Rev. Fac. Med. Hum. October 2021;21(4):780-789 .
ISSN Versión Online: 2308-0531
Facultad de Medicina Humana URP
DOI 10.25176/RFMH.v21i4.3987
ORIGINAL PAPER

CORRELATION BETWEEN MORTALITY DUE TO COVID-19, WEALTH INDEX, HUMAN DEVELOPMENT AND POPULATION DENSITY IN DISTRICTS OF METROPOLITAN LIMA DURING 2020

CORRELACIÓN ENTRE MORTALIDAD POR COVID-19, ÍNDICES DE RIQUEZA Y DESARROLLO HUMANO Y DENSIDAD POBLACIONAL EN DISTRITOS DE LIMA METROPOLITANA DURANTE EL 2020

Zalia E. Dorregaray-Farge[1,a], Alonso Soto[2,3,b], Jhony De la Cruz Vargas[2,b]

ORIGINAL PAPER

ABSTRACT

Objectives: To determine the correlation between mortality from COVID-19 and the percentage of poverty and the district Human Development Index (HDI) in the department of Lima. **Methods:** Ecological observational correlation study. The population were patients who died from COVID-19 in metropolitan Lima. All deceased patients reported in the open database of the Ministry of Health were included. The dependent variable was the mortality from COVID-19 calculated by dividing the number of deaths by the total population of the districts and the independent variables were the percentage of poverty and HDI. A secondary analysis was performed evaluating the fatality from COVID-19. The correlation was calculated using Spearman's non-parametric method. **Results:** 13,154 people died from COVID-19 during the period from March to September, the majority were male with an average age of 66 years. No significant correlation was found between mortality and percentage of poverty (rho = -0.2230; p = 0.15). A significant correlation was found between mortality from COVID-19 and IDH (rho = 0.4466; p = 0.002). Mortality was correlated with population density (rho = 0.7616; p = <0.001). A positive (rho = 0.32) and significant (p = 0.037) correlation was found between fatality and the percentage of poverty. A significant correlation was found between COVID-19 fatality and population density (rho = 0.7616; p = <0.001). No significant correlation was found between lethality and the HDI. **Conclusions:** Population density was the factor most consistently associated with mortality and fatality from COVID. Poverty was associated with higher fatality, but not higher mortality.

Key words: Coronavirus infection; Mortality; Poverty; Human development index (source: MeSH NLM).

RESUMEN

Ojetivos: Determinar la correlación entre la mortalidad por COVID-19 y el porcentaje de pobreza e Índice de desarrollo Humano (IDH) distrital en el departamento de Lima. **Métodos:** Estudio observacional ecológico de correlación. La población fueron pacientes fallecidos por COVID-19 en Lima metropolitana. Se incluyeron a todos los pacientes fallecidos reportados en la base de datos abiertos del Ministerio de Salud. La variable dependiente fue la mortalidad por COVID-19 calculada dividiendo el número de muertes entre la población total de los distritos y las variables independientes fueron el porcentaje de pobreza e IDH. Se realizó un análisis secundario evaluando la letalidad por COVID-19. La correlación se calculó mediante el método no paramétrico de Spearman. **Resultados:** 13154 personas fallecieron por COVID-19 durante el periodo de marzo a setiembre, la mayoría fue del sexo masculino con un promedio de edad de 66 años. No se encontró una correlación significativa entre mortalidad y porcentaje de pobreza (rho=-0,2230; p=0,15). Se encontró una correlación significativa entre mortalidad por COVID-19 e IDH (rho= 0,4466; p=0,002). La mortalidad se correlacionó con la densidad poblacional (rho=0,7616; p=<0,001). Se encontró una correlación positiva (rho=0,32) y significativa (p=0,037) entre la letalidad y el porcentaje de pobreza. Se encontró una correlación significativa entre letalidad por COVID-19 y densidad poblacional (rho=0,7616; p=<0,001). No se encontró correlación significativa entre letalidad y el IDH. **Conclusión:** La densidad poblacional fue el factor asociado de manera más consistente a mortalidad y letalidad por COVID. La pobreza se asoció a mayor letalidad, pero no a mayor mortalidad.

Palabras clave: Infección por Coronavirus; Mortalidad; Pobreza; Índice de desarrollo humano (fuente: DeCS BIREME).

[1] Facultad de Medicina Humana, Universidad Ricardo Palma. Lima, Perú.
[2] Instituto de investigaciones en Ciencias biomédicas. Facultad de Medicina Humana, Universidad Ricardo Palma. Lima, Perú.
[3] Departamento de Medicina. Hospital Nacional Hipólito Unanue.
[a] Medical Surgeon
[b] Internal Medicine . MSc, PhD

Cite as: Zalia E. Dorregaray-Farge, Alonso Soto, Jhony De la Cruz Vargas. Correlation between mortality due to COVID-19, wealth index, human development and population density in districts of Metropolitan Lima during 2020. Rev. Fac. Med. Hum. Octubre 2021; 21(4):780-789. DOI 10.25176/RFMH.v21i4.3987

Journal home page: http://revistas.urp.edu.pe/index.php/RFMH

INTRODUCTION

The pandemic by COVID-19 initiated towards the end of 2019 in the city of Wuhan in China[1]. This disease has a wide range of clinical symptoms that range from asymptomatic infection, mild deses of upper respiratory tract to a serious viral pneumonia with respiratory distress[2,3]. However, few research exists that evaluate the correlation between sociodemographic and economic aspects of the populations with mortality by COVID-19.

In international studies, they reference the deaths by COVID-19 are comparable and sometimes superior to the total of deaths by opioids and HIV/AIDS[4]. In the United States, monetary income inequality is reflected in a greater number of deaths, and this could generate differences found in the different states[5]. Other studies that have assessed the effect of sociodemographic indicators in rural and urban communities have found an association between socioeconomic status (relative risks [RR] of 1.42 and 1.71) and housing and transportation domains (RR 1.52 and 1.32) with a major risk of COVID-19 diagnosis and death[6]. Another reported consequence of inequalities is associated with the diagnostic test availability for the entire population. In the beginning of the pandemic, there were more diagnosis in the most unfavorable locations, but this changed over time, a greater number of positive cases in wealthier places began to be reported. The inequalities associated to racial factors have also played a role. For example, a double risk for COVID-19 hospitalizations among the African American population in the United States has been reported[7].

A Peruvian study analyzed mortality by non-violent causes and district quintiles, showing a relation between human development index (HDI) and mortality due to COVID-19, with a greater number of deaths due to COVID-19 in quintiles with lower HDI. Although this study did not find a significant association between poverty and mortality, their findings are limited due to short observation time[8].

Our study seeks to find a correlation between mortality due to COVID-19, poverty percentage, HDI, and population density in districts within Metropolitan Lima during 2020.

METHODS

Design and Field of study

An observational, ecological, correlational study, conducted based on data from Metropolitan Lima.

Population and Sample

The study's population was made up of all patients that died from COVID-19 in the districts of Metropolitan Lima, for the development of this research we used a free access data base from the Ministerio de Salud del Perú available in the following link: https://www.datosabiertos.gob.pe/dataset/fallecidos-por-covid-19-ministerio-de-salud-minsa/resource/4b7636f3-5f0c-4404-8526.

Variables and instruments

The principal variable was mortality due to COVID-19 and also as potential factors that could influence infection and death rates. These factors can be grouped into four principal categories: population characteristics, environmental/geographical factors, health policy, and virus-related factors.

To perform this study, we used the free-access data base from the Ministerio de Salud del Perú[4,9]. The HDI statistics and the district poverty rate were obtained from the report: "Herramienta de lucha contra la pobreza-Módulo Perú"[9]. The demographic density of the districts in Lima was obtained from the study titled: "Provincia de Lima: Compendio estadístico-2017". This document is part of the last population census and the housing development by the Instituto Nacional de Estadística e Informática (INEI) in 2017[10].

Procedures

Once the consolidated data base was obtained by district, the descriptive analysis was carried out based on the variable type.

Statistical analysis

The descriptive analysis was carried out based on the type of variable. For quantitative variables the measures of central tendency and dispersion were used according to data normality. Frequencies and percentages were used for qualitative variables.

ORIGINAL PAPER

The correlation between mortality due to COVID-19, poverty rate, and population density was calculated using the Spearman correlation method. A value of p<0.05 was considered significant. The statistical analysis was carried out using the Stata V15 Statistical[11]. At the same time a multivariate analysis (robust regression) was performed.

Ethical aspects

This research uses the information from a free access data base. Patient coding makes it impossible to discover the personal data of patients who died from COVID-19. The study was approved by the comité de ética institucional from the Universidad Ricardo Palma.

ORIGINAL PAPER

RESULTS

We analyzed the data of 13,154 people who died due to COVID-19 in Lima from March 18th to September 30th, 2020. 70,9% (9325) of the deceased were males. The districts with greater number of deaths were San Juan de Lurigancho with 11.4% (1,499), Lima with 8.3% (1,096) and San Martin de Porres with 7.0% (919). The districts with fewer number of deaths were the districts of Punta Hermosa (9 deceased), San Bartolo (9 deceased), Punta Negra (2 deceased), Santa María del Mar (1 deceased). The districts with greater fatalities due to COVID-19 were Villa El Salvador (6.04%), La Victoria (5.12%), Chorrillos (5.07%) and San Juan de Lurigancho (4.99%). The districts with lower fatalities due to COVID-19 were Santa María del Mar (1.54%), Jesús María (1.72%) and Punta Negra (2.0%). The total number of deceased per districts are shown in table 1. Mortality and fatality due to COVID-19 in the same period are shown in table 2.

Table 3 shows the poverty rate and human development index of each district of Lima during 2020. The poverty rate of the districts varied from 0.2% in the district of Miraflores, San Isidro up to 41.1% in the district of Pachacamac and 40.7% in Puente Piedra. With regards to the district HDI, we observe that San Isidro and Miraflores have the highest indexes with 0.809 and 0.790, respectively. The districts with lowest HDI were the districts of Puente Piedra (0.673) and Pachacamac (0.669. Table 3 shows a population density of the districts in Lima according to the last census carried out by INEI. We observe that the districts of Punta Negra and Punta Hermosa have the lowest population density with 64 and 67 Inhab/Km2, respectively, while the districts of Surquillo and Breña had the highest levels of population density with 2 6438 and 2 3202 Inhab/Km2.

Mortality due to COVID-19 and its correlation with poverty, HDI, and population density

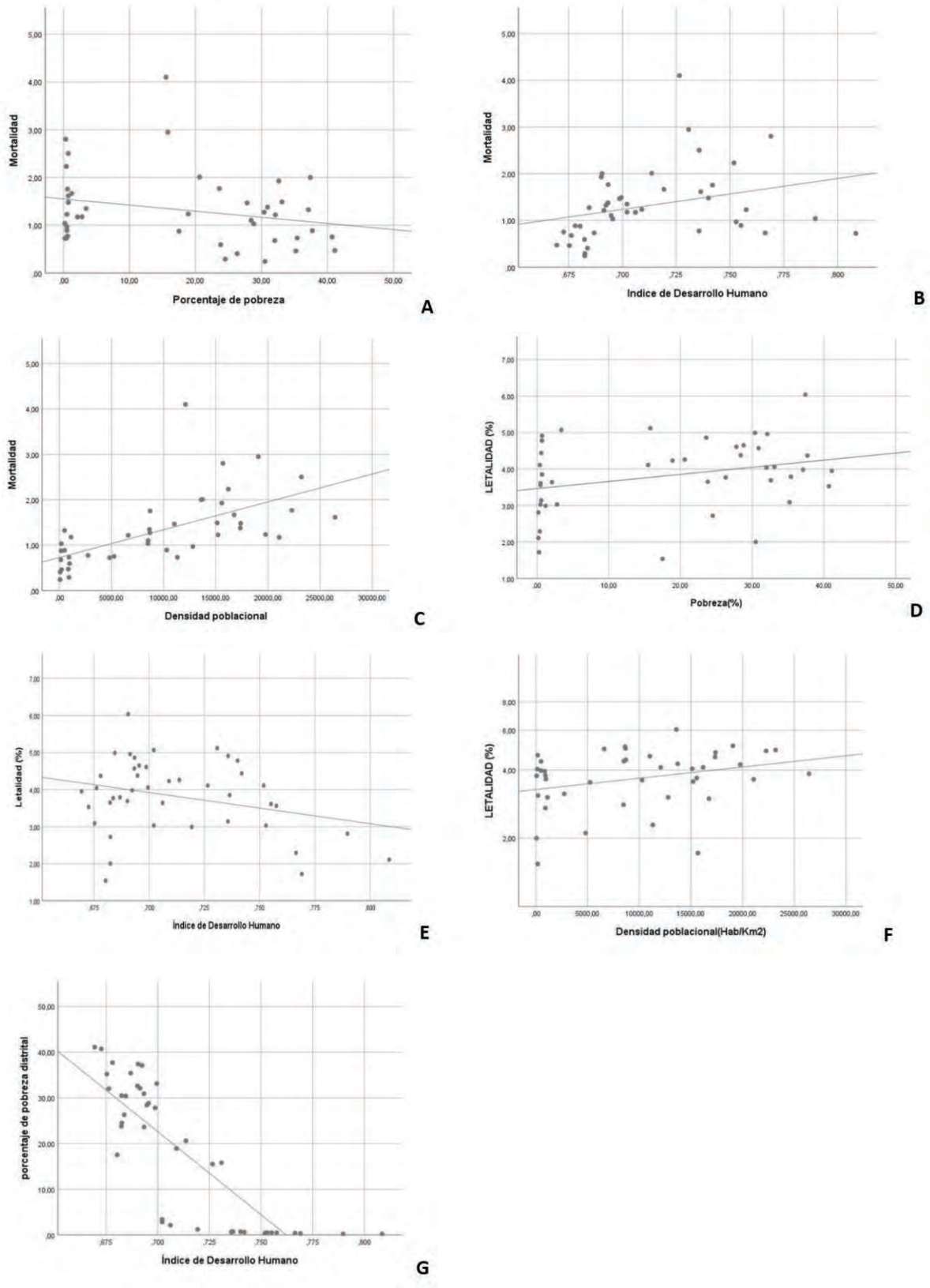
No significant correlation was found between mortality and poverty rate (rho= -0.2230; p=0.150) (Figure1). A significant correlation was found between mortality due to COVID-19 and HDI (rho= 0.4466; p=0.002) (Figure 1). A significant correlation was found between mortality due to COVID-19 and population density (rho=0.7616; p=<0.001) (Figure 1).

Fatality due to COVID-19 and its correlation with poverty, HDI, and population density

A statistically significant correlation was found between fatality due to COVID-19 and district poverty rate (rho=0.319; p=0.037) (Figure 1). No significant correlation was found between fatality due to COVID-19 and district HDI (rho=-0.106; p=0.501) (figure 1). A significant correlation was found between fatality due to COVID-19 and population density (rho=0.7616; p=<0.001) (Figure 1).

Additionally, a significant correlation was found between poverty rate and district HDI (rho= -0.8871; p<0,001) (Figure 1).

In the robust regression model used, only population density was a factor associated with mortality due to COVID-19 (Beta coefficient:0.06 CI95%:0.03-0.08; p<0.001). Population density was also associated with fatality due to COVID-19 (Beta coefficient: 0.06 CI95%:0.03-0.08; p<0.001). The results are shown in Table 4, therefore, it is assumed that robust



Graphic 1. A: Scatter plot: mortality by Covid-19 and district poverty rate. B: Scatter plot: mortality by COVID-19 and district human development index. C: Scatter plot: mortality by COVID-19 and district population density. D: Scatter plot: mortality by COVID-19 and district poverty rate. E: Scatter plot: fatality by COVID-19 and Human Development Index. F: Scatter plot: fatality by COVID-19 and district population density. G: Scatter plot: Dispersion diagram: human development index and percentage of district poverty.

Table 1. Frequency of death by COVID-19, Lima 2020.

District	Deaths by COVID-19	
	Frequency	%
San Juan de Lurigancho	1499	11,4
Lima	1096	8,3
San Martin de Porres	919	7,0
Villa el Salvador	848	6,4
Comas	841	6,4
Ate	740	5,6
San Juan de Miraflores	569	4,3
La Victoria	556	4,2
Villa Maria del Triunfo	533	4,1
Chorrillos	480	3,6
El Agustino	428	3,3
Los Olivos	413	3,1
Santa Anita	392	3,0
Santiago de Surco	364	2,8
Rimac	362	2,8
Independencia	332	2,5
Puente Piedra	298	2,3
Carabayllo	293	2,2
Breña	233	1,8
Jesus Maria	229	1,7
Lurigancho	168	1,3
San Miguel	168	1,3
Surquillo	162	1,2
Pueblo Libre	139	1,1
Lince	133	1,0
La Molina	124	,9
Miraflores	113	,9
Lurin	97	,7
San Borja	93	,7
San Luis	93	,7
Magdalena del Mar	80	,6
Pachacamac	67	,5
Barranco	63	,5
Ancon	56	,4
Chaclacayo	52	,4
San isidro	49	,4
Pucusana	22	,2
Cieneguilla	18	,1
Santa Rosa	11	,1
Punta Hermosa	9	,1
San Bartolo	9	,1
Punta Negra	2	,0
Santa Maria del Mar	1	,0
Total	13154	100,0

Table 2. Mortality and Fatality by COVID-19 in Lima, 2020.

District	Population	Cases	Deaths	Mortality(x 1000 inhab)	Fatality(%)
Villa El Salvador	423887	12326	848	2,00	6,04
La Victoria	188619	9499	556	2,95	5,12
Chorrillos	355978	8390	480	1,35	5,07
San Juan de Lurigancho	1177755	26351	1499	1,27	4,99
Villa María del Triunfo	437992	9562	533	1,22	4,96
Breña	93111	3708	233	2,50	4,91
Santa Anita	221776	7093	392	1,77	4,86
Pueblo Libre	94010	2300	139	1,48	4,78
San Bartolo	8722	172	9	1,03	4,65
Comas	573884	15888	841	1,47	4,61
San Juan de Miraflores	412865	10740	569	1,38	4,57
Barranco	35915	1148	63	1,75	4,44
Ate	670818	14305	740	1,10	4,38
Lurín	109506	1924	97	0,89	4,37
Rímac	180260	7530	362	2,01	4,26
San Martín de Porres	744050	18260	919	1,24	4,23
Lima	267379	23359	1096	4,10	4,11
Lince	59578	2507	133	2,23	4,11
Independencia	222850	7175	332	1,49	4,06
Ancón	82677	1140	56	0,68	4,04
Pucusana	16615	503	22	1,32	3,98
Pachacámac	142133	1417	67	0,47	3,95
Surquillo	100339	3429	162	1,61	3,85
Carabayllo	400414	6596	293	0,73	3,79
Punta Hermosa	22230	159	9	0,40	3,77
El Agustino	221974	10043	428	1,93	3,69
Lurigancho	283231	3949	168	0,59	3,65
Los Olivos	351983	9671	413	1,17	3,64
Santiago de Surco	408086	8231	364	0,89	3,61
Magdalena del Mar	65139	1855	80	1,23	3,56
Puente Piedra	395819	7517	298	0,75	3,53
La Molina	160244	3060	124	0,77	3,14
Cieneguilla	39055	421	18	0,46	3,09
Chaclacayo	44157	1450	52	1,18	3,03
San Miguel	173309	4384	168	0,97	3,03
San Luis	55793	2242	93	1,67	2,99
Miraflores	108855	3170	113	1,04	2,81
Santa Rosa	37940	331	11	0,29	2,72
San Borja	127102	3447	93	0,73	2,29
San Isidro	67703	2129	49	0,72	2,11
Punta Negra	8243	100	2	0,24	2,00
Jesús María	81743	11381	229	2,80	1,72
Santa María del Mar	1142	65	1	0,88	1,54

Table 3. Poverty rate and district growth rate in Lima, 2020 and district population density during the last census in Lima.

District	Poverty (%)	Human Development Index (HDI)	District	Population density (Inhab/Km2)
Pachacámac	41,10	,669	Punta Negra	64.00
Puente Piedra	40,70	,673	Punta Hermosa	67.00
Lurín	37,70	,678	Ancón	139.00
Villa El Salvador	37,40	,690	Santa María del Mar	173.00
Pucusana	37,10	,692	San Bartolo	179.00
Carabayllo	35,40	,687	Cieneguilla	207.00
Cieneguilla	35,20	,675	Pucusana	481.00
Independencia	33,10	,699	Lurín	496.00
El Agustino	32,60	,690	Pachacámac	855.00
Villa María del Triunfo	32,10	,691	Carabayllo	917.00
Ancón	32,00	,676	Santa Rosa	921.00
San Juan de Miraflores	30,90	,693	Lurigancho	970.00
Punta Negra	30,50	,682	Chaclacayo	1119.00
San Juan de Lurigancho	30,40	,685	La Molina	2734.00
San Bartolo	28,80	,695	San Isidro	4816.00
Ate	28,40	,695	Puente Piedra	5241.00
Comas	27,80	,699	Villa María del Triunfo	6600.00
Punta Hermosa	26,30	,684	Miraflores	8484.00
Santa Rosa	24,50	,683	Ate	8515.00
Lurigancho	23,80	,682	Chorrillos	8630.00
Santa Anita	23,60	,693	San Juan de Lurigancho	8674.00
Rímac	20,60	,714	Barranco	8700.00
San Martín de Porres	18,90	,709	Santiago de Surco	10290.00
Santa María del Mar	17,50	,680	Comas	11021.00
La Victoria	15,80	,731	San Borja	11316.00
Lima	15,50	,727	Lima	12088.00
Chorrillos	3,40	,702	San Miguel	12803.00
Chaclacayo	2,80	,702	Villa El Salvador	13594.00
Los Olivos	2,10	,706	Rímac	13723.00
San Luis	1,20	,719	Independencia	15135.00
Surquillo	,70	,736	Magdalena del Mar	15215.00
Pueblo Libre	,70	,740	El Agustino	15574.00
Breña	,70	,736	Jesús María	15685.00
La Molina	,60	,736	Lince	16193.00
Barranco	,60	,742	San Luis	16751.00
Santiago de Surco	,50	,755	San Juan de Miraflores	17342.00
San Miguel	,50	,753	Pueblo Libre	17381.00
Magdalena del Mar	,50	,758	La Victoria	19068.00
San Borja	,40	,766	San Martín de Porres	19777.00
Lince	,40	,752	Los Olivos	21080.00
Jesús María	,30	,769	Santa Anita	22291.00
San Isidro	,20	,809	Breña	23202.00
Miraflores	,20	,790	Surquillo	26438.00

Table 4. Factors associated to mortality and fatality by Covid-19 at district level.

Mortality by COVID-19	Beta coefficient	p- value	CI 95%
Poverty rate	0,03	0,07	-0,015;0,021
Human development index	0,46	0,90	-7,35;8,27
Population density	0,06	<0,001	0,03;0,08
Fatality by COVID-19	**Beta coefficient**	**p-value**	**CI 95%**
Poverty rate	0,2	0,205	-0,01;0,06
Human development index	-6,56	0,370	-7,35;8,27
Population density	0,06	0,003	0,02;0,10

regression associates much more population density with mortality and lethality, being poverty and HDI, nonsignificant variables.

DISCUSSION

The results from this study show that mortality due to COVID-19 in the districts of Lima were greater mostly in older adults over 60 years of age and of masculine gender. In addition to this, we were able to determine that from the beginning of the pandemic until the month of September there was a positive correlation (at district level) between fatality due to COVID-19 and poverty rate at the district level. Population density was the factor associated more consistently to mortality and fatality due to COVID-19. For every increase in population density (in one thousand inhabitants), the fatality and mortality from district COVID-19 infection would increase 6%. Poverty was associated with greater fatality, but not with greater mortality.

Deaths due to COVID-19 mostly in older adults of male gender with comorbidities such as hypertension, obesity, diabetes[31-34]. Prior studies such Hernández-Vásquez et al.[8] describe that there is an excess of mortality of 20,093 non-violent deaths and 2,979 COVID-19 confirmed deaths in the department of Metropolitan Lima during the first 24 weeks of the year 2020, where older adults, males, and in poverty were the ones who died most from this disease[8].

The main results from this study show that the greater the district poverty, the greater COVID-19 fatality. This resembles prior research such as those of Ogedegbe et al., Gadson et al. and Hernández-Vásquez et al.[8] among others[14,15]. Ogedegbe et al. showed in his study the existence of a substantial variation of COVID-19 fatality in the districts of New York city, determining that zones with greater number of people living in poverty and lower educational levels had higher rates of deaths related to COVID-19[9]. In this same manner, Hernández-Vásquez et al. describe that the excess of deaths due to COVID-19 were greater in the districts with extreme poverty[8]. The study of these relationships demonstrates the importance of accessibility of district monetary resources facing the fatality of this pandemic, given that districts with less accessibility of economic resources have greater chance of counting on less infrastructure resources and human resources, reporting in turn a greater number of deaths[14,15].

This study has evaluated the correlation between fatality and poverty rate at the district level. This study evaluated a smaller population compared to other studies such as Achoki et al. which evaluated countries that showed a similar situation[16-18]. Achoki et al. Demonstrated that fatality due to COVID-19 (in the beginning of the pandemic) was greater in impoverished countries in continents, such as Africa, and that this too could replicate in countries in Latin America, as we can observe through results from this study[18,19].

The main implications in this research were the possibility to determine population groups with greater risk, where the state and health ministry can intervene and target prevention actions such as early detection of cases, of patients with greater risk of infection and mortality, as well as early referral to health establishments with greater complexity, mainly in those districts with higher poverty levels.

The main limitations from this research were related

ORIGINAL PAPER

to the data base quality. It is possible that an underreporting of patients who died in the beginning of the pandemic exist, due to lack of knowledge of diagnostic criteria and delay in molecular test results, among others. Since it is an ecological study, the results should be interpreted at a district level and not necessarily at an individual level. However, we consider that the risk of ecological fallacy is highly unlikely.

CONCLUSION

COVID-19 is transmitted directly from person to person, being the cause of many complications such as a trigger of pneumonia, the transmission is among people that keep little distance from each other, this disease will travel through respiratory droplets, this disease spreads when the infected person coughs, this is why the association between mortality and fatality with population density is important, since once there is contact between people the spread is greater. This is shown in the results of robust regression, that when population density in a thousand inhabitants increases, the district fatality due to COVID-19 increased by 6%, and we can also observe that the districts with less population density had less deaths in a bivariate analysis, and it is much more associated in a robust regression, therefore we show that population density is a very relevant factor, with poverty and HDI not having any association.

The prevention of the agglomeration of people is very important in enclosed places or those with poor ventilation, since this would make the spread easier.

ORIGINAL PAPER

Authorship contributions: The authors participated in the genesis of the idea, project design, data collection and interpretation, analysis of results and preparation of the manuscript of this research work.

Financing: Self-financed.

Interest conflict: The authors declare that they have no conflict of interest.

Received: June 8, 2021

Approved: August 5, 2021

Correspondence: *Zalia Elizabeth Dorregaray Farge.*
Address: *Av. Alfredo Benavides 5440, Santiago de Surco, Lima, Perú.*
Telephone: *+51 999986642*
E-mail: *zalia.dorregaray@urp.edu.pe*

BIBLIOGRAPHIC REFERENCES

1. Chan JWM, Ng CK, Chan YH, Mok TYW, Lee S, Chu SYY, et al. Short term outcome and risk factors for adverse clinical outcomes in adults with severe acute respiratory syndrome (SARS). Thorax. 2003;58(8):686–9. DOI: 10.1136/thorax.58.8.686
2. Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. Lancet 2020;395(10223):497–506. DOI: 10.1016/S0140-6736(20)30183-5
3. Chen N, Zhou M, Dong X, Qu J, Gong F, Han Y, et al. Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study. Lancet. 2020;395(10223):507–13. DOI: 10.1016/S0140-6736(20)30211-7
4. Goldstein JR, Lee RD. Demographic perspectives on the mortality of COVID-19 and other epidemics. Proc Natl Acad Sci U S A. 2020;117(36):22035–41. DOI: 10.1073/pnas.2006392117
5. Oronce CIA, Scannell CA, Kawachi I, Tsugawa Y. Association Between State-Level Income Inequality and COVID-19 Cases and Mortality in the USA. Journal of general internal medicine. 2020; 35:2791–3. DOI: 10.1007/s11606-020-05971-3
6. Khazanchi R, Beiter ER, Gondi S, Beckman AL, Bilinski A, Ganguli I. County-Level Association of Social Vulnerability with COVID-19 Cases and Deaths in the USA. Journal of general internal medicine. 2020; 35:2784–7. DOI: 10.1007/s11606-020-05882-3
7. Price-Haywood EG, Burton J, Fort D, Seoane L. Hospitalization and Mortality among Black Patients and White Patients with Covid-19. N Engl J Med. 2020;382(26):2534–43. DOI: 10.1056/NEJMsa2011686
8. Hernández-Vásquez A, Gamboa-Unsihuay JE, Vargas-Fernández R, Azañedo D. [Excess mortality in Metropolitan Lima during the COVID-19 pandemic: A district level comparison]. Medwave. 2020;20(8):e8031. DOI: 10.5867/medwave.2020.08.8032
9. Ogedegbe G, Ravenell J, Adhikari S, Butler M, Cook T, Francois F, et al. Assessment of Racial/Ethnic Disparities in Hospitalization and Mortality in Patients With COVID-19 in New York City. JAMA Netw open. 2020;3(12):e2026881. DOI: DOI: 10.1001/jamanetworkopen.2020.26881.
10. INEI. Provincia de Lima: Compendio estadístico-2017. 2017. Disponible en https://www.inei.gob.pe/media/MenuRecursivo/publicaciones_digitales/Est/Lib1477/libro.pdf. Fecha de acceso 8/04/2021.
11. StataCorp. 2017. Stata Statistical Software: Release 15. College Station, TX: StataCorp LLC.
12. Gadson A, Akpovi E, Mehta PK. Exploring the social determinants of racial/ethnic disparities in prenatal care utilization and maternal outcome. Semin Perinatol [Internet]. 2017;1–10. Disponible en: http://dx.doi.org/10.1053/j.semperi.2017.04.008
13. Abedi, V., Olulana, O., Avula, V. et al. Racial, Economic, and Health Inequality and COVID-19 Infection in the United States. J. Racial and Ethnic Health Disparities (2020). DOI: 10.1007/s40615-020-00833-4
14. Porcheddu R, Serra C, Kelvin D, Kelvin N, Rubino S. Similarity in Case Fatality Rates (CFR) of COVID-19/SARS-COV-2 in Italy and China. J Infect Dev Ctries. 2020;14(2):125–8. DOI: 10.3855/jidc.12600
15. Acosta LD. [Response capacity to the COVID-19 pandemic in Latin America and the Caribbean]. Rev Panam Salud Publica. 2020;44:e109. DOI: 10.26633/RPSP.2020.109
16. Andrades-Grassi JE, Cuesta-Herrera L, Bianchi-Pérez G, Grassi HC, López-Hernández JY, Torres-Mantilla H. Análisis espacial de riesgo de morbilidad y mortalidad por COVID-19 en Europa y el Mediterráneo en el año 2020. Cuad Geográficos. 60(1):279–94. DOI: 10.30827/cuadgeo.v60i1.15492
17. Ponce P, Loaiza V, del Río M de la C, Parra LB. Efecto de la desigualdad y la actividad económica en el COVID-19 en Ecuador: un bosquejo de sus posibles determinantes económicos, sociales y demográficos. Contaduría y Adm. 2020;65(4):211. DOI:10.22201/fca.24488410e.2020.3044.
18. Achoki T, Alam U, Were L, Gebremedhin T, Senkubuge F, Lesego A, et al. COVID-19 pandemic in the African continent: forecasts of cumulative cases, new infections, and mortality. medRxiv. 2020. Disponible en: https://www.medrxiv.org/content/10.1101/2020.04.09.20059154v3
19. Schmidt A, Sfeir D, Schlosser H. Correlación entre características psicosociodemográficas con la tasa de mortalidad y letalidad por COVID-19 según región en Chile. Rev ANACEM. 2019;13(1): 10–20. Disponible en: correlation-between-psycho-socio-demographic-variables-and-cov_FyKO8Qx.pdf (bvsalud.org)

ORIGINAL PAPER