Effect of Co-Morbidities on Mortality from COVID-19 in Mexico: an Ecological Study

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With the emergence of a SARS-CoV-2 infection pandemic in China and its spread to other countries, mortality was shown to be high and to a greater extent if there were underlying pathologies. It is said (or an ecological analytical cross-sectional study, of the open records of confirmed and discarded cases for COVID-19 of the General Directorate of Epidemiology of the Secretary of Health of Mexico. A specific mortality of 9.79% is reported; being higher in men between the ages of 20 to 59 and over 60 years. Mortality rates from underlying diseases were higher than those reported in the USA in early May 2020. Asthma was found to be a protective factor for COVID-19 mortality. It is concluded that mortality was higher in the presence of comorbidities.

Keywords: COVID-19; Co-Morbidities; Mortality; SARS-CoV-2.
infectivity. COVID-19 patients who present with a comorbid condition may have an increased risk of deterioration and should therefore be admitted to a designated unit for close monitoring in accordance with the WHO guidelines for screening and triage. In a series of 41 patients infected with SARS-CoV-2, 32% had some underlying pathology, diabetes 20%, hypertension 15%, cardiovascular disease 15%, chronic obstructive pulmonary disease (COPD) 2%. The objective was to compare deaths from confirmed and discarded cases of COVID-19, as well as to analyze the effect of co-morbidities on deaths of patients with COVID-19.

**MATERIAL AND METHODS**

A Cross-sectional study in the Mexican population is designed, with data published by the General Directorate of Epidemiology and the National Epidemiological Surveillance System of the Ministry of Health on May 6th, 2020.

Where analyzed all registries published by Secretary of Health in Mexico, with confirmed and discarded cases of COVID-19. Registries with not full data were eliminated from analysis.

Data were collected on age, gender, symptom onset date, RT-PCR test result, date of death, if applicable, as well as associated factors or diseases (smoking, obesity, pneumonia, cardiovascular disease, asthma, COPD, diabetes, hypertension, chronic kidney disease, Immunosuppression).

A suspected case is a patient who, in the previous 14 days, has presented fever and/or cough, headache, myoarthralgia, dyspnea and has had contact with a confirmed case or has traveled to China, Europe or the USA and becomes confirmed when in addition of the above, it presents positive RT-PCR test. To establish whether the case was confirmed or ruled out, it was based on the result of the RT-PCR, recommended by the WHO.

For the statistical analysis, variables were crossed with confirmed cases and discarded cases, associated diseases and deaths. Odds Ratios (OR) and 95% confidence intervals were calculated to find an effect between gender, underlying pathologies and the possibility of dying. Logistic regression models were designed for death and being a case of COVID-19, as well as death and not being a case for COVID-19, adjusted by age group and sex, for each of the morbidities. Statistical analysis was performed on STATA® 13.0 (Stata Corp., College Station, TX, USA).

**RESULTS AND DISCUSSION**

The sample of public records of confirmed and discarded cases of the General Directorate of Epidemiology, of the National System of Epidemiological Surveillance of the Ministry of Health of Mexico, was made up of 134,663 records of which 45,032 (33.44%) were confirmed cases and 89,631 (66.56%) were negative for the RT-PCR test.

For confirmed cases 27,634 (29.57%) the age range was from 0 to 113 years with a mean of 46.72 ± 15.62 years; for 65,807 (70.43%) discarded cases, the age range was from 0 to 110 years with a mean of 39.92 ± 17.62 years (t = 55.63, degrees of freedom 93439, P = .00001).

Table 1 shows the distribution by age group, gender of confirmed cases and discarded cases caused by SARS-CoV-2. For both gender and age groups, there are significant differences between cases with no cases of COVID-19.

Table 2 shows the deaths between confirmed cases and discarded cases; the specific fatality rate for COVID-19 was 9.79%; Among the discarded cases, 1.93% of deaths were registered.

**Table 1. Distribution by confirmed and non-cases of COVID-19 in Mexico, until May 6, 2020 (n=93,341)**

| Variable          | Confirmed cases (n=27,634) | Non-cases (n=65,807) |
|-------------------|---------------------------|----------------------|
|                   | n (n (%))                 | n (%)                |
| Gender            |                           |                      |
| Female            | 11,475 (41.52)            | 34,588 (52.56)       |
| Male              | 16,159 (58.48)            | 31,219 (47.44)       |
| Total             | 27,634 (100.0)            | 65,807 (100.0)       |
| Age group (years) |                           |                      |
| 0 to 5            | 150 (0.54)                | 2,361 (3.59)         |
| 6 to 11           | 129 (0.47)                | 1,265 (1.92)         |
| 12 to 19          | 335 (1.21)                | 2,210 (3.36)         |
| 20 to 59          | 21,247 (76.89)            | 51,195 (77.80)       |
| 60 and higher     | 5,773 (20.89)             | 8,776 (13.34)        |
| Total             | 27,634 (100.0)            | 65,807 (100.0)       |

Source: Secretary of Health
Among the deceased with a confirmed diagnosis of SARS-CoV-2, men predominated (68.31%) and in both groups, being a woman was a preventive factor of death in up to 37% (Table 3). By age group, deaths between 20-59 years (50.55%) and 60 or older (49.11%) predominated;

Table 2. Distribution of deaths among cases and non-cases of COVID-19, until May 6, 2020 (n=93,341)

| Variable       | Confirmed cases (n=27,634) | Non-cases (65,807) | Chi-squared test (df) | P-value |
|----------------|-----------------------------|--------------------|-----------------------|---------|
| Deaths         |                             |                    |                       |         |
| Yes            | 2,704 (9.79)                | 1,269 (1.93)       | 3003 (1)              | 0.0001  |
| No             | 24,930(90.21)               | 64,538 (98.07)     |                       |         |
| Total          | 27,634 (100.0)              | 65,807 (100.0)     |                       |         |

Source: Secretary of Health

Table 3. Distribution of deaths by confirmed cases and non-cases of COVID-19, by gender and age group on Mexico, until May 6, 2020

| Gender | Confirmed cases COVID-19 (n=27,634) | Non-cases COVID-19 (65,807) |
|--------|------------------------------------|-----------------------------|
|        | Deaths n% | Non-deaths n% | Deaths n% | Non-deaths n% |
| Females| 857 (31.69) | 10,61842.59 | 54142.63 | 34,04752.67 |
| Male   | 1,847 (68.31) | 14,31257.41 | 72857.37 | 30,49147.33 |
| Total  | 2,704 100.00 | 24,930 100.00 | 1,269100.00 | 64,538 100.00 |
| OR (CI95%) | 0.63 (0.57 to 0.68) | 0.67 (0.59 to 0.74) |

Source: Secretary of Health

Table 4. Missing data in co-morbidities and whether confirmed COVID-19 patients in Mexican Sample from the start until May 6th, 2020

| Co-morbidity                   | Confirmed COVID-19 patients | Non-confirmed COVID-19 patients |
|--------------------------------|-----------------------------|-------------------------------|
| Diabetes                       | 262                         | 135                           |
| Hypertension                   | 257                         | 123                           |
| COPD                           | 259                         | 125                           |
| Asthma                         | 267                         | 119                           |
| Cardiovascular disease         | 265                         | 125                           |
| Immunosuppression              | 263                         | 140                           |
| Chronic kidney disease         | 270                         | 112                           |
| Smoking                        | 257                         | 125                           |
| Obesity                        | 247                         | 99                            |
| Pneumonia                      | 2                           | 7                             |

Source: Secretary of Health
in the discarded cases, deaths predominated in men (67.37%) with ages 60 or older (57.37%). (Table 3)

When analyzing the co-morbidities, the records were eliminated because they did not know if they suffered from the associated diseases: Table 4 summarized the number of patients with missing data for each disease analyzed in this study.

OR for the association between deaths and co-morbidities, it is reported that those who died from COVID-19 were three times more likely to have had diabetes, hypertension, COPD and chronic kidney disease; for cardiovascular disease, immunosuppression and obesity, the OR were less than 3, but continue to show an effect of these pathologies on death. For smoking, the effect was almost null on death (Table 5).

### Table 5. Distribution of deaths by cases and non-cases of COVID-19, by co-morbidities in Mexico

|                         | Confirmed cases COVID-19 (n=27,634) | Non-cases COVID-19 (65,807) |
|-------------------------|-------------------------------------|-----------------------------|
|                         | Deaths | Non-deaths |Deaths | Non- deaths |
|                         | n   | %     | n   | %     | n   | %     | n   | %     |
| Diabetes                |       |        |       |        |       |        |       |        |
| Yes                     | 1,075 | 40.07  | 4,116| 16.67  | 511 | 49.78  | 6,737| 10.46  |
| No                      | 1,608 | 59.93  | 20,573| 83.33  | 742 | 50.22  | 57,682| 89.54  |
| OR (CI95%)              | 3.34 (0.37% to 3.63)                | 5.90 (5.25 to 6.62)         |
| Hypertension            |       |        |       |        |       |        |       |        |
| Yes                     | 1,173 | 45.70  | 4,896| 10.83  | 548 | 20.48  | 9,672| 15.01  |
| No                      | 1,511 | 54.30  | 19,797| 89.17  | 708 | 79.52  | 54,756| 84.99  |
| OR (CI95%)              | 3.14 (2.89 to 3.41)                | 4.38 (3.91 to 4.91)         |
| COPD                    |       |        |       |        |       |        |       |        |
| Yes                     | 1,825 | 6.74   | 499  | 2.02   | 163 | 13.02  | 1,558| 2.42   |
| No                      | 2,501 | 94.33  | 24,193| 97.98  | 1,089| 86.98  | 62,872| 97.58  |
| OR (CI95%)              | 3.53 (2.96 to 4.20)                | 6.04 (5.09 to 7.17)         |
| Cardiovascular disease  |       |        |       |        |       |        |       |        |
| Yes                     | 75    | 2.80   | 841  | 3.41   | 166 | 6.20   | 1,948| 3.02   |
| No                      | 2,606 | 97.20  | 23,845| 96.59  | 2,513| 93.80  | 62,479| 96.98  |
| OR (CI95%)              | 0.82 (0.64 to 1.03)                | 0.53 (0.38 to 0.74)         |
| Pneumonia               |       |        |       |        |       |        |       |        |
| Yes                     | 2,008 | 74.26  | 6,374| 25.57  | 879 | 69.27  | 7,676| 11.90  |
| No                      | 696   | 25.74  | 18,554| 74.43  | 390 | 30.73  | 56,855| 88.10  |
| OR (CI95%)              | 8.67 (7.92 to 9.50)                | 4.82 (4.07 to 5.72)         |
| Immunopression          |       |        |       |        |       |        |       |        |
| Yes                     | 100   | 3.73   | 387  | 1.63   | 122 | 9.76   | 1,666| 2.59   |
| No                      | 2,581 | 96.27  | 23,303| 98.37  | 1,128| 90.24  | 62,751| 97.41  |
| OR (CI95%)              | 2.43 (1.95 to 3.04)                | 7.13 (6.02 to 8.46)         |
| Chronic kidney disease  |       |        |       |        |       |        |       |        |
| Yes                     | 196   | 7.31   | 514  | 2.08   | 170 | 13.50  | 1,380| 2.14   |
| No                      | 2,484 | 92.69  | 24,170| 97.92  | 1,089| 86.50  | 63,056| 97.86  |
| OR (CI95%)              | 3.71 (3.13 to 4.40)                | 1.29 (1.09 to 1.52)         |
| Obesity                 |       |        |       |        |       |        |       |        |
| Yes                     | 801   | 29.82  | 5,019| 20.32  | 241 | 19.13  | 9,141| 14.18  |
| No                      | 1,885 | 70.18  | 19,682| 79.68  | 1,019| 80.87  | 55,307| 85.82  |
| OR (CI95%)              | 1.67 (1.53 to 1.82)                | 1.43 (1.24 to 1.65)         |
| Smoking                 |       |        |       |        |       |        |       |        |
| Yes                     | 245   | 9.14   | 2,186| 8.85   | 159 | 12.69  | 6,535| 10.14  |
| No                      | 2,435 | 90.86  | 22,511| 91.15  | 1,094 | 87.31 | 57,894| 89.86  |
Asthma prevented death in confirmed cases (18%) and non-cases (47%) (Table 5).

Regarding the discarded cases of COVID-19, the OR between diabetes, hypertension, COPD, cardiovascular disease, pneumonia, immunosuppression, chronic kidney disease, obesity and smoking, in all cases an effect of pathologies on the possibility is detected of death and much higher the OR than those obtained in the cases (Table 5).

With the logistic regression model, for confirmed cases with diabetes, the age group acted as a confounder, an effect that was not found for gender, a similar result for the discarded cases. Similar results for hypertension, chronic obstructive pulmonary disease, cardiovascular disease, pneumonia, immunosuppression, chronic kidney disease. Obesity had a slight effect on mortality in confirmed cases and discarded cases; Smoking had virtually no effect on deaths (Table 6).

The samples reported as confirmed cases of COVID-19 were 27,634 with 2,704 deaths, with a specific rate of 9.79%. COVID-19 deaths

| Co-morbidities                   | OR crude (CI95%) | OR adjusted by agegroup (CI95%) | OR adjusted by gender (CI95%) |
|----------------------------------|------------------|---------------------------------|-------------------------------|
| Diabetes                         |                  |                                 |                               |
| Cases COVID-19                   | 3.34 (3.07 to 3.63) | 2.39 (2.18 to 2.61) | 3.34 (3.07 to 3.63) |
| Non-cases                        | 5.89 (5.25 to 6.62) | 3.78 (3.33 to 4.29) | 5.89 (5.25 to 6.62) |
| Hypertension                     |                  |                                 |                               |
| Cases COVID-19                   | 3.14 (2.89 to 3.41) | 2.09 (1.91 to 2.28) | 3.17 (2.92 to 3.44) |
| Non-cases                        | 4.38 (3.91 to 4.91) | 2.68 (2.36 to 3.04) | 4.35 (3.89 to 4.88) |
| COPD                             |                  |                                 |                               |
| Cases COVID-19                   | 3.53 (2.96 to 4.20) | 1.92 (1.60 to 2.31) | 3.65 (3.06 to 4.35) |
| Non-cases                        | 6.04 (5.09 to 7.57) | 2.71 (2.25 to 3.27) | 5.97 (5.03 to 7.10) |
| Asthma                           |                  |                                 |                               |
| Cases COVID-19                   | 0.53 (0.38 to 0.74) | 0.57 (0.40 to 0.80) | 0.55 (0.39 to 0.77) |
| Non-cases                        | 0.82 (0.64 to 1.04) | 0.92 (0.72 to 1.18) | 0.88 (0.69 to 1.12) |
| Cardiovascular disease           |                  |                                 |                               |
| Cases COVID-19                   | 2.54 (2.13 to 3.02) | 1.52 (1.26 to 1.82) | 2.53 (2.12 to 3.02) |
| Non-cases                        | 4.82 (4.07 to 5.72) | 2.73 (2.28 to 3.26) | 4.74 (4.00 to 5.63) |
| Pneumonia                        |                  |                                 |                               |
| Cases COVID-19                   | 8.40 (7.67 to 9.20) | 6.68 (6.17 to 7.44) | 8.18 (7.47 to 8.96) |
| Non-cases                        | 16.69 (14.78 to 18.85) | 14.24 (12.56 to 16.15) | 16.40 (14.51 to 18.52) |
| Immunosuppression                |                  |                                 |                               |
| Cases COVID-19                   | 2.43 (1.95 to 3.04) | 2.15 (1.70 to 2.72) | 2.49 (1.99 to 3.12) |
| Non-cases                        | 4.07 (3.36 to 4.94) | 3.32 (2.73 to 4.05) | 4.09 (3.37 to 4.96) |
| Chronic kidney disease           |                  |                                 |                               |
| Cases COVID-19                   | 3.71 (3.13 to 3.13) | 2.72 (2.27 to 3.25) | 3.67 (3.10 to 4.36) |
| Non-cases                        | 7.13 (6.02 to 8.46) | 4.38 (3.67 to 5.24) |                               |
| Obesity                          |                  |                                 |                               |
| Cases COVID-19                   | 1.67 (1.53 to 1.82) | 1.72 (1.57 to 1.88) | 1.69 (1.55 to 1.85) |
| Non-cases                        | 1.43 (1.24 to 1.65) | 1.27 (1.10 to 1.47) | 1.46 (1.26 to 1.68) |
| Smoking                          |                  |                                 |                               |
| Cases COVID-19                   | 1.04 (0.90 to 1.19) | 0.99 (0.86 to 1.01) | 0.96 (0.83 to 1.10) |
| Non-cases                        | 1.29 (1.09 to 1.52) | 1.13 (0.95 to 1.34) | 1.20 (1.02 to 1.42) |

Source: Analysis of data of Secretary of Health13
predominated in men ages 20 to 59 and those aged 60 or older. Globally, the WHO reported a mortality from COVID-19 of 6.34%16.

According to the same WHO report, Italy had a specific mortality rate of 12-80%, the United Kingdom of 12.78%, Spain 10.3%, the United States of America, 3.97% and Brazil of 2.96%

The case-specific mortality in Mexico was 9.79% and according to the WHO report of May 6th, 2020, overall the case-specific mortality was 6.9%, for the Americas region it was 5.38% and for Europe 9.3 %17.

There is currently evidence that mortality rates are higher in men than in women, as indicated by the Italian Institute of Health in one of its reports, where of 23,188 deaths, approximately 70% of these were men, as well as in China and South Korea18. In Mexico, mortality was higher in men (68.31%) than in women (Table 2 and 3).

The incidence of SARS-CoV-2 infection has been seen to be more frequent in adult male patients between the ages of 34 and 59, and it has also been observed that people 60 years of age or older and with comorbidities represent severe cases that may present coinfections19. Among the confirmed cases in Mexico, mortality between 20 and 59 years was 50.55% and 49,115 in those over 60 years of age (Table 3).

In the United States, the National Center for Health Statistics, until May 9th, 2020 reports that patients with comorbidities of all ages are 49,770; stratifying each comorbidity and reporting a specific mortality of 14.27% in people with diabetes, 7.34% for kidney failure, 43.41% for pneumonia, 3.45% for cardiovascular disease, 7.72% for COPD, 2.65% for obesity and 20.22% for hypertension20. In Mexico, among the confirmed cases of diabetes, mortality was 40.07; 45.70% among those with hypertension, 74.26% in those with pneumonia, 29.82% in those with obesity, 9.14% among smokers 6.20% among those with cardiovascular disease, 7.31% among those who reported chronic kidney disease, 5.67% among those with COPD 3.73% among those with some type of immunosuppression and 2.80% among those with asthma (Table 5). In general, the specific death rate from co-morbidities was higher than that reported in the USA.

Of the discarded cases of COVID-19 they had an overall mortality of 1.93%13. One explanation for the higher OR’s for the pathologies included in this analysis, among the discarded cases of having COVID-19, is that they all had a respiratory condition that made them consider themselves suspected of being infected with SARS-CoV-2.

CONCLUSION

Mortality in Mexico among confirmed cases of COVID-19 is higher for adult men, over 20 years and older adults. Regarding the underlying pathologies, mortality was higher in Mexico than in other affected countries. In this population it was three times more likely to die having diabetes and confirmed COVID 19 and six times more likely to die by having diabetes but not confirmed for COVID-19. same for other pathologies except asthma.

Conflict of interest
Nothing to declare

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None

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