more abundantly in black sesame (36.95%). The highest carbohydrate found in Rice (73.74%), Taro, sesame (30.75%) and food item prepared by it. The highest fat content was found in sesame, fermented fish, curry prepared with pork, green leafy vegetables, green chilies and ginger.

4. CONCLUSION

In conclusion, this study provided an insight into the nutritional composition of the tested food items in addition to their therapeutic potentials. It was concluded that the presence of these nutrients and phytochemically-active components in the plant samples might be responsible for their therapeutic activity as antimalarial plants. Further in-depth studies on diet consumed in different communities in malaria-endemic areas with malaria tolerance in different geographical location of the world and their relation with their food habits in molecular level may lead to new research scope and preventive measures to fight against malaria, which may be a great help to public health.

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Research Article

A RETROSPECTIVE STUDY OF MALARIA TRENDS OF GHAGUA HEALTH CENTRE, KAMRUP METROPOLITAN DISTRICT, ASSAM, INDIA

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ABSTRACT

The present study was carried out in Kamrup Metropolitan District, Assam, India with the principal objectives to analyze the trends of Malaria to create early warning signals and public awareness for prophylactic measures. Malaria is rapidly occurring in many parts of the world in all age groups. Data were collected from active and passive cases registered in Digaru state dispensary (SD) and Sonapur primary health center (PHC) from 2009 to 2018. Data were analyzed in MS-excel. The results showed the fluctuating but declining trends of cases. Preventive measures and changes in the treatment guideline may be the major factor for declining of cases. However, malaria admissions are fluctuating over these years. The outcome of this study shows timely analyzing various data to reduce disease burden and there is a need to continue all the preventive measures especially in vulnerable groups. It has been observed that Malaria infection was associated with time, place and person with major preventive contribution from disease surveillance.

Keywords: Retrospective, trend, early warning signal, prophylactic, vulnerable, disease burden.

INTRODUCTION

Malaria is an infectious disease transmitted by vector organisms, mosquitoes, and it is caused by parasite microorganisms. The disease has spread over tropical latitudes of climate, demographics, and societal conditions[9]. Being humanities oldest and world's most devastating parasitic disease; it has been a major public health problem since decades[14]. 50 % of the world population is affected by malaria[1,19]. The transmission bionomics of malaria is partially linked with changes in temperature, rainfall and humidity. Sonapur block under Kamrup Metro district, Assam also has been reporting higher annual parasitic incidence (API) from the past. The prevalence gradually decreased due to many intervention programs. Despite continuous efforts, the persistence of malaria is as the major cause of morbidity, mortality and socioeconomic problems in many parts of the world[2]. The various factors like expensiveness of the control program, the resistance of the parasite to anti malarials and vectors to insecticides, and complexity of control process are the major road blockade in the process of disease control process[3,4,6-8,13]. At present, due to global support for malaria elimination is taking a major role for eliminating malaria and report from different parts of the world show decreasing trends of malaria but the exact factors for its reduction are not well defined. Therefore, this study was initiated to analyze the nine-year trend prevalence of malaria and to assess the impact of the control measures taken by the current national vector-borne disease control program on malaria prevalence in the study area.

Prevention and control activities of National Vector Borne Control Programs have been introduced during the course of time to reduce the burden of malaria. Four major intervention strategies that are being applied in Kamrup Metro district to combat malaria are early diagnosis and prompt treatment, selective vector control that involves the use of indoor residual spraying (IRS), Insecticide-treated Nets (ITNs)/Long Lasting Insecticidal Net (LLIN) and public awareness programs. For malaria control, field evaluation of insecticide-treated mosquito nets (ITNs)[11] was carried out for the first time in India at Sonapur, in Kamrup Metro district, Assam. Global malaria control program has been intensified to evaluate and to estimate malaria incidence and time trends[12].

The study will provide current trends of malaria envisages that it might strengthen the information so far for scaling up and to design effective communication strategies to combat these diseases in the study area.

MATERIALS AND METHODS

Ethics statement

The study was carried out as per Action Plan of District Vector Borne Disease Control Program, Kamrup Metropolitan District, Assam 2015-16 and 2017-18 and the result was incorporated in Annual report. Consent was taken from subjects and study was in accordance with ICH GCP Guidelines.

Study area

This record review comparative study was conducted in Ghagua sub-center (SC) under Sonapur Block PHC (Figure 1) a rural setting where it is a hilly area with natural foothills, tea estates and water bodies, which is favorable for the transmission of malaria. Under this sub-center, the villages which are affected by malaria are with higher annual parasitic incidence (API) of the district. The study sites had accessibility to a health center and a state dispensary. Laboratory technicians and surveillance workers

tested for malaria in hospitals and rapid diagnostic kit at field respectively. A retrospective comparative study design was employed using data from local health services (passive and active). This was done by reviewing malaria morbidity records of local health facilities pertaining to villages within a specified radius of Ghagua sub-center. This sub-centre has been reporting malaria cases for many years. Although malaria has been controlled compared to the previous year's still it is proved to be endemic in the district. Insecticide-treated nets, a vital element of actions to roll back malaria were field evaluated against *An. minimus* transmitted malaria in endemic villages of Kamrup district. *P. falciparum* was recorded in all age groups of both sexes. There was clustering of cases in villages near the vector-breeding habitats (perennial seepage streams) and foothill villages. The data presented are indicative of moderate to high levels of malaria transmission by *An. minimus* and would be of value for evolving future intervention strategies. The trend of malaria prevalence was analyzed.

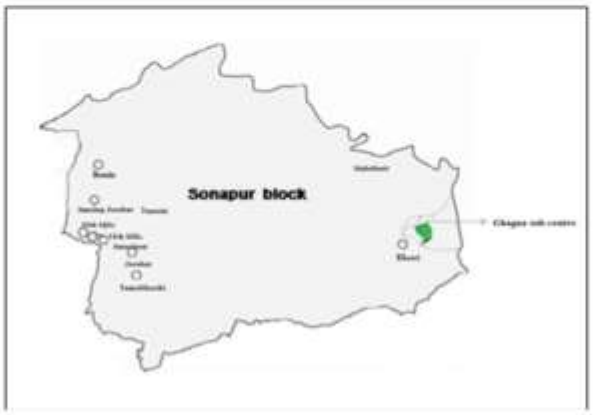

Figure 1: The map of Sonapur block showing location of Ghagua sub centre

Study design

A retrospective study is conducted to determine the trend of malaria by blood samples. The prevalence of malaria was done at Ghagua health-centre and Sonapur block PHC.

Data collection

Malaria cases are treated both clinically and as confirmed malaria accordance to national guideline[17] depending on the degree of diagnostic capabilities at different levels of the healthcare system. Confirmed cases are registered on preformatted registration books (M3 format) at health care levels and reported both fourth night as well as monthly to the next higher level of the health management system. The present study included all malaria records of the local healthcare unit (SD). A format was prepared on a computer spreadsheet (Excel) collect the secondary data from the registers maintained at SD. All the patients who visited hospital tested positive for malaria and the patients tested positive by the surveillance workers in the field are recorded year wise. The detection of malaria is done by National Vector Borne Disease Control Program (NVBDCP) supplied antigen-based rapid diagnostic kits (RDK) and peripheral blood smear examination well-prepared and well-stained blood film is used as the gold standard in the centre. For this study data was collected from 2009 to 2018.

Factors affecting malaria trends

The department of vector control program has national formats to collect data on a monthly basis and compiled and analyzed monthly/annually to find the trend of the disease. The awareness of malaria and other vector-borne diseases increasing and many organizations are taking initiatives for preventive measures through vector control methods, health education, Inter personal communication to sensitize community people.

Data management and processing

The data on malaria cases records collected from the health institution of the study site is then transferred to Microsoft excel sheets and analyzed by statically. Results were summarized using Tables and Figures to show the distribution of prevalence.

RESULT

Annual trends of malaria prevalence

Within the last decade (2009–2018) a total of 16,431 blood samples were tested for malaria by health workers and technician. Out of which 142 PF and 71PV and a total of 213 cases have been recorded during these years. There was a fluctuating trend of malaria within the last decade, with the maximum (58) number of confirmed malaria cases being reported in 2010 and the minimum (8) confirmed cases of malaria being reported in 2015. Blood slide examined (BSE) in 2010 and 2015 was 1555 and 1569 respectively. If we look into the annual parasitic incidence, Ghagua sub-centre is reporting the highest API (>2) from 2010 to 2015 (Figure 2). Subsequently, though there is a fluctuating of malaria in 2012 and 2015 to 2018 there is a decreasing trend.

There is declining trend of malaria indicators i.e. slide positivity rate (SPR), slide falciparum rate (SPR) with respect to annual parasitic incidence (API) (Figure 3), both species of Plasmodium were reported in each year, which accounted for malaria morbidity in the study area.

In the year 2010 to 2011; *P. falciparum* was increasing, but in 2012 it was decreasing in the study area. But in 2013 it was again increasing trend. *P. vivax* is decreasing trend from 2010 to 2012. But in 2014 is reporting more cases than the last years (Figure 4). From 2015 onwards there is a declining trend and in 2016, 2017 and 2018 there are no positive cases reported in the sub-center.

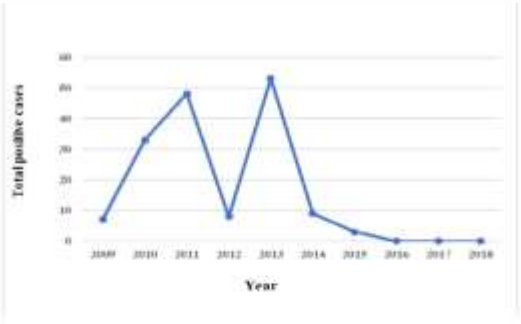

Figure 2: Annual trends of malaria cases from 2009-2018

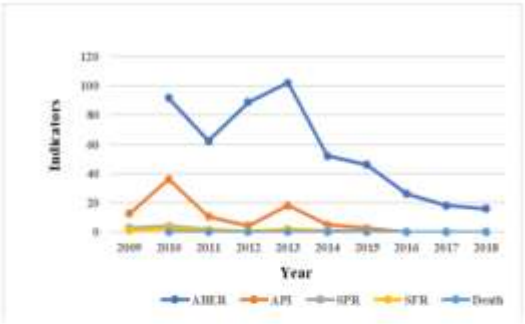

Figure 3: Annual trends of malaria indicators from 2009-2018

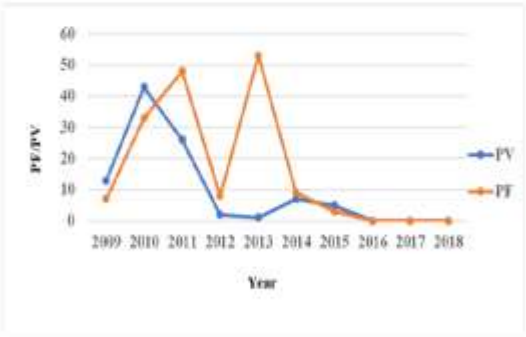

Figure 4: Species trends of malaria parasite of Ghagua sub centre from 2009-2018

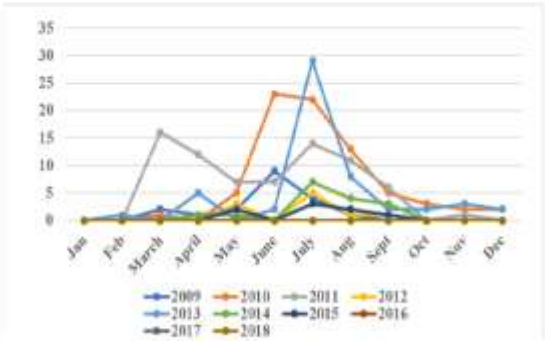

Figure 5: Month wise trend of malaria cases from 2009-2018

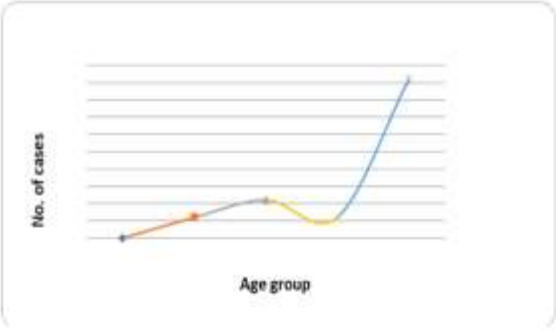

Figure 6: Distribution of cases in different age groups from 2009-2018

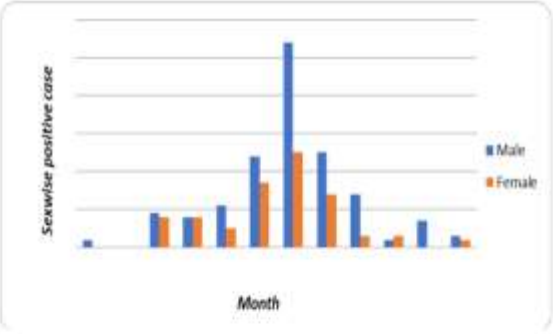

Figure 7: Distribution of cases in sexwise positive cases from 2009-2018

Age group variation

This study reveals that adult age groups are more affected than pediatric groups. No cases of below 1< have been reported during 2013-2015. Males are more affected than female (Figure 4 and 5).

Seasonal variation of malaria prevalence

The reflection of malaria cases has been noticed throughout the year. The highest peak of malaria cases in the month of July followed by June and August (Figure 6). During winter (December, January, and February) minimum numbers observed and the maximum malaria cases were observed during summer (June, July, and August) seasons.

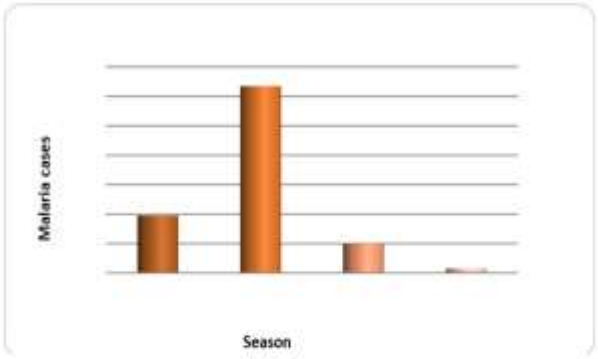

Figure 8: Seasonal variation of malaria cases under from 2009-2018

DISCUSSION

Malaria is a major public health program in terms of morbidity, mortality, and burden of the healthcare facility. The present study reveals the prevalence of malaria in the study area of Kamrup Metro district and major species is *P. falciparum*. This is very lower than studies reported from other parts of the country and the world[5,15,16]. The difference may be due to the endemicity of malaria, study design used climatic differences, altitude variation, malaria diagnosis technique variation, the skill of the laboratory personnel to detect and identify malaria parasites other factors that affect malaria case occurrences in different study factors. The study reveals a fluctuating trend occurrence of malaria cases was observed in the study area. A decrease in the number of malaria cases number occurred in 2012 and 2015 with a minimum number in 2015. However, 2010, 2011 and 2013 being reported pick numbers of malaria cases, most recently 2013. In 2016, 2017 and 2018, there are no positive cases reported in the sub-centre. Last nine years studied shows remarkable changes of PF and PV cases and *P. falciparum* found to be common in the study area. The study shows an increasing trend of malaria cases in 2013 with more numbers of *P. falciparum* but in 2015, the increasing trend of *P. vivax* is seen than the last 3 years. There was a fluctuation of malaria cases throughout these years (Figure 9). Earlier studies also showed[1,2,4,6,10-11] similar trends of malaria cases. The Annual Report of National Vector Control program, Kamrup Metropolitan District showed that there is a similar decreasing trend of other sub-centers of the district where there were symptomatic and as well asymptomatic cases were reported earlier (Hazongbari village, Suwali Lukua village, Sampothar and Kilingog village of Hazongbari sub-centre of Sonapur Block[18].

The different studies of different parts of the world reported earlier may be because of many factors like climate, ecologic and environment[3,4,6-8,13], host and vector characteristics, social and economic determinants such as healthcare infra structures. Although, many intervention programs such as ITN/LLIN, IRS, and awareness program have reduced morbidity and mortality of malaria cases, the prevalence is still sustained.

The observed decline in malaria in 2015 could be strongly attributed to the interventions. *Plasmodium falciparum* was the predominant species in the study area and accounted for malaria morbidity. This study also shows that since 2011 *P. vivax* is decreasing but in 2014 there is an increasing trend which indicates a trend shift. The severity of *Plasmodium falciparum* and problem caused by, *P. vivax* might be neglected in society and might be the reason for the rising of cases[2,10].

Age and sex group distribution reveals that adult and male groups are more affected. This is because of their occupation and staying outside the home and sleeping behaviour or may be other reasons males are more exposed to Anopheles mosquito bites, which can transmit malaria parasites.

Seasonal variation plays an important role in malaria transmission. In this study, it is seen that the highest numbers of cases reported in summer (June, July, and August). After spring, it has become favourable for malaria transmission. In Assam major transmission occurs in this season after the rain. The environmental setting and climatic condition provide the vector for continual breeding and sites16.

This study reveals the prevalence of malaria in the rural setting and due to interventions fluctuation of cases has been noticed.

CONCLUSION

Comparatively, after the introduction of current control strategies, the morbidity and mortality of malaria is decreasing but still prevalent. The highest peak of cases was observed in seasonal trend. Periodical epidemiological study for generating impending outbreak and timely intervention programs should best strengthened for a seasonal occurrence of these diseases in the study area.

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Malaria and Nutritional Status in Children Living in Endemic Areas of Kamrup Metropolitan District, Assam, India.

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Abstract: The aim of the study was to find out the status of nutritional status of children below (=<15) years between the asymptomatic and symptomatic malaria-prone village of Kamrup metropolitan District of Assam, India and to find out the association of malaria with nutritional status by measuring Body Mass Index (BMI) of children. The result was found that 49 and 55 nos. of children had normal BMI in symptomatic and asymptomatic malaria-prone villages respectively. 0-5 years had more normal BMI in both the village which may be due to breastfeeding habits and proper care. Association of malaria with nutritional status was not so clear.

Keywords: Asymptomatic, Body Mass Index (BMI), association.

1. INTRODUCTION

One of the major cause of children morbidly and mortality is due to health-related issues or disease. Malaria and malnutrition are considered as an issue among these [1] [2]. It is also always debatable about its disease effect for which it causes malnutrition leading to mortality [5] [7] [14]. Studies show acute weight loss due to *Plasmodium falciparum* [10]. There are many supportive studies available which shows a relationship between malnutrition and malaria [3] and others show no association [11]. The present study was carried out in Kamrup Metropolitan District of Assam, keeping in the view that if there any relationship between malaria-infected children and healthy children of <= 15 years. Various factors like socio-economic, demographic, gender role, health awareness is related to transmission and epidemics of malaria.

2. MATERIALS AND METHODS

2.1 Study area

Two malaria endemic villages of Kamrup Metropolitan District of Assam were considered for the study. One was Suwali Lukua village, comprising of three small villages of total populations 359. Asymptomatic malaria cases were reported by this village and were considered as study village. Another village called Hazongbari, symptomatic malaria prevalent village, of total populations 749, was considered as control village.

2.2 Study design

A total of 200 children, 100 numbers of each village was chosen for the study. Both malaria-infected and healthy children were measured their height and weight by measuring tape and Nova BGS-1231 digital weighing machine. The measurements were noted in centimeter and kilograms. Body mass index (BMI), which was considered as the measurement for nutritional status, also measured and compared according to the World Health Organization [15] (BMI of 18.5 to 25: normal, 25 to 30: overweight, over 30: obese and less than 18.5 is considered underweight). Further the age group were divided into three groups.

2.3 Data analysis

The data obtained were plotted in an excel sheet and analyzed and categorized accordingly as per WHO standards.

3. RESULT

The result was found that the control village was more normal in BMI than study village (55 & 49 nos.) and study village more undernourished and severely undernourished than control village. The boys were found as more normal BMI than the girls in both the villages. Age distribution on BMI status

was shown that 0-5 years had normal BMI in both the village. Association of malaria with BMI was not much clearer. The results were shown in Table 1, 2 and Figure 2, 3.

Table 1: BMI comparison of study and control

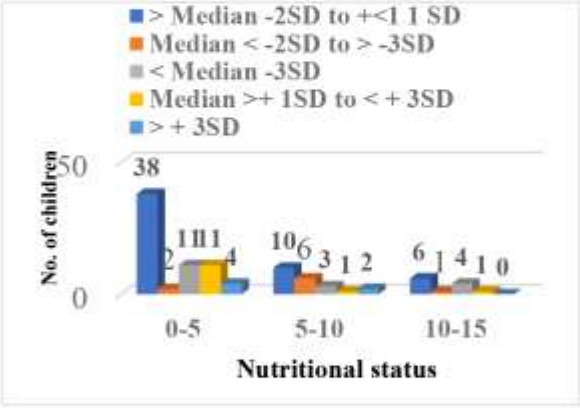
BMI Area	Nor-mal	Mod-erate under nutrition	Severe under nutrition	Overweight	Obes-ity
A	49	21	21	6	3
B	55	18	9	12	6

*A=Study village, B=Control village

Table 2: Association of BMI with Malaria

Area	With Malaria		without Malaria	
	Normal BMI	<BMI	Normal BMI	<BMI
A	53	29	6	12
B	5	6	60	29

*A=Study village, B=Control village

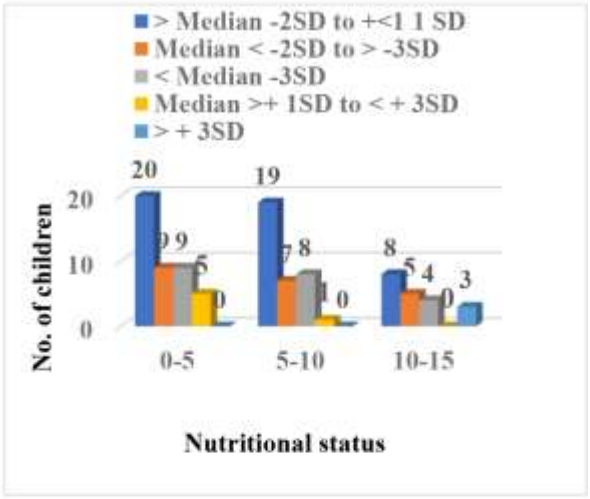


> Median -2SD to +<1 1 SD: Normal, Median < -2SD to > -3SD : Moderate undernutrition, < Median -3SD : Severe undernutrition, Median >+ 1SD to < + 3SD : Overweight, > + 3SD : Obesity

Fig. 2. Age distribution of BMI in Control village

4. DISCUSSION

The finding on the study shows that asymptomatic malaria cases of study village were greater in a number of children having malaria with normal BMI than without malaria. On the other hand, the control village was found almost equal results.



> Median -2SD to +<1 1 SD: Normal, Median < -2SD to > -3SD : Moderate undernutrition, < Median -3SD : Severe undernutrition, Median >+ 1SD to < + 3SD : Overweight, > + 3SD : Obesity

Fig. 1. Age distribution of BMI in Study village

Whereas, without malaria, control village a greater number of children had normal BMI. The study showed no clearer conclusion regarding the relationship between BMI status and malaria infection. The similar type of debatable results was reported by previous studies [4][7] [14]. Few reported as there was no association [3] [11] and other reported increased risk of malaria among stunt and underweight children [3][5][6]. According to the previous research, the nutritional status of the children played an important role in morbidity and host resistance to infection [8] [9] [12] [13]. Age distribution on BMI status showed 0-5 years had normal BMI in both the village might be the breastfeeding habits and more protective years of childhood when children were best-taken care off by the parents.

5. CONCLUSION

The study of young children's living in the malaria-endemic village(study) where asymptomatic cases reported, had a large number of malnourished children (21 moderately and 21 severely malnourished) than control village (18 moderately and 9 severely malnourished). The result was found that normal BMI with malaria-infected children had more (53) than below normal (23) in study villages. Whereas in symptomatic malaria village(control) was

found an almost equal relationship with malaria infection and BMI (5 normal and 6 below normal).

From the above result, it can be concluded that for improvement of nutritional status and to reduce malaria incidence it is suggested to take increase health awareness and to adopt preventive measures to fight against any disease. In both villages, it was found that in the group of 0-5 years had more numbers of normal BMI children (20 and 38) in study and control villages as that is the age when a child is taken care of.

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