Correlation Between COVID 19 and Selected Risk Factors: An Ecological Study

Deepak Dhamnetiya[1], Shalini Shalini[2], Abhishek Mehra[3], Ravi Prakash Jha[1*]

[1]Department of Community Medicine, Dr Baba Saheb Ambedkar Medical College and Hospital, Delhi, India
[2]Lady Hardinge Medical College, New Delhi, India
[3]Department of Mathematics and Computing, Delhi Technological University, Delhi, India

ABSTRACT

The World Health Organization (WHO), on March 11, 2020, has declared the novel coronavirus (COVID-19) outbreak a global pandemic. COVID-19 originated from Wuhan; China spread to 218 Countries and Territories around the world. We planned this study to assess the correlation between COVID 19 and selected risk factors.

An ecological study was conducted in December 2020. Data regarding the COVID-19 confirmed cases and deaths per million populations were retrieved using Our World in Data until 28th November 2020. Data regarding socio-demographic related factors of countries and health-related factors were also extracted from the same database. We categorized countries into a) seven Global Burden of Disease (GBD) super regions and World Bank income levels. We have applied Spearman's rank correlation coefficient to assess the correlation between COVID-19 cases and deaths with various socio-demographic related and health-related factors. Statistical analysis has been performed using Statistical Package for Social Sciences (SPSS) 27.0 (Trial Version). A p-value of <0.05 is considered significant.

In this study, highest number of COVID-19 confirmed cases and deaths were reported in World Bank high-income groups. Globally, we found significant positive correlations between COVID-19 deaths per million with various socio-demographic related and health related factors like median age (r=0.543,p<0.001), percentage of population aged ≥65 years (r=0.546,p<0.001), GDP per capita (r=0.531,p<0.001), HDI (r=0.567,p<0.001), female smoking (r=0.509,p<0.001), availability of hand-washing facilities (r=0.608,p<0.001), diabetes (r=0.166,p<0.05) and hospital beds per 1000 population (r=0.383,p<0.001), whereas extreme poverty is negatively correlated (r= -0.490,p<0.001).

Extra emphasis on high-income countries is required to reduce the burden of COVID 19 cases and deaths. A multi-centric study should be planned to know the reasons for the high burden of cases and deaths in high-income countries.

Keywords: COVID-19, Diabetes, Smoking, Hand-washing, HDI, Poverty

Introduction

The World Health Organization (WHO), on March 11, 2020, has declared the novel coronavirus (COVID-19) outbreak a global pandemic (WHO 2020a). COVID-19 originated from Wuhan; China spread to 218 Countries and Territories around the world. A total of 61.8 million reported cases of coronavirus and 1.4 million deaths globally since the start of the pandemic, as of 29 November 2020 (WHO 2020b). This data is increasing day by day throughout the Globe, which is a matter of serious concern. The virus has raised world concern because of its high transmission capability as well as high mobility and mortality (Chen 2020; Phelan 2020; Li 2020).

This ongoing pandemic of COVID-19 is a global challenge which resulted in significant morbidity and mortality worldwide. Since the beginning of the pandemic, researchers trying to assess the potential risk factors of COVID 19, which either increases the risk of getting an infection or worsen the outcome of the COVID 19 disease. Researchers found that diabetes is associated with increased incidence and severity of COVID-19 (Singh 2020), whereas active smoking is significantly linked with the risk of more severity of COVID-19 (Tsigaris 2020). To prevent virus transmission, the Center for Disease Control (CDC) recommends frequent hand washing with soap and water for 20 seconds (CDC 2020), so the unavailability of a handwashing facility might increase the risk of COVID 19 infection. Though a high human development index (HDI) means longer life expectations, better education, and better living standards, it is surprising that it associates with a higher infection rate and

*Corresponding Author: Ravi Prakash Jha, Statistician cum Tutor, Department of Community Medicine, Dr Baba Saheb Ambedkar Medical College and Hospital, Sector-6, Rohini, Delhi, India -110085.
E-mail: ravijha0292@gmail.com, Phone: +918004417689
ORCID ID: Deepak Dhamnetiya: 0000-0002-5634-3315, **Shalini Shalini:** 0000-0003-2954-811X, **Abhishek Mehra:** 0000-0001-8138-4648, **Ravi Prakash Jha:** 0000-0001-5230-1436

mortality rate for COVID 19 (Liua 2020).To the best of our knowledge, there is no research study published that depicts the correlation of these factors with COVID 19 at the Global level, so we planned this study to assess the correlation between COVID 19 and selected risk factors.

Material and Methods

An ecological study was conducted in December 2020 to assess the correlation between COVID 19 and selected risk factors. Data regarding the COVID-19 confirmed cases and deaths per million populations was retrieved using Our World in Data (Roser 2020) up to 28th November 2020. Socio-demographic related factors of countries like median age, percentage of population aged ≥65 years, GDP per capita, percentage of extreme poverty, population density and HDI and data regarding health-related factors like the prevalence of male and female smoking, diabetes, handwashing facilities and availability of hospital beds per 1000 population were also extracted from the same database. We categorized countries into a) seven Global Burden of Disease (GBD) (GBD 2020) super regions, including 1. South Asia, 2. Southeast Asia, East Asia & Oceania, 3. Central Europe, Eastern Europe & Central Asia, 4. North Africa &Middle East, 5. Sub-Saharan Africa, 6. Latin America & Caribbean, and7. High-income; b) World Bank income levels (World Bank 2020), including (1. Low-income countries, 2. Lower middle-income countries, 3. Upper middle-income countries, and 4. High-income countries).

Data has been extracted and recorded in an MS-Excel spreadsheet. We have calculated COVID-19 confirmed cases and deaths per million populations with their 95% confidence intervals (CIs) by each region classified according to GBD and World Bank. We have applied Spearman's rank correlation coefficient to assess the correlation between COVID-19 cases and deaths with various socio-demographic related and health-related factors. A Scatter plot matrix has been prepared for Socio-demographic related factors and health-related factors with COVID-19 cases and deaths separately. Statistical analysis has been performed using Statistical Package for Social Sciences (SPSS) 27.0 (Trial Version). A p-value of <0.05 is considered significant.

Results

As of November 28, 2020, the highest number of COVID-19 confirmed cases and deaths per million were reported in high-income regions (24477.67) and Latin America and the Caribbean region (670.30), respectively. The lowest COVID-19 confirmed cases (570.42) and deaths (14.82) per million were reported in Southeast Asia, East Asia, and Oceania region of GBD study super regions (Table 1A).

According to World Bank Classification, the highest number of COVID-19 confirmed cases (23552.65) and deaths (512.73) per million were reported in high-income groups. In contrast, the lowest number of COVID-19 confirmed cases (498.46) and deaths (12.46) were reported in low-income groups (Table 1B).

The median age and percentage of the population aged ≥65 years were highest in the high-income region and high-income countries, whereas it was lowest in Sub-Saharan Africa and low-income countries. We have provided the values of countries having minimum and maximum population density, GDP per capita, percentage of the population in extreme poverty, HDI, female smoking, male smoking, diabetes, hand washing facilities and hospital beds per 1000 population for each GBD Super region and World Bank income groups (Table 1, Table 2).

Globally, we found significant moderate positive correlations between COVID-19 cases per million with various socio-demographic related factors like median age (r=0.609,p<0.001), percentage of population aged ≥65 years(r=0.532,p<0.001), GDP per capita(r=0.632,p<0.001) and HDI(r=0.652,p<0.001) whereas extreme poverty is negatively correlated (r=-0.548,p<0.001) and no significant correlation was found for population density (r=-0.116, p=0.118)(Fig. 1A).. A significant positive correlations was found between COVID-19 cases per million with various health related factors like female smoking(r=0.502,p<0.001), availability of hand-washing facilities(r=0.525,p<0.001) and hospital beds per 1000 population(r=0.419,p<0.001); however, there is no significant correlation for male Smoking (r=-0.078, p=0.361) and diabetes (r=-0.124, p=0.095)(Fig.1B).

Globally, we found significant positive correlations between COVID-19 deaths per million with various socio-demographic related factors like median age (r=0.543,p<0.001), percentage of population aged ≥65 years

Table 1. Global Burden and Mortality of COVID-19, Various Socio-Demographic Related Factors: Results Classified According To The A) Global Burden of Disease Super Region Classification and B) World Bank Income Level Based Classification

A. Global Burden of Disease Study super regions

Super Regions	Covid-19			Socio-Demographic related Factors				
	Cases per Million (95% CI)	Deaths per Million (95% CI)	Age, Median (IQR)	Population aged ≥ 65 years (%)	Population Density/1000 pop (min,max)	GDP per Capita (min,max)	Extreme Poverty % (min,max)	HDI (min,max)
Central Europe, Eastern Europe, and Central Asia Region	16866.33 (16613.94-17118.72)	287.84 (254.59-321.09)	40.75 (36.65 - 43.15)	13.49	(1.98, 137.18)	(2896.91, 32605.91)	(0.1, 5.7)	(0.65, 0.90)
High-income Region	24477.67 (24174.80-24780.54)	562.46 (515.99-608.93)	41.60 (37.9 - 43.3)	18.31	(3.20, 19347.50)	(18933.91, 94277.97)	(0.1,2.0)	(0.80, 0.95)
North Africa and Middle East region	7188.25 (7022.67-7353.82)	186.36 (159.60-213.11)	30.7 (23.2 -32.4)	5.38	(3.62, 1935.91)	(1479.15, 116935.60)	(0.1,18.8)	(0.45, 0.86)
South Asia region	5810.05 (5661.09-5959.01)	84.72 (66.68-102.76)	26.25 (23.5 - 28.2)	5.65	(21.19, 1265.04)	(2442.80, 8708.60)	(1.5,21.2)	(0.56, 0.64)
Latin America and Caribbean region	18662.06 (18396.82-18927.31)	670.30 (619.57-721.03)	29.35 (26.9 - 32.85)	7.61	(3.61, 664.46)	(1653.17, 28763.07)	(1.3, 23.5)	(0.50, 0.81)
Sub-Saharan Africa	1250.44 (1181.18-1319.71)	28.46 (18.00-38.92)	19.25 (17.9 - 21.75)	3.11	(3.08, 494.87)	(661.24, 22604.87)	(3.4, 77.6)	(0.35, 0.72)
Southeast Asia, East Asia, and Oceania region	570.42 (523.62-617.21)	14.82 (7.27-22.36)	29.3 (25.2 -34.1)	9.21	(18.22, 1454.43)	(2205.92, 26808.16)	(0.1, 30.3)	(0.54, 0.80)

B. World Bank classifications

Income Levels	Covid-19			Socio-Demographic related Factors				
	Cases per Million (95% CI)	Deaths per Million (95% CI)	Age, Median (IQR)	Population aged ≥ 65 years (%)	Population Density/1000 pop (min, max)	GDP per Capita (min, max)	Extreme Poverty % (min, max)	HDI (min, max)
High Income	23552.65 (23255.42-23849.89)	512.73 (468.36-557.10)	41.1 (36.2 -43.2)	17.73	(3.20, 19347.50)	(16978.07, 116935.60)	(0.1, 5.7)	(0.78, 0.95)
Upper Middle Income	6578.98 (6420.53-6737.44)	203.22 (175.29-231.16)	31.25 (28.8 - 38.35)	9.77	(3.08, 1454.43)	(3819.20, 26808.16)	(0.1, 18.9)	(0.59, 0.83)
Lower Middle Income	4472.26 (4341.47-4603.04)	72.83 (56.11-89.56)	25.05 (20.35 - 28.4)	5.38	(1.98, 1265.04)	(1413.89, 13913.84)	(0.1, 59.6)	(0.48, 0.77)
low Income	498.46 (454.71-542.21)	12.46 (5.53-19.36)	18.75 (17.5 - 19.4)	3.1	(7.48, 494.87)	(661.24, 4466.51)	(4.8, 77.6)	(0.35, 0.65)

Table 2: Global Burden and Mortality of COVID-19, Various Health-Related Factors: Results Classified According to the A) Global Burden of Disease Super Region Classification and B) World Bank Income Level Based Classification

A. Global Burden of Disease Study super regions							
	Covid-19		Health related factors				
Super Regions	Cases per Million (95% CI)	Deaths per Million (95% CI)	Smoking % (Female) (min, max)	Smoking % (Male) (min, max)	Diabetes % (min, max)	Hand-washing Facilities% (min, max)	Hospital Beds/1000 Pop (min, max)
Central Europe, Eastern Europe, and Central Asia Region	16866.33 (16613.94-17118.72)	287.84 (254.59-321.09)	(0.3, 44.0)	(24.7, 58.3)	(3.67, 10.08)	(71.18,99.00)	(2.60, 11.00)
High-income Region	24477.67 (24174.80-24780.54)	562.46 (515.99-608.93)	(2.0, 35.3)	(15.2, 52.7)	(3.28,12.79)	-	(2.11, 13.80)
North Africa and Middle East region	7188.25 (7022.67-7353.82)	186.36 (159.60-213.11)	(0.2, 26.9)	(15.6, 65.8)	(5.35, 17.72)	(37.75, 97.40)	(0.5, 3.70)
South Asia region	5810.05 (5661.09-5959.01)	84.72 (66.68-102.76)	(1.0, 9.5)	(20.6, 44.7)	(7.26, 10.39)	(34.81, 79.81)	(0.30, 1.70)
Latin America and Caribbean region	18662.06 (18396.82-18927.31)	670.30 (619.57-721.03)	(1.9, 17.1)	(9.9, 53.3)	(5.55, 17.11)	(22.86, 90.65)	(0.60, 5.80)
Sub-Saharan Africa	1250.44 (1181.18-1319.71)	28.46 (18.00-38.92)	(0.1, 9.7)	(7.7, 53.9)	(0.99, 15.67)	(1.19, 52.23)	(0.10, 6.30)
Southeast Asia, East Asia, and Oceania region	570.42 (523.62-617.21)	14.82 (7.27-22.36)	(0.3, 23.5)	(27.0, 78.1)	(4.00,30.53)	(25.21,95.80)	(0.80, 5.90)

B. World Bank classifications							
	Covid-19		Health related factors				
Income Levels	Cases per Million (95% CI)	Deaths per Million (95% CI)	Smoking % (Female) (min, max)	Smoking % (Male) (min, max)	Diabetes % (min, max)	Hand-washing Facilities % (min, max)	Hospital Beds/1000 Pop (min, max)
High Income	23552.65 (23255.42-23849.89)	512.73 (468.36-557.10)	(0.5,35.3)	(9.9, 52.7)	(3.28, 22.02)	(88.47, 97.40)	(1.20, 13.80)
Upper Middle Income	6578.98 (6420.53-6737.44)	203.22 (175.29-231.16)	(0.3, 44.0)	(12.3, 76.1)	(3.94, 30.53)	(24.64, 99.00)	(0.60, 11.00)
Lower Middle Income	4472.26 (4341.47-4603.04)	72.83 (56.11-89.56)	(0.2, 23.5)	(7.7, 78.1)	(0.99, 18.68)	(2.12, 90.65)	(0.30, 8.80)
low Income	498.46 (454.71-542.21)	12.46 (5.53-19.36)	(0.1, 8.8)	(8.5, 41.3)	(1.91, 15.67)	(1.19, 72.70)	(0.10, 4.80)

(r=0.546,p<0.001), GDP per capita (r=0.531,p<0.001) and HDI (r=0.567,p<0.001) whereas extreme poverty is negatively correlated (r= -0.490,p<0.001) and no significant correlation was found for population density (r= -0.008, p=0.922) (Fig.2A). A significant positive correlations was found between COVID-19 deaths per million with various health related factors like female smoking (r=0.509,p<0.001), availability of hand-washing facilities (r=0.608,p<0.001), diabetes (r=0.166,p<0.05) and hospital beds per 1000 population (r=0.383,p<0.001); however, there is no significant correlation for male Smoking (r=-0.075, p=0.390) (Fig.2B).

Discussion

In this study, we found that the highest number of COVID-19 confirmed cases were reported in World Bank high-income group which include countries like USA, Japan, South Korea and Hongkong, Australia, New Zealand, Western European countries etc. large population from China travel to these countries for various reasons like trade, tourism, education and employment. The first four countries are China's top most
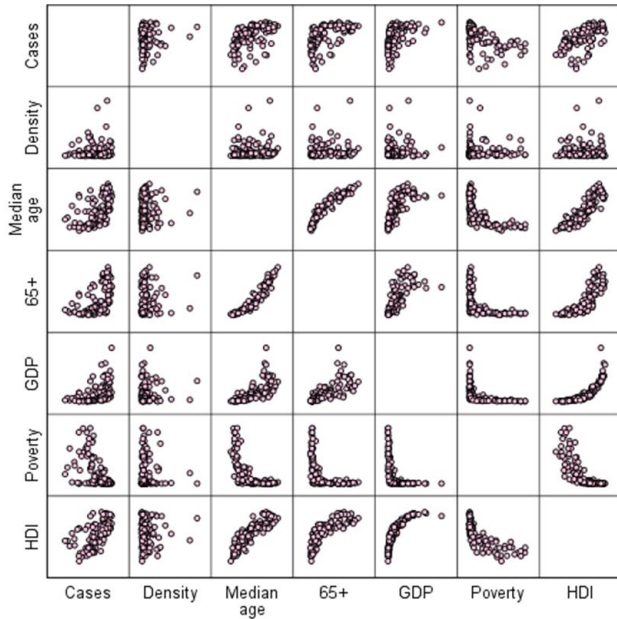
Fig. 1A. Correlation Between COVID 19 Cases With Socio-Demographic Related Factors
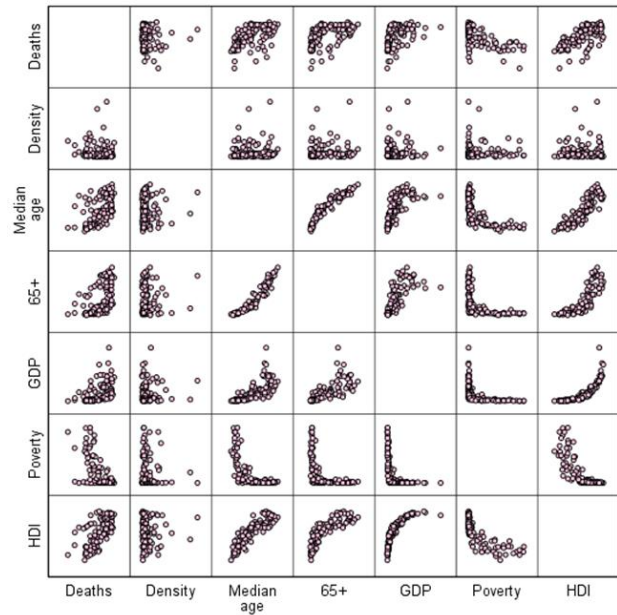

Fig. 2A. Correlation Between COVID 19 Deaths With Socio-Demographic Related Factors
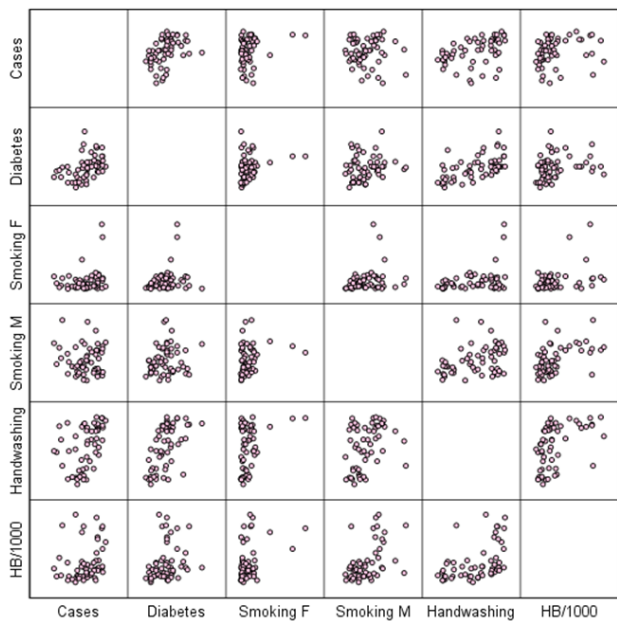

Fig. 1B. Correlation Between COVID 19 Cases With Health-Related Factors
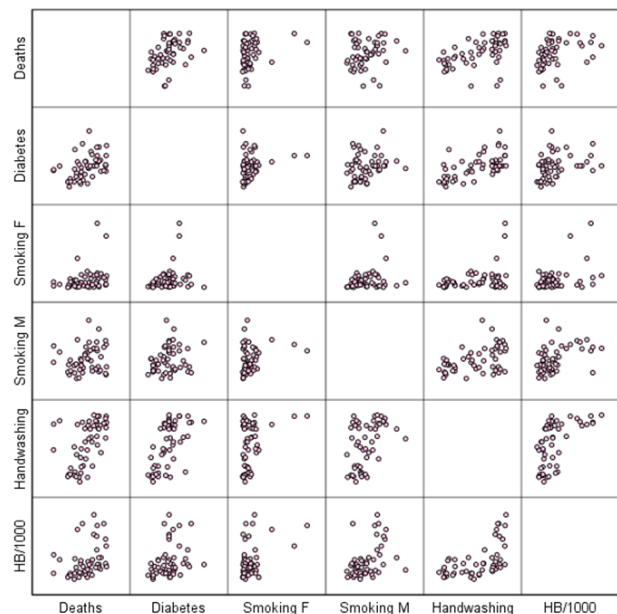

Fig. 2B. Correlation Between COVID 19 Deaths With Health-Related Factors

export and import partners (41.65% partner share) (WITS 2018). These might be the reasons for reporting of the highest number of cases from high-income groups. The high-income group also reported the highest number of COVID 19 deaths, whereas the low-income group reported the lowest number of COVID 19 deaths; this might be because of the population composition of these groups, the high-income group had 17.73% of the population aged above 65 years, and the low-income group had 3.1% of population aged above 65 years. We have also found a

significant positive correlation between population aged above 65 years and COVID 19 deaths; this is corroborated with the studies conducted by Nikolich-Zugich et al. (2020), Onder et al. (2020), Wu et al. 2020 and Zhu et al. (2020). This may be because immune responses in older adults are slower, less coordinated, and less efficient, making older adults more susceptible to emerging infections (Chen et al., 2021). This may also be due to negative effect of previous diagnosed diseases (Liu et al., 2020 and Onden et al., 2020). Additionally, elderly persons who live alone or in

poor circumstances may find it difficult to obtain food, medicine, and other supplies while under quarantine (Armitage et al., 2020; Lloyd-Sherlock et al., 2020a and Lloyd-Sherlock et al., 2020b).

We found a significant positive correlation between median age and COVID 19 cases & deaths; the same results were seen in a study conducted by other researchers (Sun 2020). HDI, which indicates longer life expectancy, better education and a decent standard of living, is positively correlated with COVID 19 cases & deaths; this is corroborated with the study conducted by Liua K et al. (2020).

In our study, extreme poverty is significantly negatively correlated with COVID 19 cases & deaths; this is a surprising finding as one link between poverty and disease that is readily observable to most physicians is the increased vulnerability of the poor to communicable diseases and the lack of medical care once infected (Alsan 2011).

In this study, a significant positive correlation has been found between female smoking and COVID 19 cases & deaths. In contrast, the study conducted by Tsigaris et al. (2020) found a negative correlation between smoking and COVID 19 cases at a population level. Zhou et al. (2020) and Yang et al. (2020) found that smoking is not a risk factor for COVID 19 mortality.

We have found a significant positive correlation between handwashing facilities and COVID 19 cases & deaths; this is again very unlike finding as hand washing reduces communicable disease transmission rate; this may be because of several confounding factors like better handwashing facilities are available in high-income countries.

Whether people with diabetes have a higher susceptibility to COVID-19 is currently unknown. Still, there is a perception that the risk of infection and severe disease is higher in people with diabetes. In this ecological study, we have found no correlation between diabetes and COVID 19 cases, but a significant positive correlation exists with COVID 19 mortality. It implies that diabetes increases the severity of COVID 19 disease. In studies conducted to know the prevalence of diabetes among survivor and non-survivor COVID 19 patients, it has been found that the prevalence of diabetes is more than twice among non-survivor patients vis-à-vis survivor patients (Zhou 2020; Yang 2020).

Strength of the present study. First, To the best of our knowledge this is first study which assess the correlation between COVID 19 cases and death

with socio-demographic and health related factors together at global level. Second, this study utilised large data from GBD study and Our World in Data.

This study has few limitations. First, We have correlated selected risk factors with COVID 19 cases and deaths at various GBD Super regions and World bank groups; it may not accurately reflect the true association between individuals within those regions. Second, being an ecological study, we could not establish a cause-and-effect relationship.

In this study, the highest number of COVID-19 confirmed cases and deaths were reported in World Bank high-income groups. We found a significant positive correlation between median age, percentage of population aged ≥65 years, GDP per capita, HDI, female smoking, availability of handwashing facilities, hospital beds per 1000 population and COVID-19 cases & deaths per million. In contrast, extreme poverty is significantly negatively correlated with COVID-19 cases& deaths per million. Diabetes had a significant positive correlation with COVID 19 deaths, but no correlation was found with COVID-19 cases. This study shows no significant correlation between population density and male smoking with COVID 19 cases & deaths.

Extra emphasis on high-income countries is required to reduce the burden of COVID 19 cases and deaths. A multi-centric study should be planned to know the reasons for a high burden of cases and deaths in high-income countries.

References

1. Alsan MM, Westerhaus M, Herce M, Nakashima K, Farmer PE (2011). Poverty, global health, and infectious disease: lessons from Haiti and Rwanda. Infect Dis Clin North Am; 25: 611-ix.
2. Armitage R, Nellums LB (2020). COVID-19 and the consequences of isolating the elderly. The Lancet Public Health 5(5):e256.
3. Centers for Disease Control and Prevention (2020). Show me the science-how to wash your hands. Available at: https://www.cdc.gov/handwashing/show-me-the-science-handwashing.html. Accessed on Dec 8, 2020.
4. Chen N, Zhou M, Dong X, Qu J, Gong F, Han Y et al. (2020) Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study. Lancet ;395:507–13

5. Chen Y, Klein SL, Garibaldi BT, Li H, Wu C, Osevala NM, Li T, Margolick JB, Pawelec G, Leng SX (2021). Aging in COVID-19: Vulnerability, immunity and intervention. Ageing research reviews 65:101205.

6. Global burden of disease super-regions classification (2020) .Available at http://www.healthdata.org/sites/default/files/files/Projects/GBD/GBDRegions_countries.pdf last assessed on 08 December 2020.

7. Li Q, Guan X, Wu P, Wang X, Zhou L, Tong Y et al. (2020) Early Transmission Dynamics in Wuhan, China, of Novel Coronavirus-Infected Pneumonia. N Engl J Med. ;382(13):1199-1207

8. Liu K, Chen Y, Lin R, Han K (2020). Clinical features of COVID-19 in elderly patients: A comparison with young and middle-aged patients. Journal of Infection 80(6):e14-8.

9. Liua K, Heb M, Zhuangc Z, Hec D, Lid H (2020). Unexpected positive correlation between human development index and risk of infections and deaths of COVID-19 in Italy. One Health;10: 100174

10. Lloyd-Sherlock P, Ebrahim S, Geffen L, McKee M (2020a). Bearing the brunt of covid-19: Older people in low and middle income countries, A global expert group on older people might be useful. BMJ 368, 1052.

11. Lloyd-Sherlock P, Kalache A, McKee M, Derbyshire J, Geffen L, Casas GL, Gutierrez LM (2020b). Covid-19: Open letter to who and member states, who must prioritise the needs of older people in its response to the covid-19 pandemic. BMJ 368, 1164.

12. Nikolich-Zugich J, Knox KS, Rios CT, Natt B, Bhattacharya D, Fain MJ (2020). SARSCoV-2 and COVID-19 in older adults: what we may expect regarding pathogenesis, immune responses, and outcomes, Geroscience 42:505–514.

13. Onder G, Rezza G, Brusaferro S (2020). Case-fatality rate and characteristics of patients dying in relation to COVID-19 in Italy. JAMA. 323, 1775–1776.

14. Phelan AL, Katz R, Gostin LO (2020). The Novel Coronavirus Originating in Wuhan, China: Challenges for Global Health Governance. JAMA ;323:709-10

15. Roser M, Ritchie H, Ortiz-Ospina E and Hasell J (2020) "Coronavirus Pandemic (COVID-19)". Published online at OurWorldInData.org. 2020. Available at https://ourworldindata.org/coronaviruslast assessed on 30 November 2020.

16. Singh AK, Gupta R, Ghosh A, Misra A. (2020). Diabetes in COVID-19: prevalence, pathophysiology, prognosis and practical considerations. Diabetes MetabSyndr; 14: 303-310.

17. Sun Y, Koh V, Marimuthu K, Ng OT, Young B, Vasoo S (2020). National Centre for Infectious Diseases COVID-19 Outbreak Research Team. Epidemiological and Clinical Predictors of COVID -19. Clin Infect Dis 2020; 71: 786-792.

18. The World Bank (2020), World Bank Country and Lending Groups, World Bank Data Help Desk(2020),Available at https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-worldbank-country-and-lending-groups ,last accessed on 08 December 2020.

19. Tsigaris P, Teixeira da Silva JA (2020). Smoking Prevalence and COVID-19 in Europe. Nicotine Tob Res. 2020;22(9):1646-1649. doi:10.1093/ntr/ntaa121

20. World integrated Trade Solutions (2018). Available at https://wits.worldbank.org/countrysnapshot/en/chn last accessed on 08 December 2020.

21. WHO (2020a) Director-General's opening remarks at the media briefing on COVID19 - March 2020

22. WHO (2020b) COVID-19 Weekly Epidemiological Update. Available on https://www.who.int/publications/m/item/weekly-epidemiological-update---1-december-2020 last accessed on 5th Dec 2020.

23. Wu C, Chen X, Cai Y, Zhou X, Xu S, Huang H, Zhang L, Zhou X, Du C, Zhang Y, Song J (2020). Risk factors associated with acute respiratory distress syndrome and death in patients with coronavirus disease 2019 pneumonia in Wuhan, China. JAMA internal medicine. 180(7):934-43.

24. Yang X, Yu Y, Xu J (2020). Clinical course and outcomes of critically ill patients with SARS-CoV-2 pneumonia in Wuhan, China: a single-centered, retrospective, observational study. Lancet Respir Med. 2020; 20: S2213 – S2600. DOI: 10.1016 / S2213-2600 (20) 30079-5.

25. Zhou F, Yu T, Du R (2020). Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. Lancet; 395: 1054–1062.

26. Zhu N, Zhang D, Wang W, Li X, Yang B, Song J, Zhao X, Huang B, Shi W, Lu R, Niu P (2020). A novel coronavirus from patients with pneumonia in China, 2019. N. Engl. J. Med. 382, 727–733.