Parasite Epidemiology and Control 1 (2016) 205–210

Contents lists available at ScienceDirect

Parasite Epidemiology and Control

journal homepage: www.elsevier.com/locate/parepi

The relation between climatic factors and malaria incidence in Kerman, South East of Iran

Minoo Mohammadkhani [a], Narges Khanjani [b,c,*], Bahram Bakhtiari [d], Khodadad Sheikhzadeh [e]

[a] Department of Epidemiology and Biostatistics, School of Medicine, Rafsanjan University of Medical Sciences, Rafsanjan, Iran
[b] Environmental Health Engineering Research Center, Kerman University of Medical Sciences, Kerman, Iran
[c] Monash Centre for Occupational & Environmental Health, School of Public Health and Preventive Medicine, Monash University, Melbourne, Australia
[d] Department of Water Engineering, College of Agriculture, Shahid Bahonar University, Kerman, Iran
[e] Department of Epidemiology and Biostatistics, School of Public Health, Kerman University of Medical Sciences, Kerman, Iran

ARTICLE INFO

Article history:
Received 21 October 2015
Received in revised form 11 June 2016
Accepted 11 June 2016
Available online 23 June 2016

Keywords:
Malaria
Climate
Temperature
Kerman

ABSTRACT

Background and objectives: Malaria is among the most important parasitic diseases, and is one of the endemic diseases in Iran. This disease is often known as a disease related to climate changes. Due to the health and economic burden of malaria and the location of Kerman province in an area with high incidence of malaria, the present study aimed to evaluate the effects of climatic factors on the incidence of this disease.

Material and methods: Data on the incidence of malaria in Kerman province was inquired from Kerman and Jiroft Medical Universities and climatic variables were inquired from the meteorological organization of Kerman. The data was analyzed monthly from 2000 to 2012. Variations in incidence of malaria with climatic factors were assessed with negative binomial regression model in STATA11software. In order to determine the delayed effects of meteorological variables on malaria incidence, cross-correlation analysis was done with Minitab16.

Results: The most effective meteorological factor on the incidence of malaria was temperature. As the mean, maximum, and minimum of monthly temperature increased, the incidence rate raised significantly. The multivariate negative binomial regression model indicates that a 1 °C increase in maximum temperature in a given month was related to a 15% and 19% increase on malaria incidence on the same and subsequent month, respectively (p-value = 0.001). Humidity and Rainfall were not significant in the adjusted model.

Conclusion: Temperature is among the effective climatic parameters on the incidence of malaria which should be considered in planning for control and prevention of the disease.

1. Introduction

Malaria as a parasitic disease is still a health problem in some countries, particularly in developing ones (Azizi et al., 2011; Mohammadi et al., 2011). The disease is caused by a protozoan of plasmodium type and includes four species of *Plasmodium malariae*, *Plasmodium vivax*, *Plasmodium ovale* and *Plasmodium falciparum* that is transmitted by infected female Anopheles

* Corresponding author at: Department of Epidemiology and Biostatistics, School of Public Health, Kerman University of Medical Sciences, Kerman, Iran.
E-mail address: n_khanjani@kmu.ac.ir (N. Khanjani).

http://dx.doi.org/10.1016/j.parepi.2016.06.001

mosquitoes (Azizi et al., 2011; Mozafari et al., 2012). *P. vivax* is most common species in Iran (Soleimanifard et al., 2011; Manouchehri et al., 1992). In 2007, 93% of all malaria cases were caused by *P. vivax* (Azizi et al., 2011).

The Eastern Mediterranean Region which Iran is geographically located, includes 60%of the world's at risk population and is an important region for malaria (Mohammadi et al., 2011). According to WHO reports Iran is now in pre-elimination stage. But the south eastern provinces of Iran including Sistan and Baluchestan, Hormozgan and the tropical regions of Kerman contain 95% of all of the nation's malaria cases, and are still an endemic area for malaria (Mohammadi et al., 2011; Edrissian, 2006; WHO, n.d.). The tropical weather, long transmission season, instability of ecologic conditions and environmental changes are the causes that led to malaria still remaining as a health problem in these provinces (Azizi et al., 2011).

Malaria is mainly known as a sensitive disease to climatic changes (Kim et al., 2012). The plasmodium and their transmitters (anopheles mosquitoes) are influenced by environmental factors such as temperature, humidity and rainfall. Temperature influences the life cycle of the parasite and mosquito. Rainfall provides a place for mosquito fertilization and breeding. Humidity and temperature together can influence malaria incidence (Kim et al., 2012; Craig et al., 2004). Most acute cases of malaria occur in the hot seasons. In Iran disease transmission is inconsistent and most infections occur in summer (Azizi et al., 2011).

Studies have shown that temperature has increased and precipitation has decreased in Kerman city from 1997 to 2000 (Bakhtiari, 2003). Other researchers have predicted that the average temperature in all months of the year and precipitation during the warm months in Kerman province in the 30 year periods of 2011–2040, 2041–2070 and 2071–2100; will increase in comparison to 1971–2000 (Hesami Kermani, 2007). These changes may be able to provide a better breeding situation for the mosquitoes in especially the south of Kerman province.

Due to the health and economic importance of malaria and its relevance to environmental changes and also the location of Kerman province in an endemic area, this study was conducted to investigate the effect of temperature, humidity and rainfall on the disease incidence in the southern cities of Kerman province in order to conduct more effective prevention and control programs.

2. Material and methods

Information about malaria cases in Kerman province were extracted from the available data from the Health Deputy of Kerman and Jiroft Universities of Medical Sciences. First the data from Kahnuj county, a city with most cases of malaria and then the data about other counties in the southern part of Kerman province in the neighborhood of Kahnooj county including Manoojan, Ghalehganj and Rudbar-e Jonubi counties since 2000 to 2012 were extracted monthly and recorded in Excel software.

Data about monthly meteorological variables including mean temperature, maximum and minimum temperature, rainfall and relative humidity were extracted from the synoptic station of Kerman Province Meteorological Organization from 2000 to 2012. Since the required meteorological data had not been recorded in Manoojan, Ghalehganj and Rudbar-e Jonubi counties, in all of the above mentioned years, the unknown measures were estimated by using GIS and the Kriging methods.

It is notable that by investigating the climate of Manojan, Qaleganj and Rudbar-e Jonubi according to the Demarton's aridity index, (a method of detecting regions climate according to rainfall and annual temperature), all of these counties were located in the arid climate zone. Demarton's aridity index is calculated by the following formula. In which P is the annual precipitation (mm) and T is the mean annual temperature (°C) (formula 1).

$$I = \frac{\mathrm{P}}{\mathrm{T} + 10}$$

Formula 1: Demarton formula for climatical classification (Kerman Meteorogical Organization, 2014).

Finally, the relation between malaria incidence and climatic factors (mean, maximum and minimum temperature, relative humidity and rainfall) was estimated with crude and adjusted negative binomial regression inSTATA11.

Table 1
The incidence rate of malaria per 100,000 people in the southern part of Kerman province in different counties in the mentioned time period.

Year	Kahnooj		Manoojan		Ghalehganj		Rudbar-e Jonubi		All cases	
	cases	incidence	cases	incidence	cases	incidence	cases	incidence	cases	incidence
2000	2488	1564.35	–	–	–	–	–	–	2488	1564.35
2001	993	661.68	–	–	–	–	–	–	993	661.68
2002	1048	742.74	–	–	–	–	–	–	1048	742.74
2003	410	310.31	127	200.20	–	–	–	–	537	274.59
2004	166	134.79	64	100.67	–	–	–	–	230	123.18
2005	740	648.10	89	139.70	–	–	–	–	829	620.17
2006	94	89.35	104	162.89	947	1347.24	13	14.84	1158	411.83
2007	688	678.34	48	75.02	387	541.19	11	12.09	1134	401.45
2008	65	66.57	23	35.87	170	233.75	9	9.54	267	94.09
2009	74	78.84	3	4.67	72	97.37	35	35.83	184	64.55
2010	30	33.31	3	4.66	13	17.30	3	2.97	49	17.11
2011	5	5.79	5	7.75	1	1.31	15	14.36	26	9.04
2012	3	3.64	0	0	0	0	2	1.86	5	1.73

According to data distribution, goodness-of-fit, Akaike information criterion (AIC) and Bayesian information criterion (BIC),negative binomial regression was the best model or analyzing the data. These calculations were done by STATA 11.

The Spearman correlation between malaria incidence and climatic factors were calculated in SPSS20. Also cross correlations were performed between malaria incidence and climatic factors with several month lags in MiniTab16.

3. Results

Over all 8948 malaria cases were registered from the southern counties of Kerman province in the health deputies of Kerman and Jiroft Universities of Medical Sciences during these 13 years and among them 8579 cases (95.88%), 341 cases(3.81%) and 28 cases (0.31%) were Vivax, Falciparum and mixed respectively.

The highest and lowest incidence rates belonged to the year 2000(2488 cases) and 2012(5 cases) respectively (see Table 1).

Kahnooj county in the year 2000 (2488 cases), Manoojan in 2003 (127 cases) and Ghalehganj and Rudbar-e Jonubi in 2006 (947 and 13 cases respectively) had the highest incidence rate. Kahnooj and Rudbar-e Jonubi counties had the lowest incidence rate in 2002 and no cases were reported in Manoojan or Ghalehganj in this year.

The summary of climatology variables in Kerman province during this time have been presented in Table 2.

The monthly malaria statistics showed that the highest and lowest number of malaria cases diagnosis happened in October with 2035 cases (22.74%) and February with 69 cases (0.77%). According to season the highest number of malaria case diagnosis happened in autumn (3673 cases) and summer (3200 cases) (Fig. 1).

Multivariate negative binomial analysis suggested that by 1°C increase in average and maximum temperature, the incidence rate increased by 9and 15% respectively which was statistically significant; but humidity and rainfall didn't change the incidence rate and they were not statistically significant (Table 2).

The effect of meteorological parameters on malaria incidence was also estimated with one month delay. In this analysis 1 °C increase in mean, maximum and minimum temperature was accompanied with significant increases in malaria incidence. But humidity and rainfall were not significant in the adjusted model (Table 3).

Temperature with one month lag resulted in the highest significant increase, in Manoojan and Ghalehganj. In Manoojan in both univariate and multivariate regression, 1 °C increase in mean temperature resulted in 21% increase in malaria incidence. Also in Ghalehganj both univariate and multivariate analysis led to 15% and 20% increase in malaria incidence, respectively (p-value = 0.001).

In Rudbar-e Jonubi the direct and reverse effects of temperature and humidity respectively was significant. An increasing 1 °C in mean temperature and 1% of humidity resulted in 12% increase (p-value = 0.005) and 8% decrease (p-value = 0.009) in incidence of malaria respectively.

In all counties the Spearman's correlation coefficients between meteorological variables with one month lag or without lag, and malaria incidence showed a positive relation with mean, maximum and minimum of temperature and a negative relation with humidity and rainfall was statistically significant. In the south of Kerman only the positive relation of minimum temperature with one month lag was statistically significant.

Analyzing all cases of malaria in Kerman province showed that the maximum temperature and rainfall had a maximum correlation of $r = 0.623$ and a minimum correlation of $r = -0.220$ (see Table 5).

After comparing malaria incidence with the meteorological parameters of the previous months, the analysis showed that the incidence of malaria in one definite month had the highest correlation with the maximum temperature of the previous month (Table 4).

Table 2
The climate variables in the southern part of Kerman province in different counties during 2000–2012.

City month	Kahnooj					Manoojan					Ghalehganj					Rudbar-e Jonubi				
	Temp	min	max	hum	rain	Temp	min	max	hum	rain	Temp	min	max	hum	rain	Temp	min	max	hum	rain
April	25.3	18.9	32.8	40.3	11.6	25.1	17.7	32.2	41.7	16.1	25.5	18.2	32.7	41.1	15.5	24.9	17.5	32.2	40.7	17.8
May	31.4	24.5	40.1	30.5	1.1	31.1	22.8	39.1	31.6	1.3	32.0	24.0	39.9	31.9	1.1	31.2	23.3	39.0	31.9	1.8
June	34.7	28.3	43.5	30.2	4.8	34.6	26.8	42.6	31.0	4.3	35.1	27.2	43.3	31.1	9.5	34.7	27.0	42.5	28.3	3.5
July	35.7	30.5	44.4	34.5	0.6	36.1	28.8	43.4	35.9	1.2	37.1	29.2	44.4	31.0	1.2	36.7	29.2	44.2	30.1	0.5
August	35.3	29.7	43.8	34.7	15.0	35.2	28.1	42.7	36.5	14.3	35.9	28.5	43.3	33.1	7.3	35.7	28.1	43.0	31.8	4.6
September	33.1	27.6	41.3	38.6	3.7	33.3	26.0	40.9	37.6	4.0	33.5	25.6	41.4	33.6	4.9	33.1	25.4	40.9	32.5	2.4
October	29.1	22.7	37.8	34.6	2.6	29.2	21.4	37.1	33.6	0.3	29.5	21.7	37.6	32.3	0.4	29.2	21.3	37.1	31.3	0.9
November	23.7	17.0	31.1	46.1	4.7	23.3	16.1	30.7	43.2	6.6	23.5	15.9	31.1	39.8	7.4	22.9	15.5	30.4	39.1	5.2
December	18.4	10.8	24.3	52.3	17.9	16.6	9.9	23.5	50.3	24.5	16.1	9.2	23.5	50.8	24.5	15.6	8.4	22.8	48.6	16.1
January	15.4	8.0	20.5	55.8	26.0	13.1	6.8	19.4	52.6	27.2	13.2	6.5	20.0	50.7	18.3	12.6	6.1	19.2	50.1	13.4
February	16.9	10.2	21.9	56.5	29.9	15.1	9.4	21.1	55.4	45.1	15.2	9.2	21.4	55.6	44.1	14.7	8.8	20.6	54.3	36.8
March	20.5	14.6	27.5	46.8	15.9	20.5	13.6	27.1	46.5	17.4	20.8	13.7	27.7	43.8	13.8	20.0	12.9	27.0	44.0	14.8

Temp = The monthly mean temperature.
Min = The monthly minimum temperature.
Max = The monthly maximum temperature.
Hum = The monthly humidity.
Rain = The monthly rainfall.

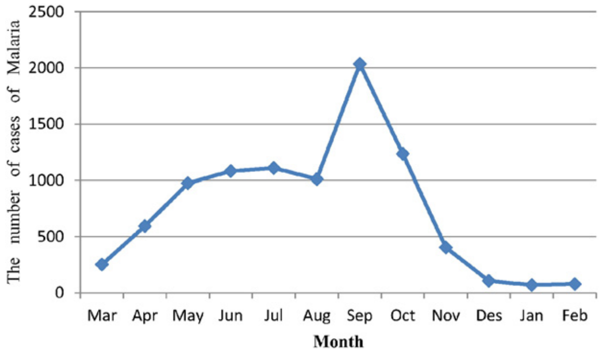

Fig. 1. Monthly distribution of malaria in Southern Kerman province, Iran during 2000–2012.

The maximum positive cross-correlation was seen between malaria incidence and mean, minimum and maximum temperature and the maximum negative cross-correlation has seen between malaria, humidity and rainfall with one month lag.

In all cases of malaria, the mean maximum monthly temperature with one month lag ($r = 0.44$),was a positive and strong predictor for increasing of malaria incidence (Fig. 2).

4. Discussion

Malaria transmission is related to environmental, physical and biological factors. Environmental factors include temperature, rainfall, humidity.

Biologic agents are the abundance of anopheles species, their desire to bite mankind, their sensitivity to the parasite, life span of mosquitoes, the growth of parasites in mosquitoes, that depend on independent environmental factors (Devi and Jauhari, 2006).

In this study in both multivariate and univariate analysis by increase in the mean, minimum and maximum temperature, the incidence rate of malaria increases significantly. Also the increase of maximum temperature in one definite month had a positive effect on the incidence of that month and one month later. The relation between temperature and malaria has been studied in many studies from the tropical and semi-tropical regions of the world and results were consistent with this study.

In a study done by Wangdi et al. (2010) in the endemic regions of Bhutan, the mean of maximum temperature with one month lag was a positive and strong predictor for malaria incidence (Wangdi et al., 2010).

Peng and et al.(2003) also reported the highest positive relation between monthly incidence of malaria and monthly minimum temperature with one month lag in Shuchen, China (Bi et al., 2003). In a study by Zhang et al. (2010) in a temperate region in China the maximum and minimum temperature had the highest positive relation with monthly incidence and this relation was also seen with one month lag and 1 °C increase in minimum temperature resulted in 12 to 16% increase in incidence and minimum temperature was more effective than maximum temperature (Zhang et al., 2010). Temperature increase, particularly minimum temperature increase in some regions increases the survival of plasmodiums and anopheles in winter and therefore results in faster transmission and distribution of malaria in populations (Devi and Jauhari, 2006).

In a study that done by Huang et al. in Motou city of Tibet, Spearman correlation coefficients showed that incidence had a positive and significant association with temperature, humidity and rainfall, while in our study the relation between incidence with temperature was only seen. In Huang et al.'s study (2011) the maximum positive cross –correlation was observed between malaria incidence and mean of temperature, and maximum and minimum of temperature with one month lag, but the maximum cross –correlation was observed between malaria and raining with two month lags (Huang et al., 2011). But in this study the maximum positive cross-correlation was observed between malaria and climatic factors with one month lag.

Table 3
The effect of temperature, humidity and rainfall on malaria incidence in the southern counties of Kerman province during 2000–2012.

Variable	Crude IRR and 95% CI	*p*-Value	Adjusted IRR and 95% CI	*p*-Value
Mean temp	1.09 (1.06–1.13)	0.001*	1.09 (1.05–1.13)	0.001*
Minimum temp	1.04 (1.00–1.09)	0.053	1.03 (0.98–1.07)	0.283
Maximum temp	1.12 (1.09–1.16)	0.001*	1.15 (1.00–1.20)	0.001*
Humidity	0.98 (0.96–0.99)	0.012*	1.00 (0.97–1.02)	0.811
Rainfall	1.00 (0.98–1.01)	0.526	1.00 (0.98–1.01)	0.866

IRR-incidence rate ratio; CI-confidence interval.
* $P < 0.05$.

Table 4
The effect of temperature, humidity and rainfall on malaria incidence with one month lag in the southern counties of Kerman province during 2000–2012.

Variable	Crude IRR and 95% CI	*p*-Value	Adjusted IRR and 95% CI	*p*-Value
Mean temp	1.14 (1.10–1.18)	0.001*	1.12 (1.08–1.17)	0.001*
Minimum temp	1.10 (1.06–1.15)	0.001*	1.07 (1.02–1.16)	0.005*
Maximum temp	1.16 (1.14–1.19)	0.001*	1.19 (1.15–1.24)	0.001*
Humidity	0.95 (0.93–0.97)	0.001*	0.98 (0.96–1.01)	0.229
Rainfall	0.99 (0.98–1.00)	0.056	1.00 (0.99–1.01)	0.907

Table 5
Spearman correlation coefficient between monthly malaria incidence and climate variables.

	Spearman coefficient	*p*-Value	Spearman coefficient with one month lag	*p*-Value
Mean temp	0.347	0.001*	0.380	0.001*
Minimum temp	0.144	0.074	0.171	0.033
Maximum temp	0.623	0.001*	0.667	0.001
Humidity	−0.308	0.001*	−0.325	0.001
Rainfall	−0.220	0.006*	−0.0213	0.008

In another study by Kim and colleagues in Korea weekly parameters were used to estimate the relation between malaria incidence and meteorological data. This study showed that malaria incidence had a positive relation with mean, maximum and minimum temperature and one 1 °C increase in temperature was associated with 17.7% and 16.1% increase in malaria incidence after 3 week and in the same week respectively. These results were consistent with the result of our study. Also by 10% increase in humidity, the malaria cases increased 10.4% in the same week that was probably due to utilizing weekly data and this effect was different from the results of our study (Kim et al., 2012).

In the south of Kerman province the incidence rate ratio was inversely related to increase in humidity with univariate analysis and this finding was statistically significant. The reason might be that in this region humidity was less than 40% and it has been reported that when the humidity decreases to <60% the life span of mosquitoes decreases and transmission does not occur (Akinbobola and Omotosho, 2012).

In Gao et al.'s study (2012) in Anhui Province, China rainfall ($r_s = 0.48$) had the highest relation with malaria incidence. Malaria is a reemerging disease in this province and rainfall is known as an important meteorological factor in the reemerging of this disease in the region. In this study beside the effect of the same month's rainfall on malaria transmission, rainfall in the earlier two months also influenced malaria incidence (Gao et al., 2012). In contrast to this study, our results showed that rainfall had the less effect in comparison to other factors and didn't change the incidence rate.

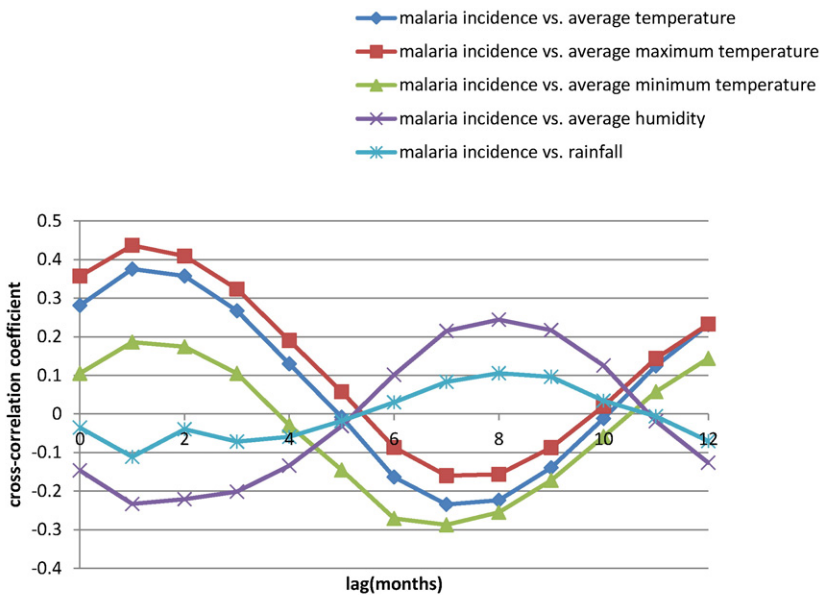

Fig. 2. Cross-correlation coefficients of time series of monthly meteorological variables and monthly malaria incidence at several lags.

This phenomenon could be due to the climate of the studied region which was a hot and dry climate and after rainfall the water evaporated or penetrated into the lower layers of soil in a short time and could not provide a suitable place for mosquito fertilization and therefore the risk of infection transmission declined.

Seven types of Anopheles mosquitoes have been discovered in Iran. The two main types that have the most important role in malaria transmission in the southeast of Iran are Anopheles Stephensi and Anopheles Culicifacies (Yavari, 2013). The nest of Anopheles larvae is stagnant clear or dark water, shallow wells, agricultural land, water canals, river banks, beside pipeline leaks, water puddles, open water storage tanks, wetlands and drainage channels (Iran Environmental Health, 2014).

This study had some limitations. There was a probability of underreporting or lately reporting malaria cases due to lack of disease symptoms or just not referring cases to health centers. Also we were unable to access data about potentially confounding factors such as socio-economical characteristics, human activities or other factors that might also affect malaria incidence.

5. Conclusion

In the southern part of Kerman province, temperature was the most effective meteorological factor in malaria incidence and by increase in the mean, maximum and minimum temperature, the incidence of malaria increased significantly. The incidence of malaria in one definite month had the highest correlation with mean monthly temperature of the previous month.

Our study shows the relation between climate factors and malaria. The results of this study can help predict the changes in malaria incidence based on climate changes in different world regions in order to prepare proper preventive measures for this disease.

Acknowledgment

The authors would like to thank Mr. Saffari at Kerman University Health Authority and the Health Deputies of Kerman and Jiroft Universities of Medical Sciences for their cooperation.

This study was funded by grant number 180-92 by Kerman University of Medical Sciences.

References

Akinbobola, A., Omotosho, J.B., 2012. Predicting malaria occurrence in Southwwest and north Central Nigeria using meteorological parameters. Int. J. Biometeorol. 1-8.
Azizi, F., Janghorbani, M., H., H., 2011. In: Azizi, T., Agha abbasloo, M. (Eds.), Epidemiology and control of common diseases in Iran, third ed., p. 915 (Tehran).
Bakhtiari, B., 2003. An analytical view about the changes in climate, precipitation and temperature in Kerman city. The Third Regional and First National Conference of Climate Change. Isfahan, Iran, pp. 181–187.
Bi, P., Tong, S., Donald, K., Parton, K.A., Ni, J., 2003. Climatic variables and transmission of malaria: a 12-year data analysis in Shuchen County, China. Public Health Rep. 118 (1), 65.
Craig, M., Kleinschmidt, I., Nawn, J., Le Sueur, D., Sharp, B., 2004. Exploring 30 years of malaria case data in KwaZulu-Natal, South Africa: Part I. The impact of climatic factors. Tropical Med. Int. Health 9 (12), 1247–1257.
Devi, N.P., Jauhari, R., 2006. Climatic variables and malaria incidence in Dehradun, Uttaranchal, India. J vector borne dis 43 (1), 21.
Edrissian, G.H., 2006. Malaria in Iran: past and present situation. Iran. J. Parasitol. 1 (1).
Environmental Health [Internet], d. Anopheles mosquitoes. [cited 2014 April 9] (Available from) http://www.environmentalhealth.ir/221.
Gao, H.-W., Wang, L.-P., Liang, S., Liu, Y.-X., Tong, S.-L., Wang, J.-J., et al., 2012. Change in rainfall drives malaria Re-emergence in Anhui Province, China. PLoS One 7 (8), e43686.
Hesami Kermani, M.R., Dec 19, 2007. Predicting the climate changes of Kerman province by using statistical down-scaling methods. Conference of Qualitative Weather PredictionThe Climate Research Center. National Weather Bureau, Tehran, Iran.
Huang, F., Zhou, S., Zhang, S., Wang, H., Tang, L., 2011. Temporal correlation analysis between malaria and meteorological factors in Motuo County, Tibet. Malar. J. 10, 54.
Kerman Meteorogical Organization [Internet], Classification of Kerman climate.[cited 2014 Oct28] (Available from) http://weather.kr.ir/index.php?option=com_content&view=category&layout=blog&id=40&Itemid=63.
Kim, Y.M., Park, J.W., Cheong, H.K., 2012. Estimated effect of climatic variables on the transmission of plasmodium vivax malaria in the Republic of Korea. Environ. Health Perspect. 120 (9), 1315.
Manouchehri, A., Zaim, M., Emadi, A., 1992. A review of malaria in Iran, 1975–90. J. Am. Mosq. Control Assoc. 8 (4), 381.
Mohammadi, M., Ansari-Moghaddam, A., Raiesi, A., Rakhshani, F., Nikpour, F., Haghdost, A., et al., 2011. Baseline results of the first malaria indicatorsurvey in Iran at household level. Malar. J. 10, 277.
Mozafari, G., Almamaleki, R.M., Hashemi, A., 2012. Biochemical analysis of the malaria prevalence in the chabahar city. Scientific J of Geographical Space 12 (38), 21–37.
P., Y., 2013. Epidemiology textbook of prevalent diseases in Iran. In: Sharifi, H., Akbarin, H. (Eds.), first ed.Communicable Diseases Vol. Volume 1, pp. 291–298 (Tehran).
Soleimanifard, S., Akbari, M., Sabetghadam, M., S., S., 2011. Malaria situation in Isfahan in the last five years. Journal of Isfahan Medical School 29(132).
Wangdi, K., Singhasivanon, P., Silawan, T., Lawpoolsri, S., White, N.J., Kaewkungwal, J., 2010. Development of temporal modelling for forecasting and prediction of malaria infections using time-series and ARIMAX analyses: A case study in endemic districts of Bhutan. Malar. J. 9 (251), 251–259.
WHO, d. Int [internet]. World malaria report 2011. [cited 2014 Nov 9] (Available from) http://www.who.int/entity/malaria/world_malaria_report_2011/en/.
Zhang, Y., Bi, P., Hiller, J.E., 2010. Meteorological variables and malaria in a Chinese temperate city: a twenty-year time-series data analysis. Environ. Int. 36 (5), 439–445.