

Mobility indicators and COVID-19 growth ratio in Iraq: a correlation study

Faris Lami¹, Hanan Abdulghafoor Khaleel², Yousef S. Khader³

¹Department of Community Medicine, College of Medicine, University of Baghdad, Baghdad, Iraq

²Communicable Diseases Control Center, Public Health Directorate, Ministry of Health, Baghdad, Iraq

³Medical Education and Biostatistics, Department of Community, Medicine, Public Health and Family Medicine/Faculty of Medicine, Jordan University of Science & Technology, Ar-Ramtha, Jordan

Address correspondence to Hanan Abdulghafoor Khaleel, Email: drhanan.cdcci@gmail.com

ABSTRACT

Background There is no prior study of the effect of mobility-limiting measures on the occurrence of COVID-19 in Iraq.

Objectives To determine the relationship between publicly available mobility index data and the growth ratio (GR) of COVID-19.

Method We used Google COVID-19 Community Mobility Reports to extract Iraq's mobility data and the official Ministry of Health COVID-19 statements. We used the data to calculate the Pearson's correlation coefficient and fit a linear regression model to determine the relationship between percentage change from the baseline in the mobility indices and the GR of COVID-19 in Iraq.

Results There was a moderate positive correlation between each of the mobility indices except the residential index and COVID-19 GR in Iraq. The general linear model indicated that as each of the mobility indices increases by one unit, the GR of COVID-19 increases by 0.002–0.003 except for the residential index. As the residential mobility index increases by one unit, the GR decreases by 0.009. All the findings were statistically significant (P -value < 0.0001).

Conclusion Mobility-limiting measures may be able to reduce the growth rate of COVID-19 moderately. Accordingly, mobility-limiting measures should be combined with other public control measures particularly mass mask use.

Keywords correlation, COVID-19, mobility-limiting measures

Introduction

The year 2020 was started with the announcement of an unprecedented COVID-19 pandemic caused by SARS-CoV-2 virus originating from Wuhan, China and spreading worldwide.¹ As of 13 September, there were 28 944 152 cases and 924 577 deaths globally,² and there were 41 193 cases and 1559 deaths in Iraq.³ Not all the Iraqi governorates were on the same order in the pandemic phases. Some governorates were somewhat delayed, particularly, the governorates with limited testing capacity. In addition, the implementation of the mobility-limiting measures was not uniform among the governorates and even within the same governorate. All these factors play an important role in determining how mobility and COVID-19 occurrence interplay.

By September 2020, there was still neither no vaccine nor a therapeutic agent to COVID-19; therefore, only behavioral and public policy interventions are able to limit the spread

of the virus.⁴ Since the beginning of the pandemic, several mobility-limiting public health measures were taken by most countries and were found to be effective in some of them in limiting the spread of the virus.⁵

Iraq reported the first case on 26 February 2020 in Najaf governorate, and spread later to affect all Iraqi governorates.³ Thereafter, several mobility-limiting measures were implemented including complete curfew in the middle of March for two weeks followed by partial curfews, interrupted curfews, online educational platforms for schools and universities, travel restrictions, minimizing the number of people at workplaces, and stay home orders. All these

Faris lami, Assistant Professor

Hanan Abdulghafoor Khaleel, Director of Surveillance Section

Yousef S. Khader, Professor of Epidemiology

non-pharmaceutical interventions aimed to reduce the number of contacts per person leading ultimately to reducing COVID-19 transmission. However, the application of these measures cannot continue forever and most of the countries have set criteria to go back to new normal community activities.^{5–7}

A limited number of studies used Google mobility data to quantify and determine the relationship between mobility indices and the occurrence of COVID-19.^{1,4–14} In Iraq, there is no study of the relationship between mobility indices and the occurrence of COVID-19. Therefore, the aim of the current study was to determine the direction and the magnitude of the correlation between mobility indicators (MI) and COVID-19 growth ratio (GR) in Iraq. Evaluating the effect of dynamic changes in human mobility on the occurrence of COVID-19 will help understanding the effectiveness of ongoing/future control measures.

Methods

Data sources

The daily number of COVID-19 cases was collected from the Ministry of Health official announcements. The daily percentage change from baseline in certain mobility indices in Iraq (retail and recreation, grocery and pharmacy, parks, transit stations, workplaces and residential) were obtained from Iraq's publicly available data on Google COVID-19 Community Mobility Reports website.¹⁵ Iraq's data from 15 February 2020 to 26 June 2020 were downloaded from the site. The indicators were calculated as a percentage difference from the baseline. Details on how the data are collected are available on Google COVID-19 Aggregated Mobility Research Dataset website.¹⁵ The website provides a global, time-varying anonymized mobility map of flows at a resolution of 5 km². The data set has guaranteed differential privacy while capturing mobility flows (MF) at every level of spatiotemporal resolution.

In Iraq, mobility indices can be explained as follows: Retail and recreation index include visits to restaurants, cafes, shopping centers, museums, libraries and movie theaters. Grocery and pharmacy index include visits to grocery markets, food warehouses, vegetables and fruit markets, specialty food shops, drug stores and pharmacies. Parks encompass public parks and public gardens. Transit stations cover airports, bus and train stations. The residential index refers to the average duration (hours) spent in places of residence. The description of these variables on Google is slightly different as they included all forms relating to each variable that may not be present in all countries.

Data analysis

We used the daily COVID-19 cases report to calculate the GR for COVID-19. The ratio was defined as the logarithmic rate of the moving average (number of newly reported cases) over the previous 3 days relative to the logarithmic rate of the moving average over the previous week. GR for a day t was calculated as follows:

$$GR = \frac{\log(\sum C/3)}{\log(\sum C/7)}$$

where C is the daily COVID-19 cases. Values of GR can only be positive. A GR equals 1 when the average number of new cases per day over the last 3 days was the same as the average over the last 7 days. A GR below 1 means that the GR during the last 3 days was lower than that of the last week, whereas a value greater than 1 represented a GR increase in the last 3 days relative to the last week. We used moving averages to smooth data.

We fitted a general linear model for each of the MI with the GR, specifically using lagged mobility indicator (MI) as a predictor of COVID-19 GR and tested the correlation of MI and GR at a time lag of 14 days. The Pearson's correlation coefficient between MI and GR was computed from separate models for each MI as well as a combined single model for all indicators; however, the results were the same and therefore we chose to present the results from the separate models.

Microsoft Excel 365 was used for collection and processing of the data. R V 4.0.1 was used for fitting the correlation and plotting the correlogram. SPSS IBM V.26 was used to fit the general linear model between the mobility indices and the GR.

Results

Using Google Community Mobility Indices and the growth rate of COVID-19, we evaluated how limiting mobility influenced the rate of new COVID-19 infections in Iraq with the highest number of confirmed cases on 16 April 2020, by fitting a general linear model for each mobility index, using lagged mobility index as a predictor of COVID-19 GR. The correlation coefficient ranged from 0.50 to 0.57 with each of the mobility indices except the residential index as it was -0.56 . All estimates were statistically significant with a P -value < 0.001 , as shown in [Table 1](#).

The results of an unadjusted general linear model are listed in [Table 2](#). The findings indicate that as each of the mobility indices increase by one unit, the GR of COVID19 increases by 0.002–0.003 except for the residential index as it was found that as the residential mobility index increases by one unit,

Table 1 Pearson’s correlation coefficient between MI and the GR of COVID-19 in Iraq

Mobility indicator	Pearson’s correlation coefficient (R)	Coefficient of variation (R ²)	P-value
Retail and recreation	0.56	0.313	< 0001
Grocery and pharmacy	0.50	0.247	< 0001
Parks	0.56	0.318	< 0001
Transit stations	0.57	0.328	< 0001
Workplaces	0.54	0.293	< 0001
Residential	−0.56	0.317	< 0001

Table 2 The linear regression analysis of the association between each of the MI and the growth rate of COVID-19

Mobility index	B	Lower bound	Upper bound	P-value
Retail and recreation	0.002	0.002	0.003	< 0001
Grocery and pharmacy	0.003	0.002	0.003	< 0001
Parks	0.003	0.002	0.004	< 0001
Transit stations	0.002	0.002	0.003	< 0001
Workplaces	0.003	0.002	0.003	< 0001
Residential	−0.009	−0.012	−0.007	< 0001

the GR decreases by 0.009. All the findings were statistically significant (*P*-value < 0.001), as is stated in Table 2.

On the other hand, each of the mobility indices were highly correlated with one another as the Pearson’s correlation coefficient values ranged from 0.84 to 0.99 except for the residential index, as shown in Fig. 1. In fact, the residential mobility index had strong negative correlation with all other indices ranging from −0.85 with grocery-pharmacy index, −0.92 with workplace index, to −0.94 with each of transit, parks, and recreation, and retail index. On the other hand, the workplace mobility index shows a strong positive correlation with each of grocery-pharmacy (0.84), parks (0.87), retail-recreation (0.88) and transit (0.89). The strongest positive correlation was between transit, parks-retail, recreation and grocery-pharmacy as the correlation values ranged from 0.95 to 0.99.

In addition, the R² value was lowest for the grocery index and ranged from 0.25 to 0.32. This suggests that each of the indices can explain 25–32% of the variation in the model.

Discussion

Main findings of the study

Findings from our study suggest that there is a moderate positive correlation between each of the mobility indices (retail and recreation, grocery and pharmacy, parks, transit stations

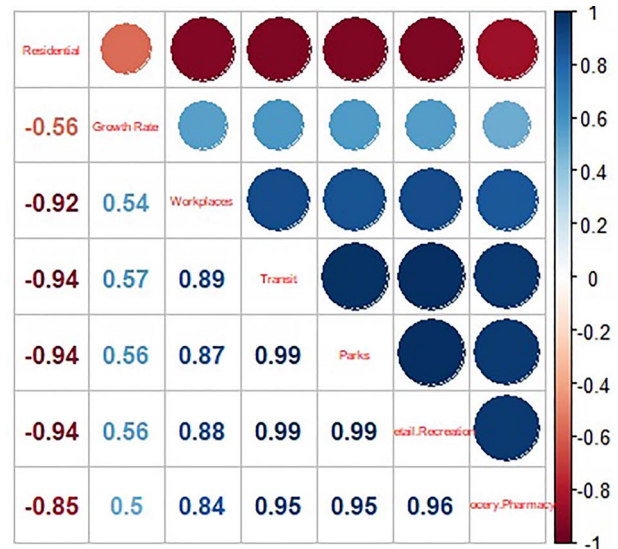


Fig. 1 Correlogram of the relationship between MI and the GR of COVID-19 in Iraq.

and workplaces) and growth rate of COVID-19. That is, if the percentage changes from the baseline of any of the mobility indices increases, there will be a moderate increase in the GR of COVID-19 in Iraq. In fact, the moderate increase in the GR could translate into a large increase in the number of the reported cases of COVID-19 because the GR is derived from the log of the moving average of the cases.

The moderate relationship may be underestimated due to the fact that ~80% of the cases are mild/asymptomatic and may not have asked for testing, considering the delay in having lab results from the overwhelmed labs.¹⁰ Another factor can be due to the adherence to personal protective measures so that even when people are mixing, the use of personal protective measures can limit the spread of the illness. Generally, all mobility indices declined after the implementation of mobility limiting measures except the residential index which increased. It is worth mentioning that mobility is not the only factor affecting the GR. In fact, there are many other factors that play an important role that might even be more important than mobility, such as, the use of personal protective equipment, personal hygiene, local social distancing and avoidance of mass gatherings. Although the MI were objective, they cannot measure mobility in an exact way, particularly in the Iraqi cultural setting where the extended families, large number of households and the local gatherings among neighbors could explain the negative correlation between the residential index and the GR.

Google mobility data are based on those who have turned on location services on their mobile devices, therefore, data regarding mobility could be underestimated and that in turn could have led to the moderate correlation between each of the mobility indices and the growth rate. This could be more apparent in low socioeconomic areas where smart phone use is not quite available while, in fact, these areas are less likely to adhere to mobility restriction.

What is already known on this topic

Mathematical modeling studies have found a strong relationship between a mobility index derived from a combination of the mobility indices tracked in Google and COVID-19 occurrence.^{9,11,13} For example, a correlation study of how the implementation of control measures affected COVID-19 growth rates found that the growth rates became negative despite evidence of local chain of transmission.¹³ Moreover, a microsimulation study found that the combination of five mobility limiting interventions will prevent deaths related to COVID-19.¹⁶ Another cross-country study found that strict implementation of lockdowns through fines significantly reduced physical mobility.¹⁴ Furthermore, the timing of the implementation of the mobility limiting measures was affected by factors such as the income, the population density, health preparedness and case detection capacity.¹⁷

The current study has many strengths. First, it is the first study in Iraq to characterize the effect of changes in certain mobility indices on the growth rate of COVID-19. Second, we used publicly available data that are anonymized. Third, it

provides an insight to policy makers on the effect of limiting mobility on the transmissibility of COVID-19.

Limitations of the study

The study also has limitations. First, there are no data about the mobility indices at the governorate and the district level. The availability of such data could have enabled us to study differences between governorates. As not all Iraqi governorates are on the same order of the pandemic; therefore, the available data represent average mobility data, and the numbers represent the general country incidence data. This might explain the moderate association. Second, there are no data about the adherence of people to mask use, social distancing, sanitizers use, which could have provided better insight into how personal protective measures and mobility indices affected the growth rate of COVID-19.

Conclusion

The mobility indices, except the residential index, correlated moderately and positively with the COVID-19 GR in Iraq. A combination of mobility limiting measure and adherence to personal protective measures contributed to limiting the spread of COVID-19. Findings from the current study can be extrapolated to future outbreaks of infectious respiratory diseases to inform policy makers of how mobility-limiting measures can limit the spread of contagious diseases.

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