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Role of Meteorological Variables in COVID-19 in Iraq 2020

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ABSTRACT

Cross Sectional Analytic study conducted in five Iraqi cities (Sulaimanyiah, Diyala, Baghdad, Najaf and Basrah) for characteristics of COVID-19 cases both epidemiological (infection, recovery, death) and meteorological variables (mean temperature MT, relative humidity RH and daily temperature range DTR). The published official data has been collected for the period from 23/2/2020 to 2/8/2020, week no.8 to week no.31 directly from governmental web sites. To calculate the association between incidence rates and metrological variables we considered one-week lag phase. in order to estimating correlation coefficient between parameters we use (spearman correlation, coefficient correlation and P. value); considering the confidence interval 95%, if the P. value is equal or less than 0.05. Data analysis was done by MS. Excel 2019, SPSS programs. The result show significant correlation of COIVED-19 incidence; cure rate% and CFR% with meteorological variables (MT, DTR and RH). The type and strength of the relation were varied temporally and spatially, which may due to the differences in the climate pattern of Iraqi cities. The meteorological variables are important factors for in COVID-19 infection in Iraq. The Iraqi government should take this in the account in emergencies and respond plan setting. Another studies direction is to be covering (air pollution, patient health history and age groups) to achieve a better insight for the fighting model against COVID-19.

Keywords: COVID-19, Iraq, Epidemiology, Meteorological variables,

Introduction

The novel coronavirus "2019-nCoV" emerging in Wuhan, China in "the end of" 2019 had led to global outbreak and considers major health risk. It is spread directly by human-to-human transmission via droplets or direct contact, and infection has been estimated to have mean incubation period of 6.4 days [1] , COVID-19 pandemic raising the international argument about the climate change impacts. One of the clearest manifestations about human induced climate change impacts is "dramatic" heat increasing which studied as risk factor for cardiovascular and respiratory disease [2], [3] Also recent studies highlight the significant positive relation of high temperature with increase mortality [4,5]. The Intergovernmental Panel on Climate Change (IPCC) 4th report emphasize that global surface temperature increases especially since 1950 the range was 0.74 ± 0.18°C for the 100-years interval (1906–2005), while the range increase (0.6 ± 0.2°C) during the 100-year warming trend at the time of (1901– 2000). The last 50 years average heating increase (0.13 ± 0.03°C per decade) which may be twice of the last 100-yraes [6].

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The shape of the relationship between extreme "low/high" air temperature, Daily Temperature Range (DTR) and humidity, with human health is increasing concern around world. A positive relation between DTR and cardiovascular and respiratory illness [7]; extreme temperature may have positive relation with daily death counts, but humidity has negative with COVID-19 [8]. The influenza infection " occurrence and spreading" have been affected by some metrological variation; winter season " low temperature" and both rainy " high humidity" and dry "low humidity" weather may increase influenza cases in Canada. [9] High temperature may reduce replication of influenza viral "in vitro [10].The COVID-19 infection prevalence in Baghdad-Iraq show clears affected by the level of air pollution; they interpreted that by increasing susceptibility of Baghdad population due to long exposure to air gases pollutant [11].

On 24th February 2020, Iraqi Ministry of Health and Environment recorded the first confirm COVID_19 infection in holy city of Najaf; follow by the Baghdad city " capital" on 29th February; Basrah city 9th March; Sulaimanyiah 1th March and Diyala 4th March. [12]. In light of sudden appearance of COVID-19 pandemic; with limited experience in Iraq; our study aims to investigate the association of metrological variables with COVID-19 cases (incidence, recover and mortality), It is the first study in Iraq with this method and subject.

Methods

Study design: prospective Cross sectional analytic study conducted in Iraq for characteristics of COVID-19 cases both epidemiological (infection, recovery, death) and meteorological variables (mean temperature, relative humidity and daily temperature range) in a selected Iraqi city by using stratified random sampling based on dividing Iraq into four geographical categories:

1- Sulaimanyiah "north region" (35.56 °N 45.43°E, 847 asl) with population (1283484);
2- Diyala " middle region" (34.12°N 44.98°E, 118m asl) with population (1452007);
3- Baghdad " Middle; the capital" (33.34°N 44.4°E, 41m asl) with population (8558625);
4- Najaf "Mid-Euphrates region" (32.03°N 44.35°E, 41m asl) with population (3063059);
5- Basrah "South region" (30.51°N 47.78°E, 4m asl); with population (2206514).

Laboratory testing: COVID-19 confirmed cases through the laboratory tests (nasal swab, pharyngeal swab, blood serum) PCR test for covid-19 virus antigen polymerase chain reaction (PCR) positive. For Recovery from COVID-19 patients must do 2 negative PCR test results during 24 hours to be considered recovered. Death of COVID-19 any case dies from COVID-19

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infection before recovery and any dead case test positive PCR test if the case reached hospital was dead.

Metrological variables: the metrological data collected from the Iraqi Meteorology Organization and Seismology official web site [13] daily. The targeted variables calculate as follow: Mean temperature **(MT)**: calculate by the equation.

$$MT = \frac{(Minimum\ daily\ temp. + Maximum\ daily\ temp.)}{2} \quad (1)$$

Relative humidity **(RH):** the amount of water vapor in the air, expressed as a percentage of the maximum amount that the air could hold at the given temperature.

Daily Temperature Range **(DTR)**: calculate by the equation:

DTR= (Minimum daily temp. - Maximum daily temp.) (2)

Data collection period: From 23/2/2020 to 2/8/2020, week no.8 to week no.31

Data management and analysis: The digital dataset for the COVID-19 in Iraq has been obtained from the Ministry of Health and Environment official web site [14]; then the data has been registered on a weekly basis dataset according to International Epidemiological Weeks.

Epidemiological data arranged on a weekly basis and calculated as incidence rates per 100,000, Cure rate and case fatality rate CFR) for each city in order to determine the association between COVID-19 cases and the meteorological factors (MT, RH and DTR).

To calculate the association between incidence rates and metrological factors we considered one-week lag phase; based on the incubation period for COVID-19, which is the time between exposure to the virus (becoming infected) and symptom onset, is on average 5-6 days [12].While the case fatality rates calculated by dividing the death number of a specific week by the number of patients with confirmed COVID-19 infection.

Since the retrieved data was not distributed normally, thus in order to estimating correlation coefficient between parameters we use (spearman correlation, coefficient correlation and P. value); considering the confidence interval 95%, if the P. value is equal or less than 0.05 then the

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risk factor considered having statistically significant association with outcome. Data analysis was done by MS. Excel 2019, SPSS programs.

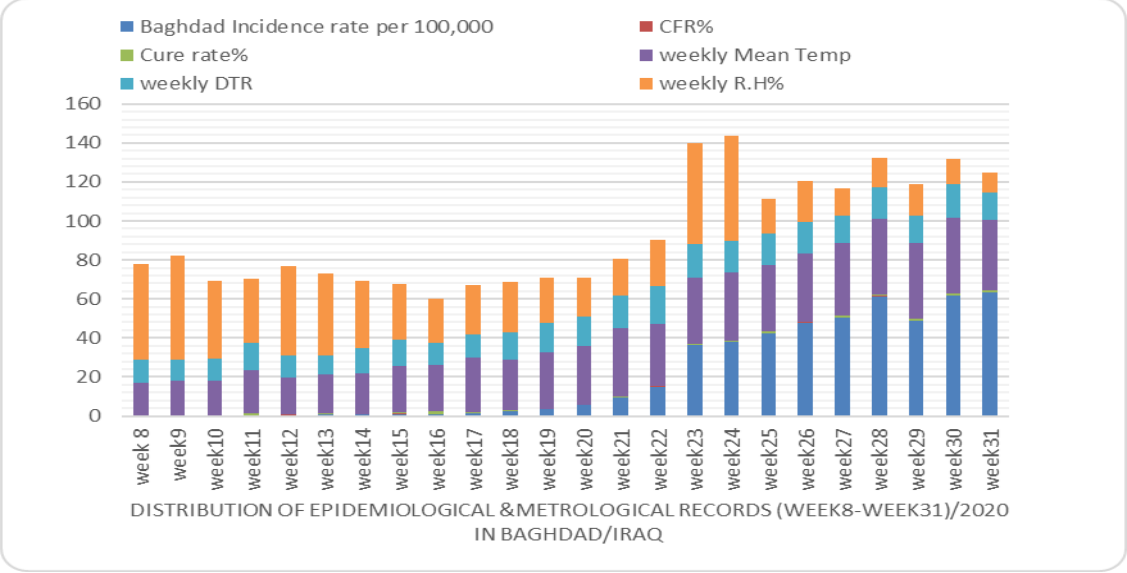
Result and Discussion

Our study was designed to illustrate the potential impacts of meteorological variables on the COVID 19 in Iraq. We are using the lag effect (one week) for the incidence calculation; depending on the incubation period of COVID_19.

Comprehensive daily monitoring of COVDI_19 (Infection, cure and CRF); and the metrological variables (MT; DTR and RH) data in five "selected" Iraqi cities shown in figure-1.

The association between incidence and MT, DTR and RH were differing spatially and temporally showing in table-1.

The result shows that COVID-19 incidence and (MT, DTR) correlations were significant positive in the fifths cities. MT correlation score at Baghdad was (r^2=0.917 P value=0.0001); while the lowest was at Najaf (r^2=0.664, P value=0.001). DTR correlation reach (r^2=0.714, P value=0.0001) at Baghdad; while the score was (r^2=0.522, P value=0.006) at Najaf. RH had negative "significant at 0.01 levels" correlation with incidences, the scoring was (r^2=-0.749) at Sulaimanyiah; while at Najaf was (r^2= -0.468) see table-1.



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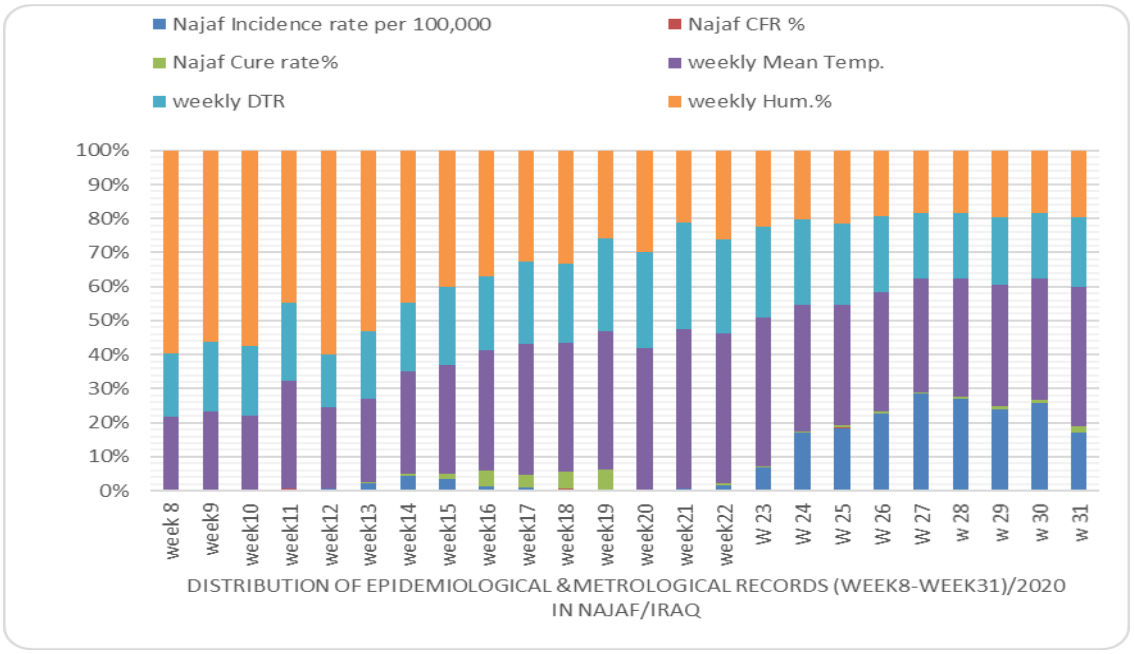

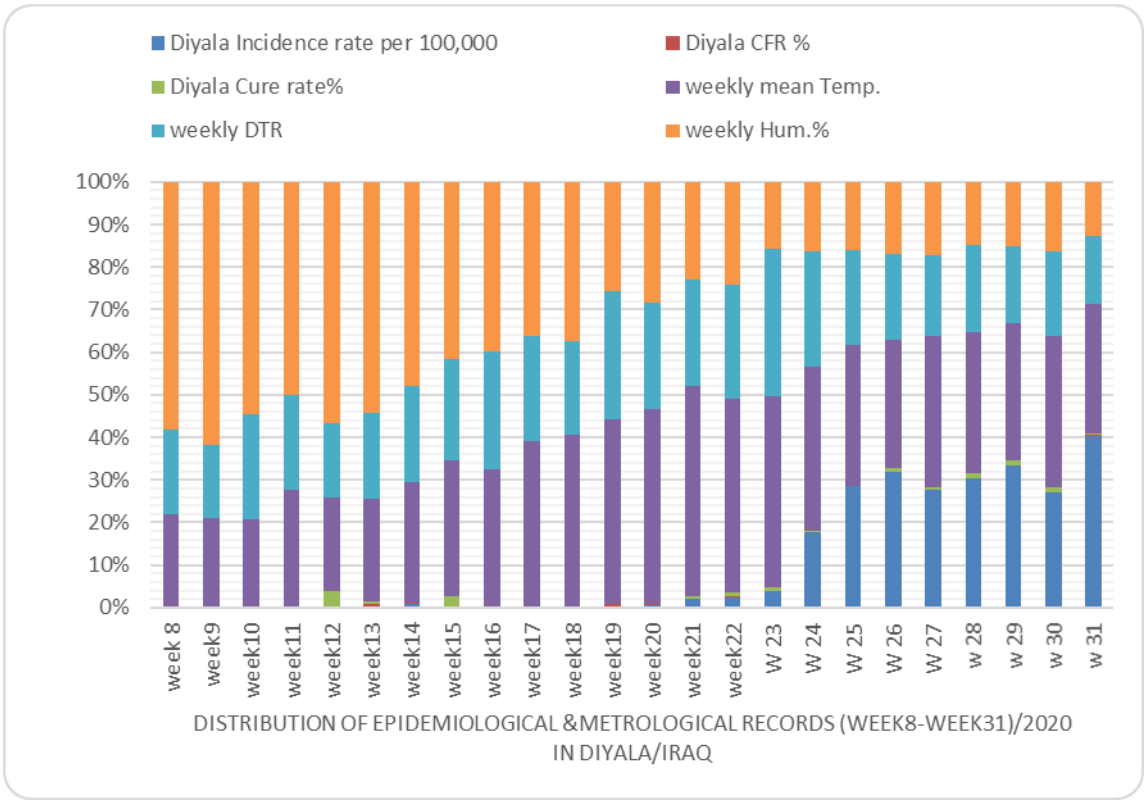

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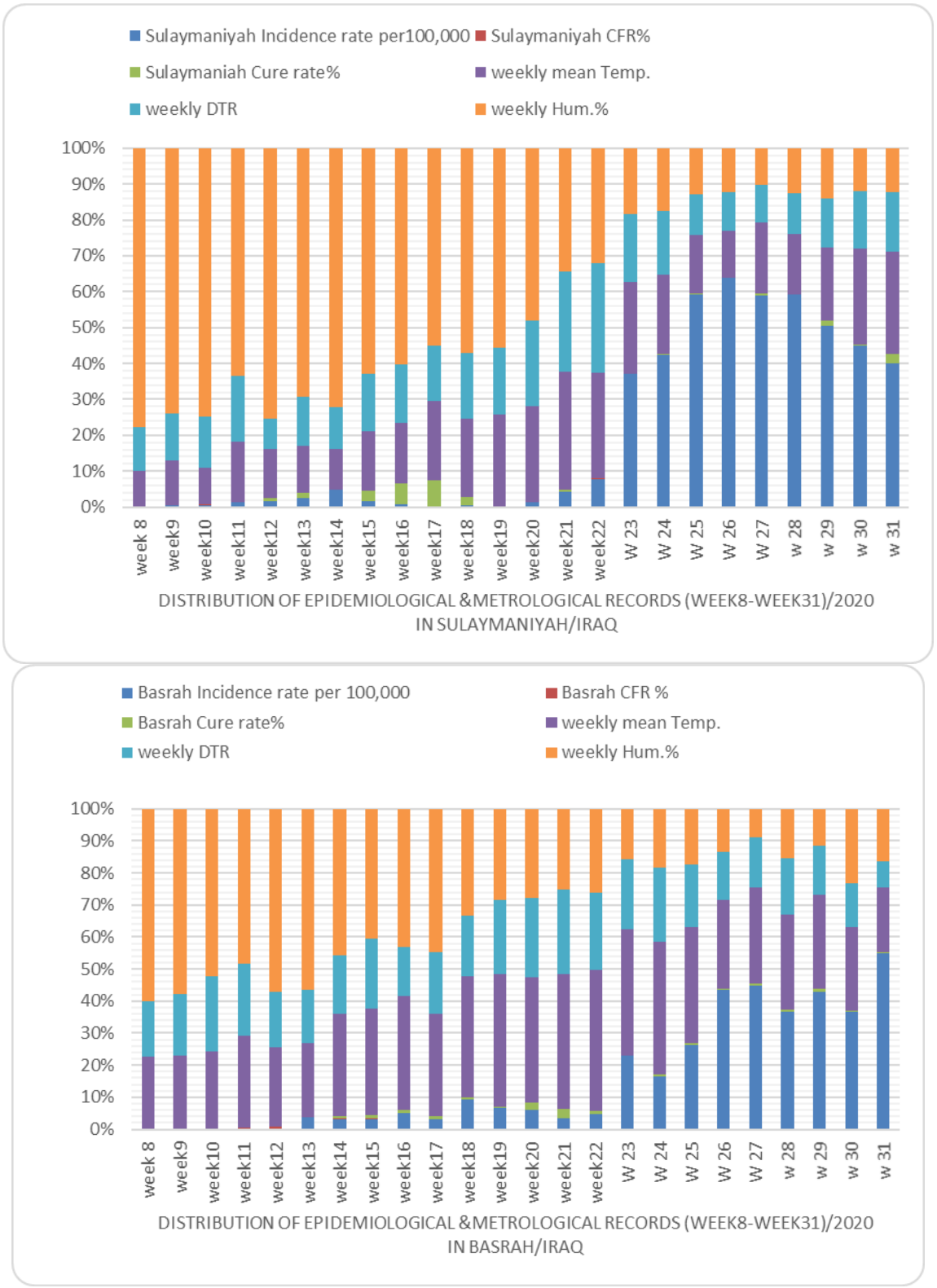

Figure 1: Distribution of epidemiological & metrological records (week8-week31)/2020 in: A- Baghdad, B- Najaf, C- Diyala, D-Sulaymaniyah, and E- Basra.

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Table 1:Correlation and Association between COVID-19 Weekly Incidence "per 100,000" and Weekly Metrological Data (MT, DTR, RH), Iraq from 23/2/2020 (week 8) to 2/8/2020 (week 31).

Metrological variables	Correlation	Iraqi selected cities				
		Sulaymaniyah	Diyala	Baghdad	Najaf	Basrah
MT	r^2	0.755	0.824	0.957	0.664	0.917
	P value	* 0.0001	* 0.0001	* 0.0001	* 0.001	* 0.0001
DTR	r^2	0.66	0.612	0.714	0.522	0.695
	P value	* 0.001	* 0.002	* 0.0001	* 0.006	* 0.0001
RH	r^2	-0.749	-0.698	-0.703	-0.468	-0.718
	P value	* 0.0001	* 0.0001	* 0.0001	* 0.024	* 0.0001

The number of incidences of COVID_19 correlated positively with MT and DTR in India [15]; but the correlation of RH was positive; that may due to the difference in the climatic regions. DTR values correlated significantly with the rate of hospital admissions cases for cardiovascular- and respiratory-related illness [16]. Influenza incidence "positively" correlated to (MT and DTR) in temporal region [16]. Same significant correlation of DTR on the influenza seasonality in dry season found by [17] in Hon Kong.

In China Wuhan city "The cradle of COVID_19" humidity play protective role against COVID_19 infection. These findings consistent to our result indicate that correlation of COVID_19 incidences with RH was negative; but positive relation with MT and DTR.

Our study covers the beginning period of the spread of the COVID-19 pandemic. Number of incidences increase logically; thus the increase in the number of incidences may not be associated with temperature rates. This may be attributed to the fact that the current study period included the summer months known for a gradual rise in temperatures in Iraq.

The result show differing spatially and temporally between COVID_19 cure and MT, DTR and RH see table-2.

Table 2: Correlation and Association between COVID-19 Weekly cure rate% and Weekly Metrological Data (MT, DTR, RH), Iraq from 23/2/2020(week 8) to 2/8/2020 (week 31).

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Metrological variables	Correlation	Iraqi selected cities				
		Sulaymaniyah	Diyala	Baghdad	Najaf	Basrah
MT	r^2	0.172	0.465	0.548	0.362	0.46
	P value	0.433	*0.025	*0.007	0.09	*0.027
DTR	r^2	0.121	0.087	0.357	0.089	0.434
	P value	0.582	0.693	0.094	0.687	*0.039
RH	r^2	-0.115	-0.212	-0.545	-0.1	-0.391
	P value	0.602	0.332	*0.007	0.649	0.065

The results showing positive correlation between (cure rate %) and meteorological variables (MT and DTR) in all "selected" Iraqi cities. Baghdad score was (r^2=0.548, p value=0.007); while the score was (r^2=0.362, p value=0.09) at Najaf. But the correlation of RH was negative recoded (r^2=-0.545, p value=0.007) at Baghdad; while the score was (r^2= -0.1, p value=0.649) at Najaf, see table-2.The research deal with the relation between cure rate and metrological factors was very rare.

But the exposure of human body to heat may further motivate the immune system "the second line of body defense" by fever mimicking lead to activation of innate and acquired immunity which motivates physiological resilience [18].The Association between Case Fatality rate (CRF) and MT, DTR and RH were differing spatially and temporally shown in table-3.

Table 3:Correlation and association between COVID-19 weekly Case Fatality rate % and Weekly Metrological factors (MT, DTR, RH), Iraq from 23/2/2020(week 8) to 2/8/2020 (week 31).

Metrological variables	Correlation	Iraqi selected cities				
		Sulaymaniyah	Diyala	Baghdad	Najaf	Basrah
MT	r^2	0.404	0.286	-0.405	0.396	0.077
	P value	0.056	0.186	0.055	0.061	0.727
DTR	r^2	0.296	0.322	-0.517	0.257	-0.025
	P value	0.171	0.134	*0.011	0.235	0.91
RH	r^2	-0.347	-0.326	0.272	-0.105	0.035
	P value	0.104	0.13	0.212	0.635	0.873

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Result show positive correlation between CFR % and MT in four cities, the highest correlation was (r^2=0.04, P value=0.056) at Sulaymaniyah; while the lowest was recorded at Diyala (r^2=0.286, P value=0.186).

DTR operate at the same pace with daily MT changes in three cities; the highest value was (r^2=0.322, P value=0.171) at Diyala, but the lowest at Najaf (r^2=0.257, P value=0.235) but no significance was noticed see table-3.

Recent international studies indicate the positive correlation between temperature and mortality. The study of [19] on the impacts of temperature and DTR on mortality in 63 cities in five East-Asian countries during various times between 1972 and 2013; they indicated the impact of extreme temperature (MT and DTR) values on increasing mortality; this effect gets worst when the patient had a history of cardiovascular disease. Also, in India [5] found that the number of mortality increased rapidly with increasing in temperature range (25-40 ^{0}C).

The correlation was negative in Baghdad "capital of Iraq" and Basrah. This result may be attributed to temperature extremes (see figure.1). High temperature may have negative impact on mortality rate [20].

Result shown negative correlation of RH with "CFR %" in three cities; but the relation was positive in Baghdad and Basrah "correlated negatively with DTR"; the values were (r=0.272; 0.035) with P value (0.212; 0.873) respectively. The RH range in Baghdad and Basrah (10~ 47); (16 ~ 57 %) respectively; this may be higher than other cities. RH range fluctuation (40~70%) was correlated positively with COVID-19 mortality in India [5].

The humidity impact has been studied in United State of America for 25-year period by [21] he found that low-humidity levels might cause a large increase in mortality rates, potentially by influenza infection.

The estimated effects of low and high temperatures on mortality varied by community and country; the meta-analysis results show that both cold and hot weather increased the risk of mortality [22].Harmonizing to this finding; our result show that the impacts of meteorological variables may varies temporally and spatially.

Conflict of Interest: None declared

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Ethical Clearance: Al-Karkh University of Science

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Conclusion

The meteorological variables are important factors for in COVID-19 infection in Iraq; thus the Iraqi government should take this in the account when prepare emergencies and respond plan setting. Our result implies that sustainable environmental policies should be considered as it would contribute to reduce the spread of infectious agents such as COVID-19. But despite of the encouraged findings of our study; further study including the other meteorological factors and cover the colder period is important; and another studies direction is to be covering (air pollution, patient health history and age groups) to achieve a better insight for the fighting model against COVID-19.

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