Original Article

Transmission and case fatality rate associated with COVID-19 in Asian countries as per Global hunger index score

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Introduction : COVID-19, a new novel virus has posed an unprecedented challenge to the health care system and governments worldwide. The Global Hunger Index (GHI) could be an ideal tool to measure nutritional status among respective countries. Transmission and case fatality rate associated with COVID-19, might differ among countries classified according to GHI.

Objective : To determine the association of COVID-19 spread and case fatality rate among Asian countries classified according to GHI.

Methodology : An ecological study was done on the data reported for COVID-19 confirmed cases from Asian countries. The data were collected retrospectively considering the outcome as the number of daily reported cases, and case fatality rate caused by COVID-19 from inception till 19th April, 2020. Software STATA version 13, was used to conduct the statistical analyses. Generalized linear mixed model was used to determine the independent effect of predictor variables. P-value <0.05 was considered as statistically significant level.

Results : The generalized linear mixed model demonstrated that countries those at low risk of hunger had 2.8 times higher incidence rate ratio (IRR =2.8; 95% CI 2.01 to 4.05) and with a moderate risk of hunger had 1.7 times higher incidence rate ratio (IRR 1.7, 95% CI 1.3 to 2.1) when compared with serious and alarming GHI risk countries. Interestingly, low GHI risk countries had 50% less case fatality rate (IRR 0.5, 95% CI 0.26 to 0.94) and countries at moderate risk for hunger had 76% less case fatality rate (IRR 0.24, 95% CI 0.14 to 0.40) due to COVID-19 as compared with countries at high risk for global hunger in the Asian population, respectively.

Conclusion : More rigorous measures have to be taken by the countries with serious and alarming hunger index for reducing case fatality rate associated with COVID-19 in Asian countries.

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Key words **: COVID-19, Asia, GHI.**

Editor's Comment :

- **The findings of present study indicate that government should make rigorous health care policies to minimize the case fatality rate due to COVID-19 in countries falling under serious or alarming GHI.**

The word Corona is derived from the Latin word "crown". As the surface of this group of virus looks like a crown under an electron microscope, hence, it is given the name as CORONAVIRUS. To be precise, *Severe* Acute Respiratory Syndrome Coronavirus 2, is the cause of the current outbreak and hence, it is termed as SARS-CoV-2 and the disease was named as COVID-19 both by the World Health Organization and the International Committee on Taxonomy of Viruses on 11th February 2020[1]. The city Wuhan, in China is recognized as the origin of this outbreak.

On 29th December 2019, a cluster of similar cases of Pneumonia were identified by the Chinese authorities in the city and were determined as SARS-CoV2 and reported to WHO on 31st December 2019[2]. After China, the first case of COVID-19 was identified in Thailand on 13th January 2020. Due to its wide

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coverage, across the countries by 30th January 2020, WHO declared the outbreak as a Public Health Emergency of International Concern, and on 11th March, WHO declared COVID-19 as a pandemic (Fig 1).

The widespread of COVID-19, instils fear and anxiety because of gaps in our knowledge about its spread and behavior. The WHO, Situation Report-137 released on 5th June, 2020 reported 6535354 confirmed cases along with 387155 as fatality due to this infection and unfortunately the numbers are still rising exponentially all across the world every day.

There are several predictive models with limited validity have been reported in the literature to predict the case fatality and spread of COVID-19, however none of them have studied the impact of nutritional status of countries. Studies have shown that 'immunity as a passport to conquer COVID-19'. It is predicted that a poor nutritional status, could be the factor which might contribute to case fatality rate, but no study has been conducted till now, as per best of our knowledge to systematically study this effect.

To fill this research gap, we have conducted this cross-sectional study to determine the association of nutritional status considering the Global hunger index

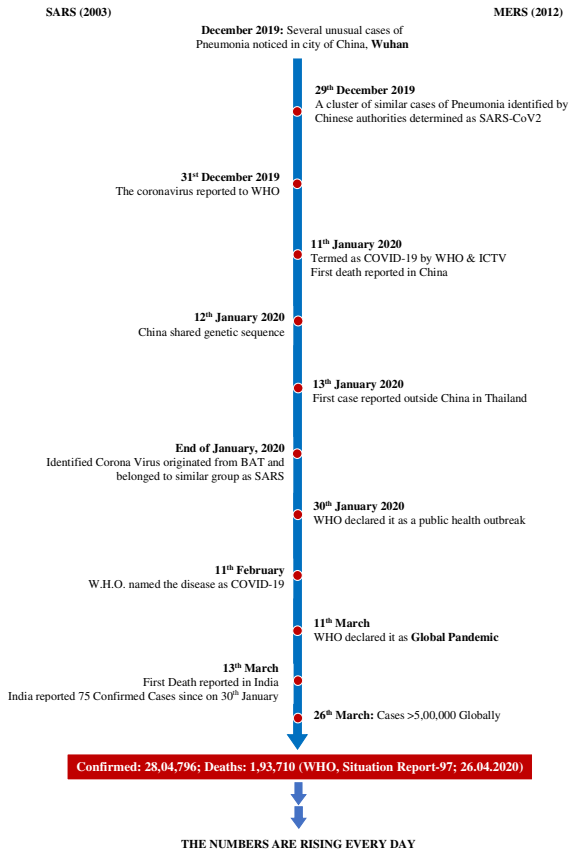

Fig 1 — Timeline of COVID-19 outbreak

(GHI) scale with number of new cases, mortality counts per day case fatality rate associated with COVID-19.

Reason to use GHI as measure of nutritional status due to:

1. GHI is based on a multidimensional approach to measure hunger.
2. COVID-19 is affecting all age-groups, therefore GHI scale is considered, because it reflects the nutritional situation of the entire population along with children.
3. The GHI is a tool to measure and track hunger and consequent undernutrition not only at the regional but also at national and global levels.
4. GHI not only reflects proportion of undernourished population; but a combination of factors which contributes to undernutrition like inadequate intake (quality or quantity) of food, poor absorption of nutrients due to infections; household food insecurity; insufficient access to maternal wellbeing or child care practices; inadequate access to health services, safe water, and sanitation.
5. GHI score are calculated each year. In the present study most recent GHI scores (2019) has been used.
6. GHI measures hunger in three dimensions: inadequate food supply (for entire population), child mortality and child undernutrition. These three dimensions are further based on four indicators including undernourishment among entire population, wasting, stunting and child mortality (Fig 2). The combination of indicators measured independently from each other reduces the impact of random measurement errors on the resulting index. The severity scale of GHI is divided into five categories: 9.9 (at low risk); 10 to 19.9 (at moderate risk); 20 to 34.9 (at serious risk); 35 to 49.9 (alarming); and 50 (extremely alarming).

There are many controversies in the existing literature regarding the immunity, economic status and status of hygiene. It's still a matter of active debate among research community. According to the "hygiene hypothesis," being too clean causes a malformation of the immune system, which may be a contributing factor for getting more prone to infectious diseases[3]. As, per the hygiene hypothesis, if the problem is being too hygiene then hypothetically the issue can be easily resolved via being unhygienic, right? But no, as it may lead to much worse. Population with high GHI are probably have low-hygiene status and disproportionally on the other hand it is predicted that people with low GHI are following better hygiene and therefore, their immunity may be affected.

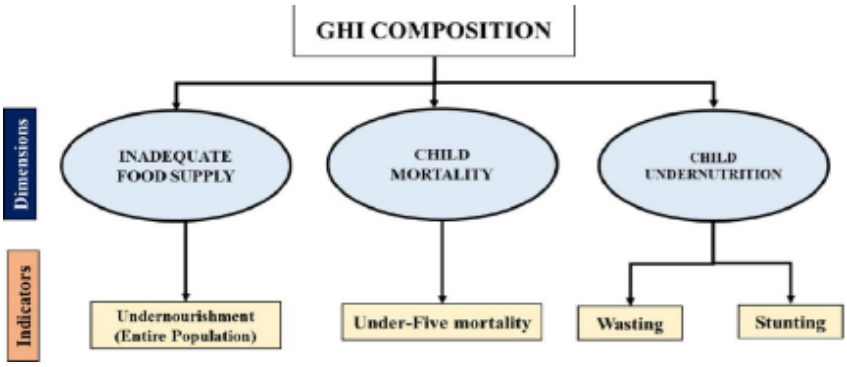

Fig 2 — Composition of Global Hunger Index

Before COVID-19 incidence, more than 820 million people went to bed hungry, and now when the nations are facing this pandemic the probability of infection rises for those who are already at risk of malnutrition which may lead to a rise in a situation of 'crisis within crisis' and when this virus is spreading in an unpredictable manner; it become necessary to study the impact of nutritional status in the individual countries in case fatality rate and spread due to COVID-19. Therefore, our study aimed to determine the association of COVID-19 spread and case fatality rate among Asian countries classified according to GHI.

Methodology :

Study design: Cross-sectional

Setting: Asian countries

Population: COVID-19 confirmed and case fatality rate cases from Asian population including all age groups and gender.

Outcome: number of new cases, and mortality counts per day due to COVID-19

Data collection: A total of 32 Asian countries with data reported for Global hunger index, confirmed cases and case fatality rate caused by COVID-19 till 19th April, 2020 were included in the study. Data was collected retrospectively from the European Centre for Disease Prevention and Control site for number of new cases and mortality counts reported per day and per country[4]. Data for global hunger index score was taken from report published in 2019 'Global Hunger Index'[5]. World meter site was used to collect data for population density and median age[6]. World Bank classification for the level of a country's income was referred[7].

Data Analysis : Since the outcome variables (number of new cases, mortality counts per day) are count (non-negative discrete number), Poisson regression is used as a standard model for analyzing such data. However, in case of over dispersion, Negative binomial regression model (NBRM) is recommended. In our case, an over dispersion test was performed to evaluate the adequacy of the NBRM over the Poisson regression model. When the ratio of variance to mean of the Poisson distribution value á (alpha) larger than one indicates over dispersion. In this study the variance was greater than the mean, and over dispersion test was significant indicated an over dispersion. Hence, the NBRM was preferred over the poison model. The effect of the association was quantified by unadjusted and adjusted incidence rate with its 95% confidence interval (CI) using univariable and multivariable negative binomial regression analysis, respectively. Data were analyzed using software STATA version 13. P value <0.05 was considered a level of signifance.

Results

A total of 32 Asian countries were included in the study (Table 1). Keeping the confirmed cases and deaths per day caused by COVID-19 as outcome, univariate regression analysis was used to study predictor and outcome relationship. The data analysis reported a significantly higher incidence of COVID-19 in countries with low risk GHI (IRR =1.74; 95% CI 1.49 to 2.04) as compared to countries with serious and alarming risk for GHI and the number of deaths was found to be significantly lower in the countries at moderate risk for GHI (IRR 0.51, 95% CI 0.39 to 0.67) when compared to countries with serious and alarming risk of GHI (Table 2).

NBRM was used to adjust the confounding effect of potential variables including number of tests done, population density and economic profile of the countries to avoid the bias of getting that countries at low risk of GHI would have high income therefore, due to better management they are having less case fatality rate. The multivariable analysis demonstrated that countries those at low risk of hunger had 2.8 times higher incidence of new cases risk (IRR =2.8; 95% CI 2.01 to 4.05) and with moderate risk of hunger had 1.7 times higher incidence (IRR 1.7, 95% CI 1.3 to 2.1) when compared with countries with serious and alarming risk for GHI. Low GHI risk countries had 50% less deaths (IRR 0.5, 95% CI 0.26 to 0.94) and countries at moderate risk for hunger had 76% less deaths (IRR 0.24, 95% CI 0.14 to 0.40) due to COVID-19 as compared with countries at high risk for global hunger in Asian population, respectively. We also observed 9% less deaths per day (IRR 0.91, 95% CI

Table 1 — *List of countries included in the study along with mortality percentage*

Country	Global Hunger Index	Case fatality	Incidence	Case fatality rate%	Average case fatality rate%
Armenia	Low risk	20	1291	1.5	**1.8**
Azerbaijan	Low risk	18	1373	1.3	
China	Low risk	4636	83803	5.5	
Georgia	Low risk	4	388	1.0	
Iran	Low risk	5031	80868	6.2	
Kazakhstan	Low risk	17	1654	1.0	
Kuwait	Low risk	6	1752	0.3	
Kyrgyzstan	Low risk	5	673	0.7	
Mongolia	Low risk	0	31	0	
Saudi Arabia	Low risk	92	8274	1.1	
Thailand	Low risk	47	2733	1.7	
Turkey	Low risk	1890	82329	2.2	
Iraq	Moderate risk	81	1482	5.4	**2.2**
Jordan	Moderate risk	7	413	1.6	
Lebanon	Moderate risk	21	672	3.1	
Malaysia	Moderate risk	88	5305	1.6	
Myanmar	Moderate risk	5	107	4.6	
Oman	Moderate risk	6	1180	0.5	
Sri_Lanka	Moderate risk	7	254	2.7	
Uzbekistan	Moderate risk	5	1495	0.3	
Vietnam	Moderate risk	0	276	0	
Afghanistan	Serious risk	30	908	3.3	**2.4**
Bangladesh	Serious risk	84	2144	3.9	
Cambodia	Serious risk	0	122	0	
India	Serious risk	507	15712	3.2	
Indonesia	Serious risk	535	6248	8.5	
Laos	Serious risk	0	19	0	
Nepal	Serious risk	0	31	0	
Pakistan	Serious risk	159	7993	1.9	
Philippines	Serious risk	382	6078	6.2	
Timor-Leste	Serious risk	0	18	0	
Yemen	Alarming risk	0	1	0	

Table 2 — *Crude association of GHI with number of new cases and deaths per day due to COVID-19*

Outcome	GHI Risk	p-value	Unadjusted IRR	95% CI
Number of new cases	At low risk	0.000	1.74	1.495 to 2.041
	At moderate risk	0.001	1.32	1.123 to 1.559
Mortality counts	At low risk	0.091	1.21	0.969 to 1.523
	At moderate risk	0.000	0.51	0.390 to 0.674

0.87 to 0.94) and 5% less incidence of reported cases per day (IRR 0.95, 95% CI 0.93 to 0.97) in countries with each year decrease in the average median age of subjects of respective countries (Table 3).

Discussion

We observed that case fatality rate caused by COVID-19 was significantly lower among countries which were at low to moderate risk of global hunger index with reference to countries which were at serious or alarming risk of GHI. In our analysis as expected we observed that 50% less deaths per day in countries with lower risk for hunger and 76% less deaths per day due to COVID-19 in countries with moderate risk for hunger with reference to countries which were at serious or alarming risk for hunger. Many confounding factors for this of study may not be adjusted in the model could explain the difference in the effect size observed in the low and high risk countries. A possible reason for less deaths per day observed in the low and moderate risk for GHI countries could be due to a high percentage of population in the low GHI countries is calorie sufficient and has dietary diversity which indicates that majority of the people in population have better overall nutritional status which may lead to the better immune system to fight with infections like COVID-19, and that is why a large percentage of people though may test positive for COVID-19 but it may not lead to mortality as their immune systems are strong enough to cope with it.

On the other hand, the population in countries with high GHI score where a high percentage of people eat poor quality diets and are calorie deficit, and hence suffer from various deficiency diseases already have a weak immune system which may not fight against the COVID-19 virus leading to high mortality rates.

Presently the world is in the grip of the pandemic COVID -19, a new novel virus and new things are far more complicated to understand initially. However, a few studies have been done in understanding the importance of nutrition in COVID-19 patients.

A paper published by Barazzoni R *et al*,[8] mentioned that patients with worst outcomes and higher mortality are reported to include immunocompromised subjects and malnourished people in general are at risk of developing factors which contribute to morbidity and mortality in chronic and acute diseases. Having a good nutritional status and preventing or treating malnutrition is likely to lower the complications in patients who

Table 3 — *Results of multivariable negative binomial regression analysis*

Variable	Number of new cases per day IRR	95% CI	p-value	Mortality counts per day IRR	95% CI	p-value
Alarming and serious	Reference			Reference		
Low Risk GHI score ≤9.9 (At low risk)	2.8	2.01 to 4.05	<0.001	0.5	0.26 to 0.94	0.033
Moderate GHI Score 10.0 to 19.9 (At moderate risk)	1.7	1.3 to 2.1	<0.001	0.24	0.14 to 0.40	<0.001
Median Age	0.95	0.93 to 0.97	<0.001	0.91	0.87 to 0.94	<0.001

Adjusted for number of tests done, population density and economic profile of the countries

are at nutritional risk and might be diagnosed as COVID-19 positive[8].

A recent study published in 'The Lancet' pointed out that COVID-19 can be accompanied with fever, nausea, vomiting and diarrhea[9]. All these symptoms may impair the food intake and absorption of nutrients in an individual. Thus, having a good nutritional status is beneficial for people to combat the severe complications of COVID-19. The nutritional status of an individual is an important factor in the outcome of a variety of different infectious diseases[10]. A recently published study on influenza pandemic highlighted the importance of nutrition in variations in morbidity and mortality figures[11].

Median age of the countries people could be an important confounder for the predictor and outcome relationship as shown by a recently published study in 'The Lancet Infectious Diseases'[12] done on COVID-19 positive patients in 38 countries found that risk of death from the disease increased with each decade of age. Therefore, we have adjusted the confounding effect associated with median age of the people living in the respective countries.

Many recent studies have highlighted the importance of good nutrition in building a strong immune system to fight against diseases like COVID 19. Based on these findings, a balanced dietary approach should be given prime importance along with the first-line treatment not only to treat any disease but also in building up a good nutritional status. The findings of the present review reinforce the concept of importance of good nutrition in fighting the infections than those with moderate or poor nutrition.

Conclusion : More rigorous measures have to be taken by the countries with serious or alarming hunger index for reducing case fatality rate associated with COVID-19 in Asian countries.

Limitation of the Study : This study has few limitations.

1. A detailed patient information regarding clinical outcomes, was not available at the time of analysis.
2. Although our findings are applicable for Asian countries, on the other hand it provides the homogeneity in findings.
3. The testing policies in the respective countries could be an important confounder for the predictor-outcome relationship although we have adjusted, the number of test done in respective countries for COVID-19 diagnosis.
4. Percentage of the elderly population (high risk for case fatality due to COVID-19) were not accounted in the current study, which would have affected the predictor-outcome relationship.
5. The effect of the lockdown could not be adjusted in the generalized linear mixed model generalized linear mixed model which could be an important confounding variable for the objective of this study.

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