Original Research Article

Study of Malaria Surveillance indicators of Visakhapatnam (GVMC) and evaluation of the status of functioning of Urban Malaria Scheme (UMS)

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Abstract

Introduction: National Framework for Malaria Elimination in India (2016-2030) was launched in the year 2016 with an objective of eliminating malaria throughout the country and to prevent not only re-establishment of transmission but also to reach the stage of zero indigenous cases by the year 2030. During the early 1970's resurgence of malaria, maximum cases (7.4%) and deaths (10.9%) were reported from urban areas where Visakhapatnam was one among them. Urban Malaria Scheme (UMS) was launched in 1971in Visakhapatnam along with other cities like Chennai, Vadodara, Vijayawada, as a component of National Malaria Eradication Program me (NMEP) to reduce/interrupt transmission particularly effecting the towns and cities. **Methods:** The present study period is from 2012 to 2020. Secondary data has been collected from GVMC Chief medical officer, District and Zonal malaria offices with their approval. The present study design is retrospective trend analysis of malaria surveillance indicators of GVMC. Year wise parasitological indices were estimated. Vector density was also obtained for the study period. Integrated Vector Management (IVM) is prime activity in Visakhapatnam city under Urban Malaria Scheme (UMS). **Results:** Blood smear collections, total number of fevers subjected to blood smear examination, smear positives, type of malaria, estimation of API (from ABER and SPR) which is the key indicator for categorization of states and district falling under stage of elimination of malaria. Starting from the year 2013 there is consistent fall of API (2.21-0.02) and SPR (3.24-0.05) There is an under-reporting in the year 2020 where sufficient number of blood smears could not be collected under active and passive surveillance. The main activity of malaria control in GVMC under Urban Malaria Scheme is IVM which brings down the critical density of the vector for transmitting the malaria parasite. Deaths were not reported throughout the time line. **Conclusion:** It is evident that Visakhapatnam city parameters of malaria surveillance are comparable to that of country wide malaria surveillance data and GVMC is already a partner in National Frame work for Malaria Elimination in India (2016-2030) and hopefully reach the objective by 2030.

Keyword: Malaria, Surveillance indicators, Evaluation, Urban Malaria Scheme.

Introduction

National Framework for Malaria Elimination in India[1,2] (2016-2030) was launched in the year 2016 with an objective of eliminating malaria throughout the country and to prevent not only re-establishment of transmission but also to reach the stage of zero indigenous cases by the year 2030. During the early 1970's resurgence of malaria, maximum cases (7.4%) and deaths (10.9%) were reported from urban areas where Visakhapatnam was one among them. Urban Malaria Scheme (UMS) was launched in 1971in Visakhapatnam along with other cities like Chennai, Vadodara, Vijayawada, as a component of National Malaria Eradication Program me (NMEP)[3] to reduce/interrupt transmission particularly effecting the towns and cities.

Since inception of UMS, the malaria wing of Public Health section of Visakhapatnam city has been getting organized under the technical guidance of District health administration, man power and logistic inputs of municipal corporation , malaria control in Visakhapatnam has been gaining strength year after year and today on par with any metropolitan cities like Delhi, Mumbai, Chennai , competing with the rest of the country to become a partner under National Framework for Malaria Elimination in India (2016-2030).

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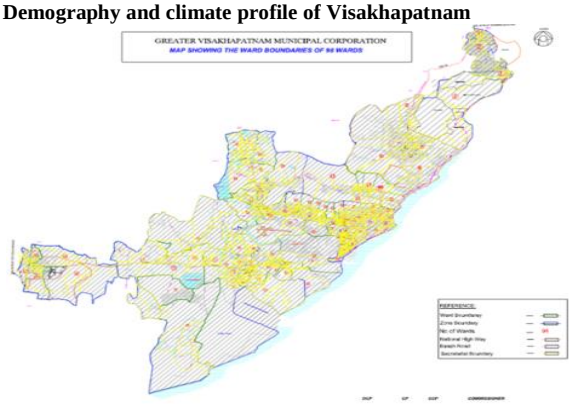
This particular aspect prompted the author of the present research work to assess the trend of the malaria situation in the city of Visakhapatnam retrospectively from almost a decade and predict the future malaria situation in relation national objective.

Demography and climate profile of Visakhapatnam



Once Visakhapatnam was an old port city, upgraded as Greater Visakhapatnam Municipal Corporation in the year 2006 with an extent of 682 KM^2 and a population of 1808290. The city has been divided into 8 zones with existing old city consists 5 zones and adjacent municipalities Gajuwaka, Bheemili, Anakapalli and 13

village panchayats forming 3 additional new zones. The density of the population is 2500 perKM². During rainy season from July to September are the warm and moist months congenial for mosquito propagation. Relative humidity ranges from 60 percent to 80 percent suitable for mosquitos to live longer, more active and feed voraciously. Entomological studies in Visakhapatnam revealed breeding of Anopheles, Culex and Aedes throughout the year and high density was found particularly during rainy season enabling them for transmission of Vector borne diseases.

Demographic Profile Of The City Visakhapatnam (GVMC)

Zone	Number of wards	Population
I	3	47350
II	9	249563
III	14	2.52656
IV	12	181463
V	26	389237
VI	19	382220
VII	5	81421
VIII	10	224380
Total	98	1808290

Out of the 8 zones II, III, IV, V, VI zones are thickly populated and the remaining zones density of population is low. Most of the thickly populated areas are situated in city proper and other zones are sub-urban areas, and panchayats distributed in vast areas with agriculture fields and vacant lands.

Objectives

The objective of the present study is to estimate the malaria surveillance indices of Visakhapatnam city (GVMC) retrospectively from the year2016 and compare to that of countrywide malaria surveillance data correspondingly, with a view to bring the city in to the time line of the National Frame Work for Malaria elimination.

Methodology

The parameters used for measurement of malaria in the present study are mostly parasitological in nature which are in vogue in our country. They are API, ABER, SPR, and SFR. The phasing out malaria elimination has been worked basing on API (as primary criteria) and ABER and SPR (as secondary criteria).

Under classification of malaria elimination category**[4]**, AP state falls under category-2 as the parameter API< 1 but some of its districts reporting API > 1. But Visakhapatnam district has been consistently showing API <1 from the year2016 including GVMC. It was further mentioned that even if the given state is not yet in elimination phase, if their districts with API less than 1 could be considered eligible for initiating elimination phase activities. In addition, each district may sub-categorize its blocks in to different phases based on their API status. This would facilitate category 2 districts to start elimination activities in their blocks falling in category 1. Stratification may be done in this manner up to the sub- center level. This particular direction, under planning and implementation of malaria elimination program me, has given impetus to the author of this article to suggest the elimination program me in GVMC, since it is reporting API <1 consistently over years. The GVMC is divided in to URBAN and PERI-URBAN and clearly alienated from the rest of the Visakhapatnam district. The integrated vector management prescribed under UMS has been affectively implemented by the public health section of GVMC, and the trend of malaria, is consistently showing downward inclination of API. The SPR is also showing down ward trend without showing much variation in percentage of smear negative fevers(un-differentiated) throughout the time line.

Data collection and Study design

The present study period is from 2012 to 2020. Secondary data has been collected from GVMC Chief medical officer, District and Zonal malaria offices with their approval. The present study design is retrospective trend analysis of malaria surveillance indicators of GVMC. Year wise parasitological indices were estimated. Vector density was also obtained for the study period. Integrated Vector Management (IVM)[5] is prime activity in Visakhapatnam city under Urban Malaria Scheme (UMS)

Parasitological Indices

API (annual parasite incidence) sophisticated measure[6] of malaria incidence in a community. It is based on intensive active and passive surveillance and cases are confirmed by blood smear examination.

$$\text{API} = \frac{\text{Confirmed cases during one year}}{\text{Population under surveillance}} \text{X } 1000$$

ABER (annual blood examination rate) index of operational efficiency. The API depends upon the annual blood collection and examination rates.

$$\text{ABER} = \frac{\text{Number of slides examined}}{\text{Population}} \text{X } 100$$

SPR (slide positivity rate) is the percentage of slides found positive for malaria parasite irrespective of the type of species.

Integrated vector management (IVM) for transmission risk reduction including[1] indoor residual spraying in selected high-risk areas[2], use of insecticide treated bed-nets[3], use of larvivorous fish[4], anti-larval measures in urban areas[5], source reduction and minor environmental engineering

Parameters of malaria surveillance[7]

By definition, surveillance also implies the continuing scrutiny of all aspects of occurrence and spread of a disease. that are pertinent to effective control. Included in these are the systematic collection and evaluation of field investigations, etc. The following parameters are widely used in the epidemiological surveillance of malaria:

(a) Annual parasite incidence (API);
(b) Annual blood examination rate (ABER);
(c) Annual *falciparum* incidence (AFI);
(d) Slide positivity rate (SPR); and
(e) Slide *falciparum* rate (SFR).

Pf - Plasmodium falciparum, BSE - Blood Smears Examined,

Results

Table-1: Year wise Malaria cases-Visakhapatnam-GVMC

Year	Urban			Peri-Urban			Total		
	Vivax	F. parum	Total	Vivax	F. parum	Total	Vivax	F. parum	Total
2012	3041	12	3053	233	64	297	3274	76	3350
2013	3006	11	3017	153	35	188	3159	46	3205
2014	2204	23	2227	403	105	508	2607	128	2735
2015	2426	27	2453	181	56	237	2607	83	2690
2016	1440	6	1446	116	30	146	1556	36	1592
2017	631	8	639	143	26	169	774	34	808

2018	373	4	377	83	15	98	456	19	475
2019	79	1	80	33	9	42	112	10	122
2020	16	2	18	21	4	25	37	6	43

Table -1 shows year wis occurrence of malaria cases, both vivax and falciparum from the year 2012 to 2020 In GVMC. There is a downward trend up to 2018 and it appears there is gross under reporting in the years 2019 and 2020 due to COVID-19. Cases due to Vivax are more in number when compared to falciparum. In the year wise time distribution total number of malaria cases, falciparum malaria is low and did not appear to cause major public health problem unlike vivax malaria.

Table-2: Visakhapatnam City-GVMC-Malaria Surveillance data 2012-2020

Year	BSE	Malaria cases			Malaria Indices				
		Vivax	F.parum	Total	ABER	API	SPR	SFR	Deaths
2012	131568	3125	62	3187	9.49	2.3	2.42	0.05	0
2013	95535	3061	39	3100	6.81	2.21	3.24	0.04	0
2014	136298	2283	126	2409	9.72	1.72	1.77	0.09	0
2015	145311	2494	76	2570	10.37	1.83	1.77	0.05	0
2016	136605	1495	33	1528	9.74	1.09	1.12	0.02	0
2017	95825	685	34	719	6.83	0.51	0.75	0.04	0
2018	135455	404	17	421	9.66	0.3	0.31	0.01	0
2019	120087	101	10	111	8.46	0.08	0.09	0.01	0
2020	79828	36	5	41	4.46	0,02	0.05	0.01	0

The table-2 shows the malaria parasite indices year wise, blood smear collections, total number of fevers subjected to blood smear examination, smear positives, type of malaria, estimation of API (from ABER and SPR) which is the key indicator for categorization of states and district falling under stage of elimination of malaria. Starting from the year 2013 there is consistent fall of API (2.21-0.02) and SPR (3.24-0.05) There is an under-reporting in the year 2020 where sufficient number of blood smears could not be collected under active and passive surveillance. The main activity of malaria control in GVMC under Urban Malaria Scheme is IVM which brings down the critical density of the vector for transmitting the malaria parasite. Deaths were not reported throughout the time line.

Table-3: Countrywide malaria Surveillance Data (2015-2020)

Year	Malaria cases			Malaria indices					
	BSE in millions	Total Malaria cases (millions	P.F. cases (millions)	PF%	API	ABER	SPR	SFR	Deaths due to malaria
2015	121	1.17	0.78	66.61	0.92	9.58	0.97	0.64	384
2016	125	1.09	0.71	65.53	0.85	9.74	0.87	0.57	331
2017	126	0.84	0.53	6230	0.64	9.58	0.67	0.42	194
2018	124	0.34	0.16	47.93	0.32	9.31	0.35	0.17	96
2019	133	0.34	0.16	46.36	0.25	9.84	0.25	0.12	73
2020	164	0.2	0.16	78.66	0.01	1.22	0.12	0.1	2

The country wide malaria situation is as shown in table-3. The malaria cases have declined from1.17 million **(1)** in 2015 to 0.34 million in 2019 and 0.20 million till Nov.2020. The data shows pf% at 46.36 (0.16 million cases) in 2019 and 78.66 (0.16 million cases) in 2020 up to Nov. The number of deaths reported in 2019 were 73 and 2 up to Nov 2020.

Table-4: Parameters of malaria Surveillance- Countrywide Visakhapatnam

Year	Countrywide					Visakhapatnam (GVMC)				
	Pf%	API	ABER	SPR	SFR	Pf%	API	ABER	SPR	SFR
2015	66.61	0.92	9.58	0.97	0.64	2.96	1.83	10.37	1.77	0.05
2016	65.53	0.85	9.74	0.87	0.57	2.16	1.09	9.74	1.12	0.02
2017	62.7	0.64	9.58	0.67	0.42	4.73	0.51	6.83	0.75	0.04
2018	47.93	0.32	9.31	0.35	0.17	4.04	0.3	9.66	0.31	0.01
2019	46.36	0.25	9.84	0.25	0.12	9.01	0.08	8.46	0.09	0.01
2020	78.66	0.01	1.22	0.12	0.1	12.2	0.02	4.46	0.05	0.01

From table-4: The countrywide malaria surveillance is showing downward trend enabling the health experts to plan for phasing out malaria elimination, category wise from our country like Polio, Neonatal tetanus, Guinea worm and leprosy. This is the time for the individual states along with districts and local bodies to assess region wise malaria surveillance parameters and to assess under which category their region falls and use the epidemiological tools to improve and sustain their efforts to be a partner in National Frame Work for Malaria Elimination in India (2016-2030).

Table-5: Undifferentiated fevers- Year wise occurrence in GVMC

Year	Urban				Peri urban			
	fever	malaria	Undifferentiated		fever	malaria	Undifferentiated	
			number	%			number	%
2012	90272	3053	87215	96	60041	297	59744	99
2013	70849	3017	67832	96	40463	188	40275	99
2014	98221	2227	95994	97	59208	508	58700	99
2015	111595	2453	109142	97	53209	237	52972	99
2016	103115	1446	102969	99	52670	146	52656	99
2017	62340	639	61701	98	48549	169	48380	99
2018	93714	377	93337	99	64650	98	64552	99
2019	78414	80	78334	99	60445	42	60403	99
2020	56326	18	56308	99	35913	25	35888	99

In the table-5 an estimation is made to find out the un-differentiated fevers other than malaria year-wise to rule out the intentional under reporting of smear positives. In that case number of undifferentiated fevers number may not be consistent. But contrary to that, smear negative fevers percentage is almost constant year wise from 2012 to 2020.

TABLE-6: GVMC-Month wise A. STEPHENSI DENCITY-2017 -2020

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2017	30	29	46	47	27	35	39	29	45	45	44	47
2018	20	15	34	30	22	35	62	40	39	61	29	24
2019	37	30	22	38	41	33	46	39	35	39	26	39
2020	39	36	24	24	27	19	45	52	66	65	60	42

Table-6 shows the mosquito density month wise for a period of 4 years (2017-2020). Critical density of mosquitos is necessary for effective transmission of malaria particularly during rainy season. The density pattern of mosquitos' month wise is similar during each year in GVMC showing stable IVM activities by GVMC.

Discussions

The present study is an observation of malaria surveillance parameters of Visakhapatnam city, retrospectively over a period of 9 years from 2012 to assess the trend of malaria and 6 years from 2015 to compare GVMC with Countrywide malaria surveillance data to know the progress achieved by the city towards malaria elimination[8]. It is imperative that each state in India shall become partner in the National frame Work for Malaria Elimination (2016-2030)[9,10]. Further it is high time for each state and its districts including local areas to study the parameters of malaria in their jurisdiction to know the trend of malaria not only to eliminate (zero indigenous transmission) but also to maintain malaria free-status and prevent re-entry**[11,12]** of malaria by the year 2030. The study in Assam**[13]** for a period of 5 years retrospectively amongst the troops of the army units from 2002 to 2006, shown raise in malaria year after year is an example of unwieldy situation for control of vector in thick jungles where troops are exposed to more mosquito bites because of the intensified counter insurgency operations. Where as in our present study in GVMC conducted on the same lines as of Assam under efficient control of vector showed downward trend of malaria and malaria surveillance indices.Visakhapatnam is one such city with vast area consisting of both Urban and Peri- Urban[14] (GVMC) area clearly alienated from the rest of the district. While phasing out the malaria elimination program[15] basing on different levels of malaria burden, the study area falls under category-1 (elimination phase) though the state AP falls under category-2 (pre-elimination phase).All the parameters of malaria surveillance of Visakhapatnam i.e., API from 1.83(2015) to 0.02(2020), SPR from 1.77(2015) to 0.05(2020) and SFR 0.05(2015) to 0.01 (2020) to that of country wide parameters API from 0.92 (2015) to 0.01 (2020), SPR from 0.97 (2015) to 0.12 (2020) and SFR from 0.64 (2015) to 0.01(2020). Further, study results show that Falciparum malaria in Visakhapatnam city**[16]** did not contribute any significant specific falciparum malaria problem showing that the present IVM activities working and need to be continued with appropriate modification as and when necessity.

Throughout the retrospective year wise analysis of malaria dataset available in GVMC, undifferentiated fevers**[17]** are consistent showing that SPR (smear positive rate)**[18]** is dependable and clinical lab tests used for detection of malaria parasite are both sensitive and specific. The density pattern of female A. Mosquitos**[19]** month wise, is almost similar during each year from 2017-2020 indicating sustained Urban Malaria Scheme activities in Visakhapatnam city.

Conclusions

Finally, from the present study, it is evident that Visakhapatnam city parameters of malaria surveillance are comparable to that of country wide malaria surveillance data and GVMC is already a partner in National Frame work for Malaria Elimination in India (2016-2030) and hopefully reach the objective by 2030.

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