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Research Report

The Impact of the COVID-19 Epidemic on Older Adults in Rural and Urban Areas in Mexico

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Abstract

Objectives: Mexico is among the countries in Latin America hit hardest by coronavirus disease 2019 (COVID-19). A large proportion of older adults in Mexico have high prevalence of multimorbidity and live in poverty with limited access to health care services. These statistics are even higher among adults living in rural areas, which suggest that older adults in rural communities may be more susceptible to COVID-19. The objectives of the article were to compare clinical and demographic characteristics for people diagnosed with COVID-19 by age group, and to describe cases and mortality in rural and urban communities.

Method: We linked publicly available data from the Mexican Ministry of Health and the Census. Municipalities were classified based on population as rural (<2,500), semirural (≥2,500 and <15,000), semiurban (≥15,000 and <100,000), and urban (≥100,000). Zero-inflated negative binomial models were performed to calculate the total number of COVID-19 cases, and deaths per 1,000,000 persons using the population of each municipality as a denominator.

Results: Older adults were more likely to be hospitalized and reported severe cases, with higher mortality rates. In addition, rural municipalities reported a higher number of COVID-19 cases and mortality related to COVID-19 per million than urban municipalities. The adjusted absolute difference in COVID-19 cases was 912.7 per million (95% confidence interval [CI]: 79.0–1746.4) and mortality related to COVID-19 was 390.6 per million (95% CI: 204.5–576.7).

Discussion: Urgent policy efforts are needed to mandate the use of face masks, encourage handwashing, and improve specialty care for Mexicans in rural areas.

Keywords: COVID-19 disparities in Mexico, COVID-19 inequalities in Mexico, COVID-19 in Mexico

The first confirmed case of coronavirus disease 2019 (COVID-19) in Mexico City was reported on February 28, 2020 (Secretaría de Salud, 2020c). A month after that, there were 848 confirmed cases in the country (Secretaría de Salud, 2020a). Around this time, the federal government began advising people in every state to stay home if possible (Kahn, 2020). However, the majority of informal sector workers continued working to meet their basic needs, which includes a significant number of older Mexican adults (Cisneros, 2020). The COVID-19 pan-

demic has highlighted the gap in public health preparedness and health care disparities in infection rates and mortality faced by communities of color in the United States (Hooper et al., 2020). Older adults aged 65 and older have been disparately affected by this pandemic. In the United States, the Centers for Disease Control and Prevention reported that eight out of 10 COVID-19 deaths are from this age group (Centers for Disease Control and Prevention, 2020). Rural areas may also be at a higher risk of negative outcomes due to the high proportion of residents who have chronic conditions and are older (Henning-Smith, 2020). Furthermore, health care infrastructure may be more limited among rural areas in less-developed countries (Warshaw, 2017).

The combination of multiple factors may exacerbate COVID-19 cases and mortality among older adults living in rural areas in Mexico. First, there are over 15 million adults aged 60 and older (12% of the population), and about 1.7 million of them live alone without social support (Instituto Nacional de Estadística y Geografía [INEGI], 2019). Second, Mexico is experiencing an epidemiological transition with a high prevalence of infectious diseases and chronic diseases (e.g., diabetes and obesity), which appear to be risk factors for COVID-19–related mortality (Holman et al., 2020; Hussain et al., 2020; Kumar et al., 2015, 2016). Additionally, about 50% of older adults in Mexico live in poverty; however, these numbers are higher among rural communities (Secretaría de Desarrollo Social, 2017). Finally, rural communities have a higher share of older adults compared to more urban areas. Approximately, 30.4% of older adults in rural areas were aged 60 and older compared to 27.6% in urban areas (Centro de Estudios para el Desarrollo Rural Sustentable y la Soberanía Alimentaria, 2015). These disparities could make older Mexican adults vulnerable to the COVID-19 pandemic, particularly those living in rural communities. Therefore, this article aims to compare clinical and demographic characteristics for people diagnosed with COVID-19 and to describe cases and mortality in rural and urban communities. It is important to assess vulnerable groups to support those at risk (The Lancet, 2020).

Method

Data

We use data from the Department of Epidemiology from the Mexican Ministry of Health circa October 19, 2020 (Secretaría de Salud, 2020b) to calculate cumulative COVID-19 cases and mortality related to COVID-19. These data contain patient-level information including demographic and clinical characteristics, as well as municipality of residence. In addition, we downloaded data from the 2010 Mexican Census and the 2015 National Evaluation Council for Social Policy and Development (Consejo Nacional de Evaluación de la Política de Desarrollo Social [CONEVAL], 2020) to retrieve county characteristics. Finally, information regarding health resources in Mexico's public health care system was obtained from the Department of Health Information from the Mexican Ministry of Health. According to the federal government's database published on October 19, 2020, there were 2,183,272 people tested for COVID-19, of which 826,576 cases tested positive. Of those, 819,353 cases had a valid municipality ID or complete information on municipality characteristics.

Measures

We calculated total number of COVID-19 cases and COVID-19–related mortality per 1,000,000 at the municipality level.

Explanatory Variable

Rural/urban

Municipalities were classified based on population as rural (<2,500), semirural (≥2,500 and <15,000), semiurban (≥15,000 and <100,000), and urban (≥100,000). These categories have been used in prior research (Salinas et al., 2010).

Municipality Characteristics

Municipality characteristics included CONEVAL's poverty and well-being measures such as the percentage of people living in extreme poverty (income below the well-being threshold and three or more additional measures in the social Deprivation Index Scale), percentage of people with low income (not enough to buy basic services and goods), percentage of people with low levels of education (mandatory/basic education), percentage of people without health insurance, percentage of people without access to government programs, and proportion of females and residents who were 0–14 years old, 15–64 years old, and 65 and older. In addition, we included information about hospitals and medical personnel available: the number of general practice doctors per 100,000 people, the number of emergency department (ED) physicians per 100,000 people, the number of nurses per 100,000 people, number of hospitals per 100,000 people, number of intensive care units (ICUs) per 100,000 people, number of intermediate units per 100,000 people, number of emergency room units per 100,000 people, total number of hospital beds per 100,000 people, and facilities with telemedicine available per 100,000 people.

Analysis

First, we described clinical and demographic characteristics of COVID-19 patients, as well as municipality characteristics by rural/urban designation. Finally, zero-inflated

negative binomial models were performed to calculate the total number of COVID-19 cases and deaths for all age groups per 1,000,000 persons using each municipality's population as a denominator. This approach was used due to excess zero counts in our data (see Supplementary Figures A1–A3). Marginal effects for rural/urban designations are reported in the main paper. The results of the full models can be seen in Supplementary Tables A1 and A2. We also conducted stratified analysis by age group (<65 vs ≥65). The data were merged using SAS 9.4, and models were run using STATA 16.0.

Results

Table 1 presents patient characteristics by age group. Approximately, 13% of COVID-19 cases were among adults aged 65 and older. A slightly lower proportion of older adults tested positive in urban areas when compared to children or younger adults (78.6% vs 80.0% and 82.7%, respectively). About half of these older adults had hypertension and one-third had diabetes. Also, 45% of older adults had a pneumonia diagnosis, and 60% needed to be hospitalized. Unadjusted results also show that about 37% of older adults died of COVID-19 symptoms.

There were 366 municipalities that were classified as rural, 955 were semirural, 898 were semiurban, and 225 were urban (see Table 2). Compared to any other designation, rural areas had a higher proportion of people living in extreme poverty (28.0% vs 24.0% vs 15.2% vs 6.1%), older adults aged 65 and older (13.6% vs 8.9% vs 7.1% vs 5.6%), and people with lower education level (32.3% vs 30.7% vs 26.1% vs 15.7%). On average, there were 70.0 general practice doctors per 100,000 people in rural areas compared to 41.1 doctors per 100,000 people in urban areas. However, rural areas were less likely to have access to hospitals and specialty care doctors than semiurban and urban areas. The number of hospital beds per 100,000 was 1.4 in rural areas compared to 18.8 in semirural, 34.2 in semiurban, and 80.4 in urban municipalities, respectively.

Rural/semirural urban areas reported a higher number of COVID-19 cases per million and mortality related to COVID-19 per million (see main model results in Table 3). As rurality increased, the number of COVID-19 cases and mortality increased. The adjusted rates in COVID-19 cases was 4135.0 per million (95% confidence interval [CI]: 3519.1–4750.8) for rural areas and 3222.3 (95% CI: 2816.0–3628.7) for urban areas. Similarly, mortality related to COVID-19 was 734.6 per million (95% CI: 566.8–902.3) in rural areas and 344.0 per million in urban municipalities (95% CI: 293.1–394.8). The stratified results by age were consistent with the main findings (see Table 3 stratified results by age: <65 and ≥65 years).

Discussion

We used national publicly available data of cumulative COVID-19 cases and mortality in Mexico. Our study found

Table 1. Patient Characteristics of Those Who Tested Positive for COVID-19 (*N* = 819,353)

Age group	0–14	15–64	65 +	*p*-value
# Cases	16,480 (2.0%)	696,716 (85.0%)	106,157 (13.0%)	<.0001
Rurality				
Rural	0.3	0.1	0.2	<.0001
Semirural	3.1	2.0	3.0	
Semiurban	16.6	15.2	18.2	
Urban	80.0	82.7	78.6	
Male, %	52.0	51.0	55.7	<.0001
Indigenous[a], %	0.7	0.8	1.7	<.0001
Diabetes[a], %	0.6	12.3	36.4	<.0001
COPD[a], %	0.1	0.7	6.2	<.0001
Asthma[a], %	3.3	2.6	2.0	<.0001
Hypertension[a], %	0.6	14.8	50.2	<.0001
Cardiovascular disease[a], %	1.0	1.2	6.6	<.0001
Kidney disease[a], %	0.4	1.5	4.6	<.0001
Obesity[a], %	3.3	18.1	17.4	<.0001
Smoke[a], %	0.5	7.5	7.5	<.0001
Pneumonia, %	6.1	14.0	44.7	<.0001
Type of care, %				<.0001
Ambulatory	86.5	82.2	40.6	
Hospitalized	13.5	17.8	59.4	
ICU, %	2.6	1.5	5.0	<.0001
Ventilator, %	1.8	2.8	11.8	<.0001
Died, %	1.4	6.3	36.4	<.0001

Note: COPD = chronic obstructive pulmonary disease; COVID-19 = coronavirus disease 2019; ICU = intensive care unit.
[a]Variable contains missing information.

Table 2. Municipality Characteristics and COVID-19 Outcomes in Mexico, by Rural/Urban Designation (*N* = 2,444)

	Rural (*n* = 366)	Semirural (*n* = 955)	Semiurban (*n* = 898)	Urban (*n* = 225)
Municipality characteristics				
Total population, no.	1281.3 (32.2)[a,b,c]	7454.1 (115.9)[d,e]	37293.3 (705.8)[f]	352889.5 (22950.6)
Demographic characteristics[g,h]				
% with low income	1.4 (0.1)[a,b,c]	2.9 (0.1)[d,e]	4.4 (0.2)[f]	8.3 (0.3)
% living in extreme poverty	28.0 (1.0)[a,b,c]	24.0 (0.6)[d,e]	15.2 (0.5)[f]	6.1 (0.5)
% with low education	32.3 (0.5)[a,b,c]	30.7 (0.3)[d,e]	26.1 (0.3)[f]	15.7 (0.4)
% without insurance	13.6 (0.5)[b,c]	12.9 (0.2)[d,e]	15.0 (0.2)[f]	17.3 (0.4)
% without government programs	75.7 (0.6)[a,c]	77.9 (0.4)[d,e]	74.4 (0.6)[f]	53.3 (1.1)
% female	51.9 (0.1)[a,b,c]	51.1(0.1)	51.0 (0.04)[f]	51.2 (0.1)
Age				
0–14	28.0 (0.3)[a,b]	31.8 (0.2)[e]	31.8 (0.2)[f]	28.6 (0.3)
15–64	57.0 (0.2)[a,b,c]	59.0 (0.1)[d,e]	60.6 (0.1)[f]	64.4 (19.4)
65 and older	13.6 (0.3)[a,b,c]	8.9 (0.1)[d,e]	7.1 (0.1)[f]	5.6 (0.2)
Hospital characteristics[i]				
General doctors per 100,000	70.1 (4.7)[a,b,c]	61.5 (1.7)[d,e]	57.7 (1.1)[f]	41.1 (1.6)
ED doctors per 100,000	0 (0)[b,c]	0.7 (0.3)[d,e]	1.3 (0.2)[f]	6.9 (0.5)
Nurses	165.7 (10.2)[c]	147.4 (10.0)[d,e]	172.7 (6.2)[f]	284.2 (14.7)
Hospitals	0.1 (0.1)[a,b,c]	0.9 (0.1)[d]	1.5 (0.1)[f]	1.2 (0.1)
ICU units	0 (0)[b,c]	0.003 (0.002)[d,e]	0.03 (0.01)[f]	1.8 (0.2)
Intermediate care units	0 (0)[b,c]	0.008 (0.003)[d,e]	0.1 (0.01)[f]	0.8 (0.1)
ED units	0 (0)[a,b,c]	0.1 (0.01)[d,e]	0.5 (0.02)[f]	2.9 (0.2)
Hospital beds per 100,000	1.4 (1.4)[a,b,c]	18.8 (4.4)[d,e]	34.2 (2.3)[f]	80.4 (5.5)
Hospitals telemedicine per 100,000	0 (0)[a,b,c]	0.2 (0.1)	0.3 (0.03)	0.3 (0.03)

Notes: COVID-19 = coronavirus disease 2019; ED = emergency department; ICU = intensive care unit. All differences are significant at least at $p < .05$.

[a]Significant differences between rural and semi-rural municipalities; [b]Significant differences between rural and semi-urban municipalities; [c]Significant differences between rural and urban municipalities; [d]Significant differences between semi-rural and semi-urban municipalities; [e]Significant differences between semi-rural and urban municipalities; [f]Significant differences between semi-urban and urban municipalities. [g]The Mexican Census was used to provide information regarding population and demographic characteristics, as well as rural and urban designations. [h]Data from the National Evaluation Council for Social Policy and Development were used to obtain measures regarding social inequities such as educational gap, health insurance coverage, and access to other services at the municipality level. [i]Data from the Department of Health Information from the Mexican Ministry of Health were used to obtain information regarding the Mexican public health care system about health care professionals and facility characteristics.

Table 3. Municipality-Level COVID-19 Cases and Mortality per Million, by Rural/Urban Designation in Mexico (*N* = 2,444)

	Rural	Semirural	Semiurban	Urban
Main model				
Cases	4135.0 (3519.1–4750.8)[a,b,c]	3335.9 (3073.0–3598.9)	3260.4 (3053.9–3466.9)	3222.3 (2816.0–3628.7)
Mortality	734.6 (566.8–902.3)[a,b,c]	397.9 (369.6–426.3)[d,e]	355.1 (336.5–373.8)	344.0 (293.1–394.8)
Age <65 only				
Cases	3729.1 (3124.6–4333.7)[a,b,c]	2785.6 (2550.7–3020.4)	2710.2 (2530.9–2889.6)	2745.8 (2391.5–3100.1)
Mortality	519.1 (354.2–684.0)[a,b,c]	205.6 (188.6–222.5)[d,e]	172.8 (163.0–182.5)	194.6 (162.4–226.8)
Age 65+ only				
Cases	849.9 (699.6–1000.3)[a,b,c]	600.7 (560.1–641.2)[d,e]	545.2 (515.2–575.2)	506.8 (445.6–568.0)
Mortality	364.9 (264.5–465.2)[a,b,c]	216.2 (198.5–233.9)[d,e]	179.0 (168.1–189.9)	181.8 (154.3–209.2)

Notes: COVID-19 = coronavirus disease 2019. The models included rural/urban designation, municipality-level sociodemographic characteristics (i.e., age, sex, educational attainment, poverty rates), municipality-level rates of uninsured, hospitals and medical personnel. All these differences are significant at least at p <.001.

[a]Significant differences between rural and semirural municipalities. [b]Significant differences between rural and semiurban municipalities. [c]Significant differences between rural and urban municipalities. [d]Significant differences between semirural and semiurban municipalities. [e]Significant differences between semirural and urban municipalities.

that COVID-19 has disproportionately impacted older and rural communities. Over one-third of older adults died of COVID-19, with higher COVID-19 cases and mortality rates among those living in rural areas. When looking at the share of people who tested positive for COVID-19 within each rural/urban designation, the proportion of older adults who tested positive in rural areas was 21% compared to 12.4% in urban areas. Put simply, as rurality increased, COVID-19 cases and mortality increased.

According to a report published by Hernández Bringas (2020), over 70% of people in Mexico who have died from COVID-19 were relatively poor and with lower levels of education. Therefore, this pandemic is exposing existing social and health inequalities in Mexico. About 50% of older adults in Mexico (~7 million) do not have access to pensions or other retirement income, which forces about 3.3 million older individuals to work in the informal economy, making them extremely vulnerable to COVID-19 (Castañeda, 2020). There is a higher proportion of older adults who are still in the labor force (Centro de Estudios para el Desarrollo Rural Sustentable y la Soberanía Alimentaria, 2015). Our data show that people living in rural areas are more likely to speak an indigenous language and have lower levels of education.

Despite higher rates of insurance coverage (Centro de Estudios para el Desarrollo Rural Sustentable y la Soberanía Alimentaria, 2015), we identified more severe cases, higher rates of pneumonia, hospitalizations, and more aggressive treatment among older adults in rural areas. We did not examine explanations for this disparity. However, these results may be partially related to the rural–urban gap in access to COVID-19 testing, specialty care, and services including telehealth, as well as access to personal protective equipment. Rural areas in Mexico have limited access to sanitation and clean water, as well as health care infrastructure and medical personnel, which may result in health inequalities (CONEVAL, 2020).

While other countries are transitioning to telemedicine to reduce provider and patient interactions, this technology is almost nonexistent in Mexico. Major health care providers (The Mexican Social Security Institute and the Institute for Social Security and Services for State Workers) should consider expanding these technologies. However, health care resources were, and remain scarce. Pre-COVID-19 pandemic, there were 1,040 public hospitals with EDs and about 230 ICUs for the entire country (Garcia, 2020). In addition, there were only 6,175 ventilators across different states, and it was not until May when Mexico received additional ventilators (Secretaría de Salud, 2020a). Rural patients may be transferred to hospitals in urban areas to receive appropriate care. Thus, COVID-19 has highlighted the many challenges faced by Mexico to protect vulnerable populations.

Our results should be interpreted in the context of several limitations, including the evolving nature of the pandemic and the cross-sectional ecological design of the

study. Although we adjusted for several municipality-level sociodemographic and health care supply-side indicators, we may have excluded factors that could explain the relationships we observed. However, other studies have found that the socioeconomic indicators are stronger predictors of COVID-19 spatial patterns (Mollalo et al., 2020). Finally, our results may underestimate the effect of spatial dependence of municipalities with high number of COVID-19 cases compared to neighboring municipalities. It is possible that some parts of the municipality have high rates of cases or deaths, and lower rates in other areas. In addition, some of these rural municipalities may show similar rates to surrounding counties, as well as being affected by neighboring areas with greater population density or COVID-19 rates. Finally, the federal government has been diligent in providing access to COVID-19 incidence and mortality. However, there is a need for more granular population and geographic information that would allow for smaller unit of analysis to identify hotspots. Future studies should use spatial models to examine geographic patterns of COVID-19 in Mexico. Nevertheless, the differences found in our exploratory analysis provide meaningful information regarding COVID-19 cases in rural and urban areas and among older adults.

COVID-19 has had a devastating impact in Mexico, ranking among the top five countries most affected by the virus with 10.4% in observed case–fatality ratio (vs 2.8% in the United States) and 65.56 deaths per 100,000 people (vs 64.74 per 100,000 in the United States) (Johns Hopkins Coronavirus Resource Center, 2020). However, the total number of cases may be even greater than those reported, given the limited testing capacity in Mexico when compared to more developed countries (Reuters, 2020). These preliminary study findings show high mortality rates among rural areas, which have limited access to health care and higher risk of severe complications. To our knowledge, this is the first study that looks at these disparities in Mexico.

Mexico may need additional mitigation strategies to limit the risk of COVID-19 and influenza coinfection among older adults. Policy efforts are needed to decrease the spread of COVID-19 (and perhaps other respiratory viruses), particularly among vulnerable populations, and specifically including rural communities within an already overwhelmed health care system. The federal government should continue to encourage or implement the mandatory use of face coverings. In addition, local governments may need to work with community organizations to identify gaps in care, deliver meals and medicine, disseminate information, and promote effective hand washing and hygiene. Finally, there is a need to increase specialty care access and quality of care for Mexicans in rural areas and among older adults to decrease disparities in COVID-19 treatment and outcomes.

Supplementary Material

Supplementary data are available at *The Journals of Gerontology, Series B: Psychological Sciences and Social Sciences* online.

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Conflict of Interest

None declared.

Author Contributions

M. Rivera-Hernandez planned the study, conducted data analysis, and wrote the paper. N. B. Ferdows guided the analysis and contributed to revising the paper. A. Kumar helped to plan the study and to revise the manuscript.

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