ORIGINAL ARTICLE

A study of the impact of massive population crowding on the incidence of COVID-19 in Iraq during the fortieth ceremony in 2020

MUSTAFA NEMA A ALI[1], SAHAR A. MAJEED[2], SUHAD T.ZAMIL[3], SUAAD T. ZAMIL[3], EKHLAS SABAH HASSAN[2], FADHAA ABDULAMEER GHAFIL[2], RANA TALIB[4], FATIMA HA[5], HAIDER W.MARDAN[6], HUSSEIN ABDULKADHIM A[7]
[1]Assistant Professor of Respiratory Medicine, Baghdad College of medicine, Iraq.
[2]Assistant Professor of Pharmacology and Therapeutics, Faculty of Medicine, University of Kufa, Iraq.
[3]Lecturer of Pharmacology and Therapeutics,Faculty of Pharmacy, University of Kufa, Iraq.
[4] Lecturer of Microbiology, Department of Microbiology, Faculty of Medicine, University of Kufa, Iraq.
[5]Research Writing Self-employed.
[6] Middle Euphrates Center of Neurosciences/AL- Sadder Teaching Hospital, Al-Najaf Al-Ashraf Health Directorate.
[7]Professor of Pharmacology and Therapeutics, Faculty of Medicine, University of Kufa, Iraq.
Correspondence to Dr.Ekhlas Sabah Hassan . E-mail: ekhlass.khazaal@uokufa.edu.iq

ABSTRACT

Background: One of the most important factors in the transmission of COVID-19 is the people crowding. This factor may enhance both increases in viral transmission and the emergence of herd immunity. However, as a rule, population crowding in religious ceremonies should logically cause a peak rise in COVID-19 incidence before the commencement of the immunity against the virus. The striking observation in this 40th ceremony in Iraq during 2020 is the occurrence of the reverse to the expected rise in the number of COVID-19 infections and deaths during the massive visitants crowding.
Aim: To assess, analyze and interpret the primary observation of the decrease in the incidence of COVID-19 during the 40th ceremony in Iraq 2020 despite approximately 14 million visitants had agglomerated during this visit.
Methods: This study was designed to assess the linear regression model of the incidence of COVID-19 during the days of Safar for the middle and southern Iraqi governorates in which almost all contributed to the ceremony in comparison with the control northern governorates population. The official registry of CMC for COVID-19 and the official northern and southern electronic counter of the visitants to Karbala were used whereas the direct visitant's contact and exposure were estimated by direct sample reviewing. Suspected cases are exclusively diagnosed based on PCR tests that belong to the formal accredited national lab with or without a chest CT scan.
Results: showed a significant decline in COVID-19 incidence and mortality soon after the commencement of the ceremony for the test population that participated in the visit to Karbala. The slope was -23 (protective) as a reverse to the expected sharp rise in the incidence due to the massive visitants' exposure. This result was compared to the control northern Iraqi population which revealed an increased rate of COVID-19 incidence and death indicated as a positive slope (11.5) during the same comparative period.
The study had reviewed several possible medical causes of this unexpected decrease in COVID-19 incidence during this ceremony, however, no one can satisfactorily interpret the findings.
Conclusion: From the overall results, further reviewing of the nature of community attitude and its role in the severity and incidence of the epidemics is mandatory for the health system decisions.
Keywords: COVID-19, RNA virus, 40th ceremony, Arba'een pilgrimage.

INTRODUCTION

COVID-19 is a rapidly spreading RNA viral epidemic[1]. SARS cov2 possesses higher binding surface proteins called S proteins to the host ACE2R and other host cell proteins that facilitate SARS cov2 entry[2]. This property favored the higher transmission rate of COVID-19 to the level of worldwide pandemic during 2020[3]. The most important factor that enhances COVID-19 incidence and spread is community contact[4]. The higher number of contacts the higher rate of COVID-19 incidence[5]. Different national and international registries confirmed that wherever there is an increase in population crowd and contact rate there will be an increase in the incidence rate of COVID-19[6]. Other important factors that contribute to the incidence of respiratory infectious disease is the mask, the disinfectant, and hygiene measures[7,8].

In different countries around the world, there are multiple forms of agglomerations and crowding of the population such as marketing, institutions, recreation, tourism, and religious ceremonies[9].

Of the largest agglomerations in Iraq is the marching of the fortieth ceremony to IMAM Hussain during the Safar Arba'een pilgrimage[10]. In which march up to 15 million of different Iraqi people of different age groups, sex and ethnicities are contributing in the visit to Karbala around 20th of SafarArba'een pilgrimage[11]. Those visitants last from 1-20 days before and during the ceremony. During which period they walk along the hundreds of kilometers of streets to arrive at Karbala from different governorates. The visitants will use to sleep in the cavalcades in close contact with each other[10]. On average each visitant may contact up to 500 others.

The study was aimed to analyze the real relationship between the incidence of COVID-19 and the massive population crowding during the 40th ceremony in 2020 and tried to interpret the reasons of the primary observation of the discrepancy of the decline in the incidence with the increase in the progress of the ceremony and increase in the number of the visitants.

Study design and methodology: The study was conducted as a linear regression model analysis of the

impact of population crowding on the incidence of COVID-19 to obtain the model slope quantity and direction as an indicator of the degree of association between the exposure and the outcomes. Samples were monitored throughout the period from the 1st of October 2020 to the 4th of September 2020. 1st of Safar had dated on the 8th of October. The lag phase of the 40th ceremony commences around the 8th of Safar (16th of October) whereas the peak crowding of visitants was around the 28th of October which is the Hijri date of the 40th ceremony. The official Iraqi CMC (communication and media commission) was the source of the COVID-19 daily database used[12], whereas daily based counting of the visitants were obtained by the southern and northern Karbala electronic counter[13].

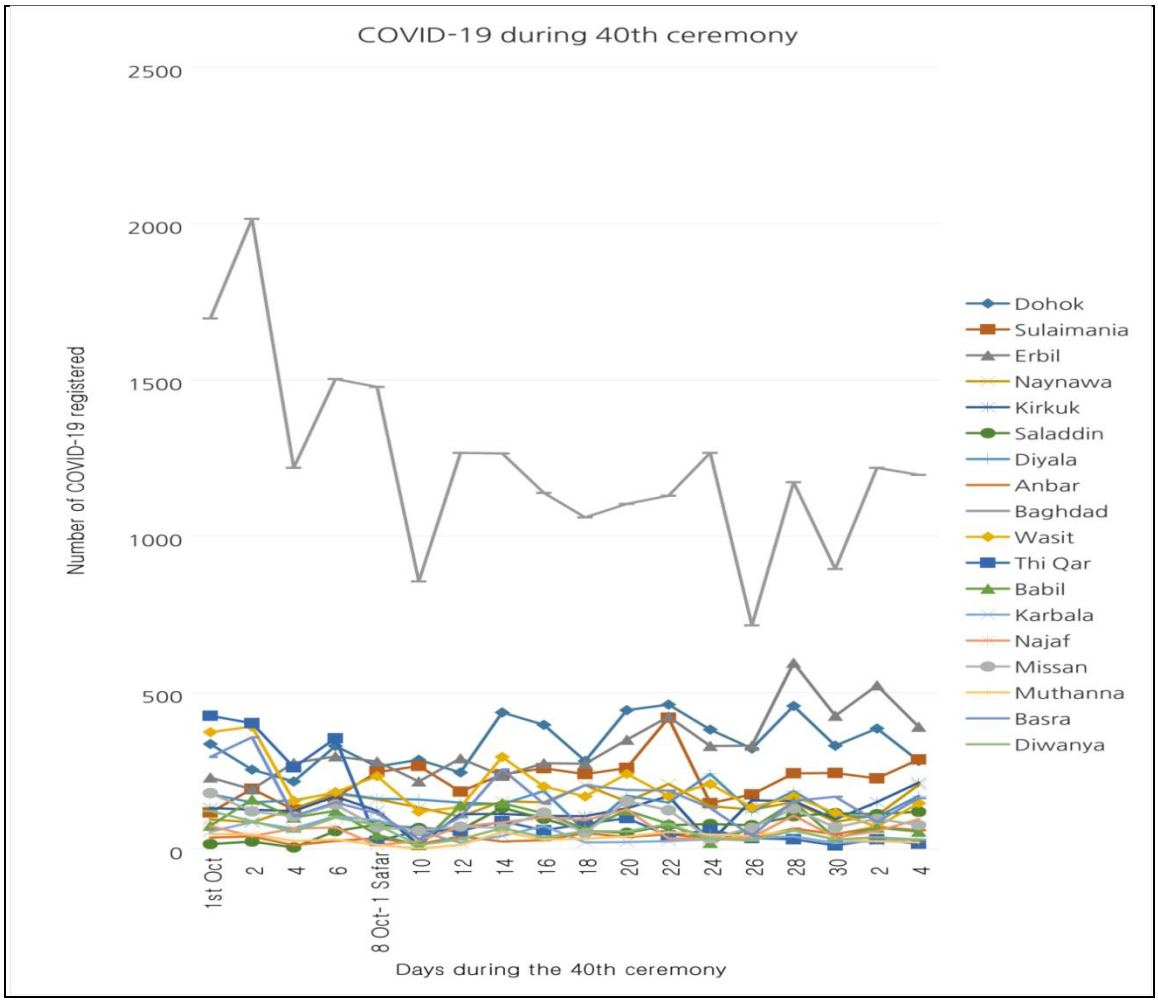
Details of the population and visitants were estimated by direct reviewing of the cavalcades and peoples. The study sample had enrolled every visitant and any participant in the ceremony services who was registered once by the electronic counter. Any bodyweight, individual age group, sex, disease, and health status, different occupations and jobs, races, and social classes were included. Visitants contacts or exposure is defined as a distance less than 2 meters that separate between the participants in the ceremony.

Statistics: The mean and standard deviation of the contact numbers, hours of visitants' exposure, and days spending during the 40th visit were calculated. The linear regression model was used to estimate the significance of the impact of the ceremony on the incidence of COVID-19.

RESULTS

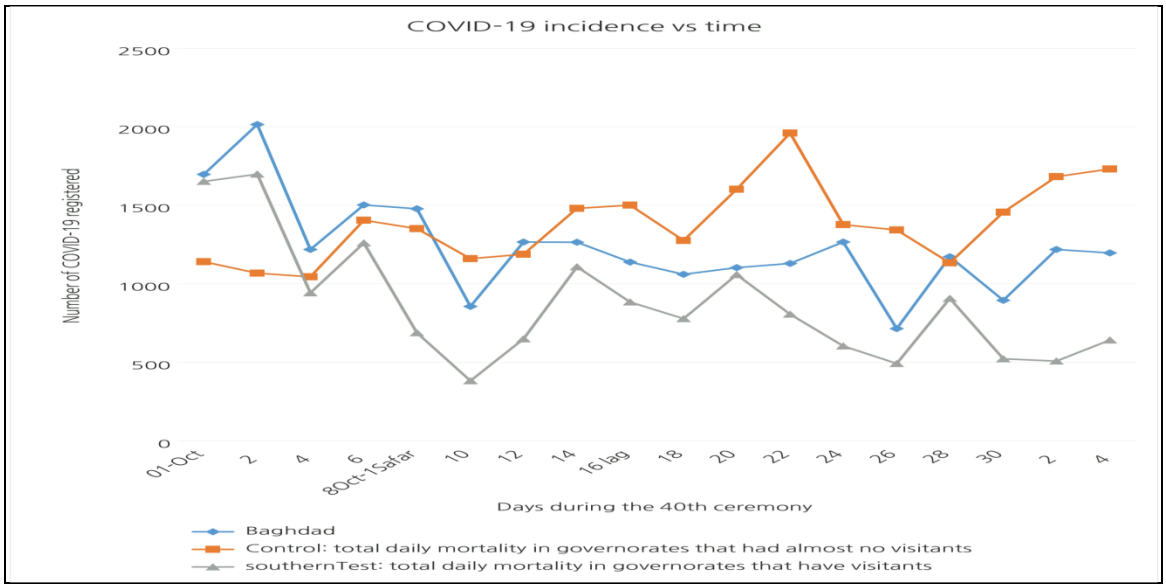
The comparative incidence of COVID-19 during and around the period of the 40th ceremony.

Figure 1: The daily diagnosed number of COVID-19 around and during the 40th ceremony in all Iraqi governorates. It's obvious that the northern governorates Erbil, Sulaimania had not only a higher incidence but showed an increasing risk index +11.5. in comparison with middle and southern governorates in which almost all have contributed to the ceremony and showed a protective index of incidence = -23. Baghdad numbers were shown just for demonstration because it's a collection of different populations although the overall COVID-19 registry revealed numbers parallel to that of middle and southern governorates.



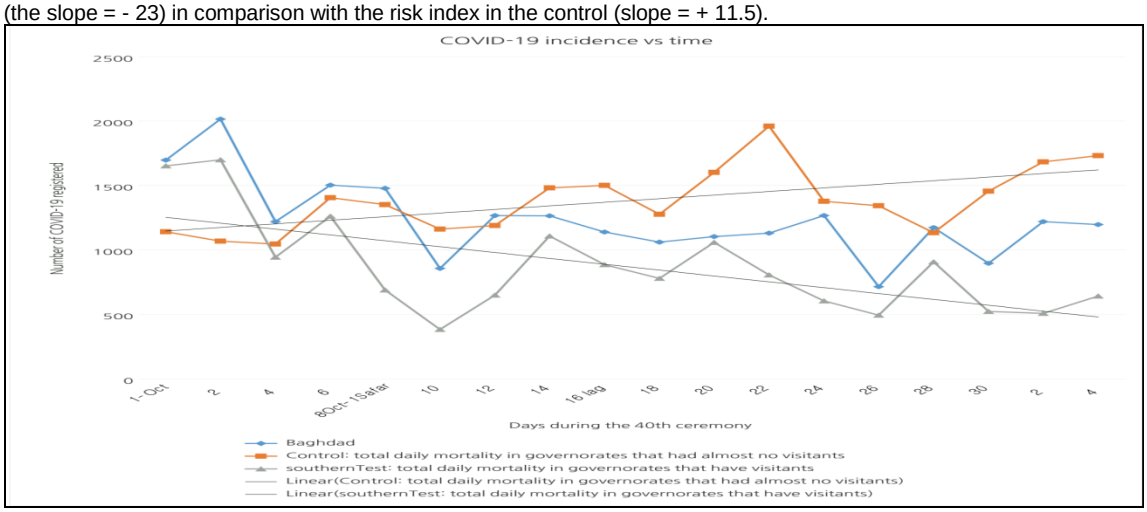
The comparison between the sum of daily COVID-19 in test and control groups of governorates

Figure 2: The sum of COVID-19 incidence to compare the linear regression between the governorates which had almost no visitants (the orange polygon which showed a risk index = + 11.5) and the governorates which had visitants (the grey polygon which showed a protective index = -23). The orange polygon indicates the sum of daily COVID-19 number in Dohok, Sulaimania, Erbil, Nainawa, Saladdin, Anbar,Kirkuk, and Dayala whereas the grey polygon indicates the sum of daily COVID-19 numbers in Babil, Wasit, Karbala, Najaf, Diwania, Muthanna, Thi Qar, Missan, Basra.



The linear regression analysis for the control and test groups

Figure 3: The linear regression model of the incidence of COVID-19 as the daily sum of numbers in the control (northern) and the test (middle and southern) governorates which showed the following models respectively. Daily incidence of COVID-19 = 11.5 x days + 1200, daily incidence of COVID-19 = -23 x days toward the ceremony + 1400. There was an obvious and significant protective index in the test (the slope = - 23) in comparison with the risk index in the control (slope = + 11.5).



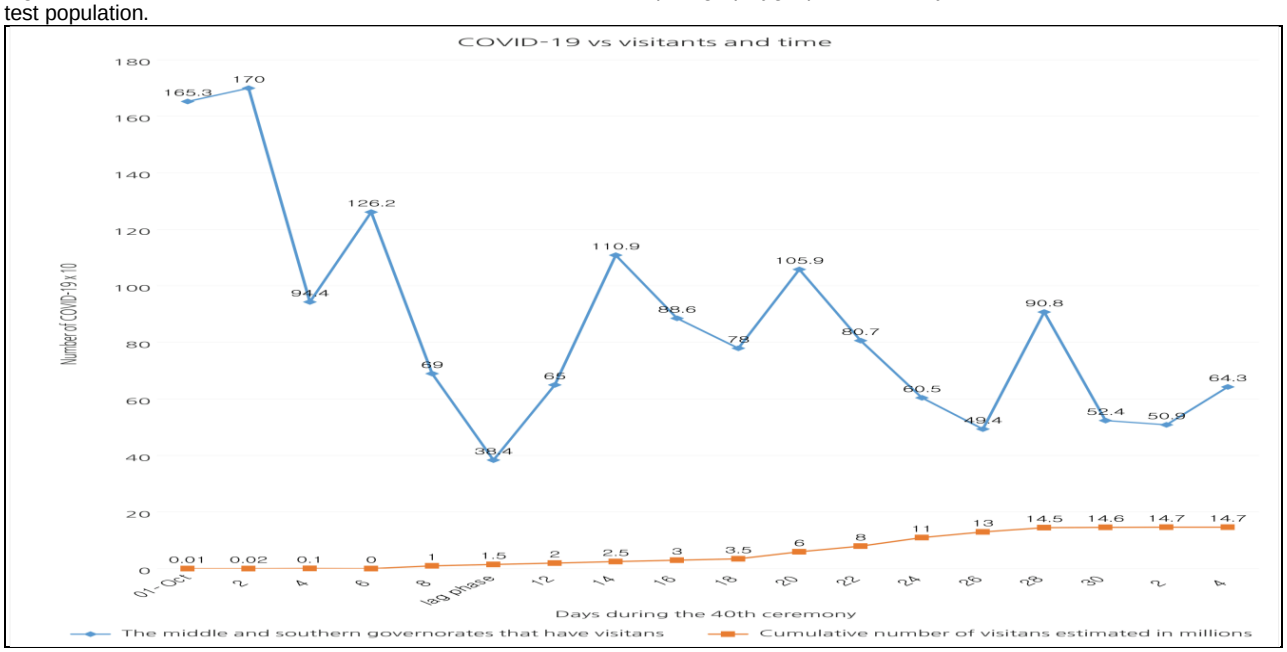
Estimation of the visitant's exposure

Table 1: The estimated means of the parameters related to the exposure of visitants and the control. Samples out of the total populations were directly assessed and analyzed.

Groups	mean days people spent out of the 15 days of ceremony	mean hours of exposure (visitants contact)	mean contacts number	comment
control: the northern population	5 +/- 2	10 +/- 3	100 +/- 10	data related to malls, institutions and tourism
test population: the visitants	5 +/- 2	30 +/- 5	500 +/- 100	data related to the ceremony

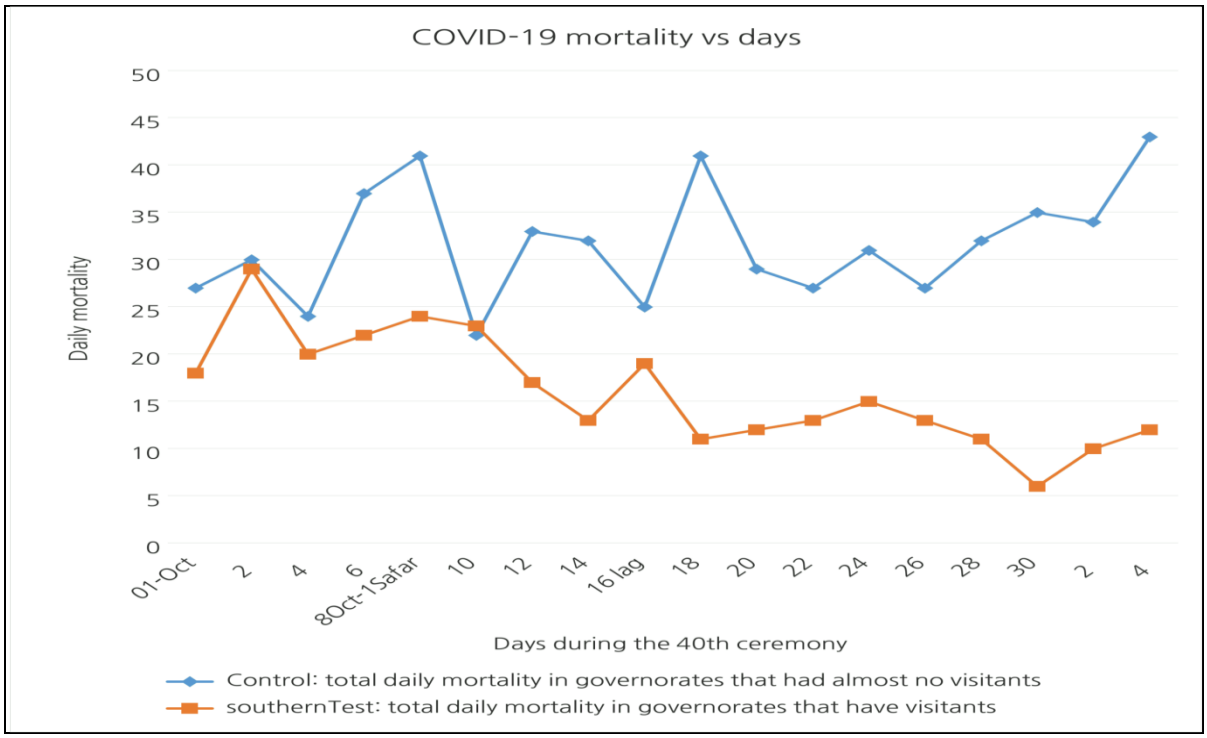
The association between incidence and visitants number

Figure 4: The association between the visitant's number in millions (orange polygon) and the daily sum of the number of COVID-19 in the test population.



Analysis of the sum of COVID-19 daily mortality for the control and test groups

Figure 5: The daily registered mortality due to COVID-19 in the test and control groups of governorates. The test (the orange polygon which indicates the governorates that had visitants) revealed the following linear regression model: the sum of the daily mortality = - 0.5 x days toward the ceremony + 25. whereas the control showed: the sum of the daily mortality = 0.2 x days + 27. Then the mortality index provides a very important and real indicator since deaths are registered regardless of any bias factor. It's obvious that the mortality index confirms the incidence index because of the parallel direction of the slope (- 0.5 in the test group i.e. protective and + 0.2 in the control group i.e. a risk factor).



DISCUSSION

A unique character for the time distribution of any RNA viral epidemic shows a decline in incidence, severity, and mortality with the progress of months[14]. However, crowding is a well-identified factor for increasing all of the above parameters. Close contact and crowding may also contribute to the development of community-based immunity but this response occurs only after real transmission of the infections between people[15,16].

The results of this current study were inconsistent with the pattern of acquiring a herd immunity since there was no noticeable increase in the incidence of COVID-19 in the test population which belongs to the middle and southern governorates which encountered a massive crowding during the 40th ceremony in comparison with the control northern governorates which almost had no visitants. On contrary, the reverse had occurred i.e. The 40th ceremony population showed a significant decline in the incidence of COVID-19 soon after the lag phase of the visit commencement and a comparative increase in COVID-19 incidence in the northern population.

The line of regression was calculated for both the test and control samples and showed a negative slope for the test sample (daily incidence of COVID-19 = - 23*days toward the 40th visit + 1400) so that the slope was similar to a protective indicator since the value was negative (- 23) in the linear model.

A similar calculation was also applied to the comparative control sample which showed the following linear model: the daily incidence of COVID-19 = 11.5 * corresponding days during the 40th visit + 1200 which means an increase in the COVID-19 incidence during the corresponding days of the 40th visit.

The possible interpretations of the inconsistent finding of COVID-19 incidence during the 40th ceremony. Although the RNA viral epidemic showed a spontaneous progressive decline in the rate of infectivity but this decline in the incidence is usually occurring after the peak of the epidemic as many studies had confirmed [17]. The spontaneous or time-dependent decrease in RNA viral infections incidence, severity, and mortality are mainly attributed to the spontaneous viral genome mutations which accumulate with viral generations in a frequency of 10^-6 [18]. Those mutations are well known to be 99.99% harmful to the virus itself so that the quality of the viral proteins structure and functions will be submaximal so that the viral virulence will significantly decrease with an increasing number of viral CFU generation[19,20].

These facts will indicate that the order of COVID-19 infection will be a critical factor in the emergence of mild or less virulent RNA viral infections. The order of the viral infection is defined as the number of the intermediate individuals between the first and the last infected patient.

COVID-19 proteins like RDRP, proteases, ribophosphatases, and structural proteins like S protein will significantly vary with time[21,22]. This variation, however, may not always mean that the severity of the infection will necessarily decrease rather some of the antigenic drift and shift will enhance the viral spreadability which may contribute to the increased incidence other than mortality[17,23].

The second point of view in explaining the discrepancies in the results is the review of the possibility of visitants denial and neglection of the COVID-19 test and registry due to commitment with the ceremony however this interpretation is not satisfactory since the registry of the mortality is a real reflection of the COVID-19 severity and is independent on the ceremony i.e COVID-19 deaths are totally and accurately registered also the mortality rate registry during the 40th ceremony was nearly parallel to the figure of the COVID-19 incidence so that the mortality rate will reject the hypothesis of interpreting the visitant's commitment with the ceremony as a cause of neglection of COVID-19 test and diagnosis.

Comparative spontaneous decreases in the incidence of COVID-19 had occurred in several countries around the world like Korea, Japan, and UAE before, during, and after the Iraqi 40th ceremony however this decline in COVID-19 incidence in these countries still can not interpret the subsidence of this epidemic in Iraq since these countries had a well-organized health measure, moreover, these countries didn't encounter such massive population crowding as that happened in Iraq during the visit of the 40th in 2020.

Another explanation of this deviation of the incidence-exposure relationship is that the visitants were unlike home locked down people, tourists, and employers they crowd in an open space, well-aerated and psychologically motivated, and comfortable. That visitant’s environment may potentiate immunity and dilute the viral infection dose. Although this is a reasonable interpretation but it needs further studies and evidence to be confirmed as well as the visitant's environment and the efforts of the ceremony were stressful that may further complicate any infection and inflammation.

CONCLUSION

Although the study sample was large enough to extract conclusive results, however molecular details about COVID-19 RNA and proteome and the host mechanism of the immune response are critical for an evidence-based interpretation for this discrepancy.

RECOMMENDATION

Further COVID-19 genomic and proteins analysis and community immunoassay are mandatory for a full understanding of the mechanism and the model of the viral epidemic infections.

REFERENCES

1. von Seidlein L, Alabaster G, Deen J, Knudsen J. Crowding has consequences: Prevention and management of COVID-19 in informal urban settlements. Vol. 188, Building and Environment. Elsevier Ltd; 2021.
2. Weston S, Frieman MB. COVID-19: Knowns, Unknowns, and Questions. mSphere. 2020 Mar 18;5(2).
3. Baxi P, Saxena SK. Emergence and Reemergence of Severe Acute Respiratory Syndrome (SARS) Coronaviruses. In 2020. p. 151–63.

4. Raoult D, Zumla A, Locatelli F, Ippolito G, Kroemer G. Coronavirus infections: Epidemiological, clinical and immunological features and hypotheses. Vol. 4, Cell Stress. Shared Science Publishers OG; 2020. p. 66–75.
5. Lotfi M, Hamblin MR, Rezaei N. COVID-19: Transmission, prevention, and potential therapeutic opportunities. Vol. 508, Clinica Chimica Acta. Elsevier B.V.; 2020. p. 254–66.
6. Belingheri M, Paladino ME, Riva MA. COVID-19: Health prevention and control in non-healthcare settings. Vol. 70, Occupational Medicine. Oxford University Press; 2020. p. 82–3.
7. Islam MS, Rahman KM, Sun Y, Qureshi MO, Abdi I, Chughtai AA, et al. Current knowledge of COVID-19 and infection prevention and control strategies in healthcare settings: A global analysis. Vol. 41, Infection Control and Hospital Epidemiology. Cambridge University Press; 2020. p. 1196–206.
8. World Health Organization. Coronavirus disease (COVID-19) advice for the public. Geneva: World Health Organization; 2020.
9. Mubarak N, Zin CS. Religious tourism and mass religious gatherings — The potential link in the spread of COVID-19. Current perspective and future implications. Vol. 36, Travel Medicine and Infectious Disease. Elsevier USA; 2020.
10. Mirzaei R, Abdi M. An influenza A outbreak in Iranian individuals following Arba'een foot pilgrimage from October to December 2019. Vol. 41, Infection Control and Hospital Epidemiology. Cambridge University Press; 2020. p. 627–8.
11. https://www.alkawthartv.com/news. tahran ; 2020.
12. https://www.facebook.com/MOH.GOV.IQ/.
13. https://alkafeel.net/news/index.
14. Fontanet A, Cauchemez S. COVID-19 herd immunity: where are we? Vol. 20, Nature Reviews Immunology. Nature Research; 2020. p. 583–4.
15. Ruppel A, Halim MI, Kikon R, Mohamed NS, Saebipour MR. Could COVID-19 be contained in poor populations by herd immunity rather than by strategies designed for affluent societies or potential vaccine(s)? Glob Health Action. 2021;14(1).
16. Suneel P, Narasimha Kumar G. Assumption of Herd Immunity against COVID-19: A Plausibility and Hope or a Terrible Thought in Modern-Day to Save the Life. J Infect Dis Epidemiol. 2020 Jul 25;6(4).
17. Lavine JS, Bjornstad ON, Antia R. Immunological characteristics govern the transition of COVID-19 to endemicity. Science (80-). 2021 Jan 12;eabe6522.
18. Sanjuán R, Nebot MR, Chirico N, Mansky LM, Belshaw R. Viral Mutation Rates. J Virol. 2010 Oct 1;84(19):9733–48.
19. Berngruber TW, Froissart R, Choisy M, Gandon S. Evolution of Virulence in Emerging Epidemics. PLoS Pathog. 2013;9(3).
20. Lan FY, Filler R, Mathew S, Iliaki E, Osgood R, Bruno-Murtha LA, et al. Evolving virulence? Decreasing COVID-19 complications among Massachusetts healthcare workers: A Cohort Study. medRxiv. medRxiv; 2020.
21. Jiang Y, Yin W, Xu HE. RNA-dependent RNA polymerase: Structure, mechanism, and drug discovery for COVID-19. Biochem Biophys Res Commun. 2020;
22. Velavan TP, Meyer CG. The COVID-19 epidemic. Vol. 25, Tropical Medicine and International Health. Blackwell Publishing Ltd; 2020. p. 278–80.
23. Koyama T, Weeraratne D, Snowdon JL, Parida L. Emergence of drift variants that may affect covid-19 vaccine development and antibody treatment. Pathogens. 2020 May 1;9(5).