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# Global COVID-19 trends: gender and age impacts

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## ABSTRACT

COVID -19 pandemic is creating an uncertainty about the demographic trends of morbidity and mortality rates across countries worldwide. Hence, this study is aimed to characterize the gender and age distribution of morbidity and mortality from COVID-19 across populations. This cross-sectional study uses aggregate data on COVID-19 cases and deaths by gender and age. Considering gender-based morbidity, men diagnosed with COVID-19 substantially outnumber infected women with statistically significant findings (*p=<0.05, □RR>2) in Asian, American, and African countries, whereas women diagnosed higher morbidity rate in European countries. However, gender-based fatality showed higher among men in most of the analyzed countries of all those continents except Australia where female fatality was higher. This study revealed 50 years old were mostly associated with the infection and death in all continents except Australia, showing more morbidity above 20 years of age, whereas, fatality rate was more in the above 80 years group. The study concludes that, across countries, COVID-19 morbidity and fatality rate is age specific rather than gender specific. Infection rates showed rising steeply with age; nevertheless, children do not stand on equal footing when COVID-19 crisis is transforming their day-to-day lives.

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## INTRODUCTION

Since its emergence, COVID-19 has resulted in a pandemic and cases and deaths continued to rise with 70 million cumulative cases and 1.6 million deaths globally, American and European countries continue to shoulder the burden of the pandemic, accounting for 85% of new cases and 86% of deaths; the confirmed cases in America, Europe, South-East Asia, Eastern Mediterranean, Africa and the Western Pacific region accounted 31,216,880, 22,884,885, 11,502,390, 4,590,514, 1,671,539, 984,795 accordingly (WHO, 2020).

Both gender and Age are important drivers of risk and response to infection and disease. Some evidence showed that men are consistently infected and dying at a higher rate than women from coronavirus disease, whereas some other studies diagnosed higher morbidity and mortality among women. Some other studies reported that elderly individuals account for a large portion of fatal cases (Onder *et al.*, 2020; Wu *et al.*, 2020). Individuals' co-morbidity, living standard, occupation, national status and, of course, their awareness is also likely to play a role in driving COVID-19 outcomes regardless of age and gender.

Therefore, A question arises whether the demographic trends of morbidity and mortality from COVID-19, is gender or age-specific or both and a clear answer is required to the question of how much age and/or gender are influencing the health outcomes of people diagnosed with COVID-19. Therefore, this study aimed at determining the demographic trends from the gender and age specific morbidity and mortality from COVID-19 worldwide.

## MATERIALS AND METHODS

The data on the registered number of COVID-19 infections were collected from the official sources published by health ministries and government authorities reported during February to September 2020. Mostly, these data were published as tables in regular epidemiological reports on the progression of COVID-19 or they were provided in official data repositories (Global Health 5050, 2020). We used data available on COVID-19 cases and deaths by gender and age for all analyzed countries for which this age-disaggregated data was available during February to September 2020.

Based on available data, Australia, 29 Asian, 40 European, 12 North Americans, eight South American and 26 African countries were taken to analyze the gender-specific morbidity; whereas Australia, 19 Asian, 34 European, nine North-American, six South American and 11 African countries were taken to analyze the gender-specific mortality. Eight countries from Asia, Europe, Australia, North and South America were taken to determine the age-specific mortality and morbidity. We also analyzed the correlation between these two variables (age-specific morbidity and mortality).

Data were entered into Epidata 3.1 version and exported to SPSS 23.0 version for further analysis. Categorical variables were summarized as frequency (percentage). Binary logistic regression (Chi-square test/Fisher exact test) were used to find the association between morbidity and mortality from COVID-19 infection which was summarized as Relative Risk (RR). P<0.05 was considered statistically significant. The Pearson Correlation test was conducted to establish the relationship between the outcome variables considering *p<0.05=statistically significant; ‡Correlation is significant at 0.05 level.

## RESULT

Figure 1 shows the COVID-19 gender-based morbidity data in Asia countries. Study showed higher morbidity rate of COVID-19 among male in 26 out of 29 countries[♂], however, 17 countries showed statistically significant findings (*p=<0.05); whereas three(3) countries[♀] had higher proportion of female COVID-19 morbidity cases, but which was not statistically significant. Moreover, thirteen countries[□] were associated with higher risk of COVID-19 infection among male than that of the female population ([□]RR>2).

Figure 2 represents the gender-based morbidity data of COVID-19 cases in various European countries. Surprisingly, when comparing the gender distribution of morbidity from COVID-19 in 40 European countries, this study showed higher incidence of female cases in most (24) of the countries[♀], but only seven countries showed statistically significant findings (*p=<.05). On the other hand, male morbidity rate from COVID-19 cases was higher than female cases in 12 countries[♂] where only two countries showed statistically significant findings (*p=<.05). Furthermore, the Relative Risks (RR) with 95% CI was not statistically significant. The gender distributions of morbidity from COVID-19 was similar between four countries[∝].

Figure 3 depicts the gender distribution of morbidity from COVID-19 in 12 North Americans countries; where male morbidity rate was higher in eight countries[♂]; however, only two countries showed statistically significant findings (*p=<.05) ; whereas the proportion of females among confirmed COVID-19 cases were higher in three countries[♀]; but was not statistically significant. The RRs with 95% CIs in these twelve European countries were not clinically significant (RR=<2). Besides, the gender distributions of morbidity from COVID-19 was quite similar in one country[∝].

Figure 4 describes the gender-based morbidity rates from COVID-19 in Australia & eight South American countries. Study showed COVID-19 related mortality rate was higher for the female population than male in Australia; whereas, it was higher for men than women across six South American countries[♂].

**Table 1: COVID-19 gender-based mortality data in Asian countries**

| | Countries | | Cases n (%) | RR | 95% CI | P- value |
|---|---|---|---|---|---|---|
| 1 | Afghanistan(n=1338)♂ | Male | 75.1% | □3 | (2.1, 4.3) | *<0.0001 |
| | | Female | 24.9% | | | |
| 2 | Armenia(n=920)♂ | Male | 54.7% | 1.2 | (0.9, 1.6) | 0.16 |
| | | Female | 45.3% | | | |
| 3 | Bangladesh(n=4759)♂ | Male | 77% | □3.3 | (2.3, 4.9) | *<0.0001 |
| | | Female | 23% | | | |
| 4 | China(n=2114)♂ | Male | 64% | 1.8 | (1.3, 2.4) | *<0.0001 |
| | | Female | 36% | | | |
| 5 | India(n=3711)♂ | Male | 64% | 1.8 | (1.3, 2.4) | *<0.0001 |
| | | Female | 36% | | | |
| 6 | Indonesia(n=8965)♂ | Male | 58.5% | 1.4 | (1.1, 1.9) | *0.01 |
| | | Female | 41.5% | | | |
| 7 | Iran(n=853)♂ | Male | 59% | 1.4 | (1.1, 1.9) | *0.01 |
| | | Female | 41% | | | |
| 8 | Israel(n=1061)♂ | Male | 53.5% | 1.2 | (0.9, 1.6) | 0.26 |
| | | Female | 46.5% | | | |
| 9 | Kyrgyzstan(n=155)♂ | Male | 62% | 1.6 | (1.2, 2.2) | *0.001 |
| | | Female | 38% | | | |
| 10 | Malaysia(n=243)♂ | Male | 76% | □3.2 | (2.2, 4.6) | *<0.0001 |
| | | Female | 24% | | | |
| 11 | Maldives(n=30)♂ | Male | 56.7% | 1.3 | (0.1, 1.8) | *0.04 |
| | | Female | 43.3% | | | |
| 12 | Myanmar(n=6)♂ | Male | 83% | □4.9 | (3.1, 7.6) | *<0.0001 |
| | | Female | 17% | | | |
| 13 | Nepal(n=305)♂ | Male | 72.1% | □2.6 | (1.8, 3.6) | *<0.0001 |
| | | Female | 27.9% | | | |
| 14 | Pakistan(n=6190)♂ | Male | 74% | □2.8 | (2, 4) | *<0.0001 |
| | | Female | 26% | | | |
| 15 | Philippines(n=4371)♂ | Male | 60.7% | 1.6 | (1.2, 2.1) | *0.002 |
| | | Female | 39.3% | | | |
| 16 | South Korea(n=372)♂ | Male | 52.4% | 1.1 | (0.8, 1.4) | 0.57 |
| | | Female | 47.6% | | | |
| 17 | Thailand(n=58)♂ | Male | 75.7% | □3.2 | (2.2, 4.6) | *<0.0001 |
| | | Female | 24.1% | | | |
| 18 | Vietnam(n=35)♀ | Male | 37.1% | 0.59 | (0.4,0.8) | *0.0002 |
| | | Female | 62.9% | | | |
| 19 | Yemen(n=584)♂ | Male | 77% | □3.3 | (2.3, 4.9) | *<0.0001 |
| | | Female | 23% | | | |

[*p<0.05, statistically significant; □Relative Risk (RR)>2, statistically significant;♂=Higher incidence of male; ♀= Higher incidence of female; ∝=Equal incidence in male & female]

**Table 2: COVID-19 gender-based mortality data in European countries**

| | Countries | | Cases n (%) | RR | 95% CI | P- value |
|---|---|---|---|---|---|---|
| 1 | Albania(n=338) ♂ | Male<br>Female | 67%<br>33% | 2.0 | (1.5, 2.8) | *<0.0001 |
| 2 | Austria(n=739) ♂ | Male<br>Female | 57%<br>43% | 1.3 | (1, 1.8) | *0.04 |
| 3 | Belgium(n=9902) ♀ | Male<br>Female | 47.2%<br>52.8% | 1.1 | (0.9, 1.5) | 0.39 |
| 4 | Bosnia and Herzegovina(n=354) ♂ | Male<br>Female | 66%<br>34% | 1.9 | (1.4, 2.6) | *<0.0001 |
| 5 | Czech Republic(n=437) ♂ | Male<br>Female | 57.4%<br>42.6% | 1.3 | (1, 1.8) | *0.04 |
| 6 | Denmark(n=633) ♂ | Male<br>Female | 56.6%<br>43.4% | 1.3 | (1, 1.8) | *0.04 |
| 7 | England(n=41545) ♂ | Male<br>Female | 56.6%<br>43.4% | 1.3 | (1, 1.8) | *0.04 |
| 8 | Estonia(n=64) ♀ | Male<br>Female | 45.3%<br>54.7% | 0.8 | (0.6, 1.1) | 0.16 |
| 9 | Finland(n=336) ♀ | Male<br>Female | 48%<br>52% | 0.9 | (0.7, 1.2) | 0.57 |
| 10 | France(n=20322) ♂ | Male<br>Female | 58.9%<br>41.1% | 1.4 | (1.1, 1.9) | *0.01 |
| 11 | Germany(n=9345) ♂ | Male<br>Female | 55.5%<br>44.5% | 1.2 | (0.9, 1.6) | 0.16 |
| 12 | Greece(n=310) ♂ | Male<br>Female | 63.2%<br>36.8% | 1.7 | (1.3, 2.3) | *0.0002 |
| 13 | Hungary(n=646) ♀ | Male<br>Female | 49.7%<br>50.3% | 1 | (0.8, 1.3) | 1 |
| 14 | Italy(n=35569) ♂ | Male<br>Female | 57.4%<br>42.6% | 1.3 | (1, 1.8) | *0.04 |
| 15 | Latvia(n=35) ♂ | Male<br>Female | 62.6%<br>37.4% | 1.7 | (1.3, 2.3) | *0.0002 |
| 16 | Lithuania(n=70) ♀ | Male<br>Female | 47%<br>53% | 0.8 | (0.7, 1.2) | 0.39 |
| 17 | Luxembourg(n=124) ♂ | Male<br>Female | 54%<br>46% | 1.2 | (0.9, 1.6) | 0.26 |

*Continued on next page*

*Table 2 continued*

| | Countries | | Cases n (%) | RR | 95% CI | P- value |
|---|---|---|---|---|---|---|
| 18 | Moldova(n=1130) ♂ | Male<br>Female | 50.9%<br>49.1% | 1.04 | (0.8, 1.4) | 0.78 |
| 19 | Northern Ireland(n=572)♂ | Male<br>Female | 52.6%<br>47.4% | 1.1 | (0.6, 1.5) | 0.39 |
| 20 | Norway(n=265)♂ | Male<br>Female | 53.2%<br>46.8% | 1.1 | (0.9, 1.5) | 0.39 |
| 21 | Poland(n=2238)♂ | Male<br>Female | 53.5%<br>46.5% | 1.2 | (0.9, 1.6) | 0.26 |
| 22 | Portugal(n=1871) ♂ | Male<br>Female | 50.3%<br>49.7% | 1 | (0.8, 1.3) | 1 |
| 23 | Republic of Ireland(n=1787) ♀ | Male<br>Female | 49.3%<br>50.7% | 0.9 | (0.7, 1.3) | 0.78 |
| 24 | Romania(n=4185) ♂ | Male<br>Female | 59.8%<br>40.2% | 1.5 | (1.1, 2) | *0.005 |
| 25 | Scotland(n=4236) ♀ | Male<br>Female | 49.6%<br>50.4% | 1 | (0.8, 1.3) | 1 |
| 26 | Serbia(n=193)♂ | Male<br>Female | 61.7%<br>38.3% | 1.6 | (1.2, 2.2) | *0.001 |
| 27 | Slovenia(n=131) ♀ | Male<br>Female | 39.7%<br>60.3% | 0.7 | (0.5, 0.9) | *0.004 |
| 28 | Spain(n=20518) ♂ | Male<br>Female | 57%<br>43% | 1.3 | (1, 1.8) | *0.04 |
| 29 | Sweden(n=5851) ♂ | Male<br>Female | 54.7%<br>45.3% | 1.2 | (0.9, 1.6) | 0.16 |
| 30 | Switzerland(n=1747) ♂ | Male<br>Female | 57.7%<br>42.3% | 1.4 | (1, 1.8) | *0.02 |
| 31 | The Netherlands(n=650) ♂ | Male<br>Female | 66.8%<br>33.2% | 2.0 | (1.5, 2.8) | *<0.0001 |
| 32 | Turkey(n=6326) ♂ | Male<br>Female | 62.1%<br>37.9% | 1.6 | (1.2, 2.2) | *0.001 |
| 33 | Ukraine(n=3466) ♂ | Male<br>Female | 54.1%<br>45.9% | 1.2 | (0.9, 1.6) | 0.26 |
| 34 | Wales(n=1597) ♂ | Male<br>Female | 55.9%<br>44.1% | 1.27 | (0.9, 1.7) | 0.09 |

[*p<0.05, statistically significant; □Relative Risk (RR)>2, statistically significant;♂=Higher incidence of male; ♀= Higher incidence of female; ∝=Equal incidence in male & female]

Interestingly, none of the gender-based morbidity data from Australia and South American countries was statistically significant, including the RRs with 95% CIs.

Figure 5 depicts the gender-based morbidity rates from COVID-19 in 26 African countries. During this study period, the proportion of male confirmed COVID-19 cases was more across 20 countries♂; where, 17 countries showed statistically significant findings (*p=<.05); whereas, only five countries♀ had higher incidence of COVID-19 cases among female compare to those of male, which showed statistically significant findings in three countries only (*p=<.05). Moreover, the Relative Risk (RR) with 95% CI was clinically significant in nine countries (□RR>2); which showed male population were more at risk from COVID-19 infection. Besides, only one country∝ showed similar rate of morbidity cases from COVIO-19 among both genders.

Table 1 represents the Gender-based COVID-19 Mortality data across 19 Asian countries. This study found higher mortality rate from COVID-19 among male in 18 countries♂ where 15 countries (Afghanistan, Bangladesh, China, India, Indonesia, Iran, Kyrgyzstan, Malaysia, Maldives, Myanmar, Nepal, Pakistan, Philippines, Thailand and Yemen) showed statistically significant findings (*p=<.05); whereas only one country♀ had higher death rate among female which was statistically significant (*p=<.05). Furthermore, the Relative Risk (RR) with 95% CI was clinically significant in eight countries (□RR>2); which showed the higher risk of death from COVID-19 infection among the male population.

Table 2 shows the gender specific mortality from COVID-19 in 34 European countries. The results showed that the COVID-19 related mortality rate is higher for men than women across 27 countries♂; where 16 countries showed statistically significant findings (*p=<.05). On the other hand seven countries♀ had higher female mortality rate; however, only one country (Slovenia) showed statistically significant finding (*p=<.05). Relative Risks (RR) with 95% CI were clinically non-significant in all of these European countries.

Table 3 depicts the Gender-Based Mortality rates from COVID-19 across nine North-American Countries. Eight countries♂ showed higher death rates among male, where seven countries showed statistically significant findings (*p=<.05). The female mortality rate was higher in only one country (Canada) but was statistically non-significant. Relative Risks (RR) with 95% CI were clinically significant in two countries (□RR>2) where a male had a higher risk of death from COVID-19 compare to the female gender.

Table 4 describes the Gender-specific mortality rate from COVID-19 in Australia and six South American countries. Australia showed higher mortality rates among female, but which was not statistically significant. On the other hand, all of those six South American countries♂ showed higher mortality rate from COVID-19 among male, and also was statistically significant (*p=<.05); moreover, two countries (□RR>2) showed clinically significant Relative Risks (RR) with 95% CI; were male had a higher risk of death rate compared to that of the female population.

Table 5 describes the gender-based mortality data from COVID-19 in 11 countries of Africa. This study showed that ten countries♂ had higher mortality rate among male; out of which nine countries showed statistically significant result (*p=<.05); whereas only one country♀ had higher mortality rate among the female population, but was statistically non-significant. Besides, Relative Risks (RR) with 95% CI were statistically significant in five countries (□RR>2) which showed a higher risk of mortality from COVID-19 among male compared to those of female population.

Figure 6 shows the correlation to age-specific morbidity & mortality rates per 100000 cases from COVID-19 in two Asian (Philippines and Pakistan) and two American (Peru from South America and Mexico from North America) countries. Between the two Asian countries, this study showed that population above 70 years of age were most susceptible for both morbidity and mortality from COVID-19 infection in Philippines, where the variables (morbidity and the mortality rates per 100000 cases) were strongly positively correlated [*r* (degree of freedom) = (the R statistic, *p* = *p*-value): *r*(.07) =.82, *p* < .006] and Pakistan showed higher morbidity rate above 50 years of age; whereas, population above 70 years of age were most susceptible for the death. Besides, the variables were found to be a weakly positively correlated [*r* (degree of freedom) = (the R statistic, *p* = *p*-value): *r* (.07) =.49, *p* < .184]; which was not significant. On the other hand; the COVID-19 related morbidity and mortality rate were higher above 70 years of age in the South-American country Peru, and the variables (The age-specific morbidity and mortality rates per 100000 cases from COVID-19) were moderately positively correlated *[r* (degree of freedom) = (the R statistic, *p* = *p*-value): *r*(.08) =.59, *p* < .07]; whereas, population above 50 years of age were most susceptible infected cases and death

**Table 3: COVID-19 gender-based mortality data in North-American countries**

| | Countries | | Cases n (%) | RR | 95% CI | P- value |
|---|---|---|---|---|---|---|
| 1 | Costa Rica (n=621)♂ | Male<br>Female | 62.5%<br>37.5% | 1.6 | (1.2, 2.2) | *0.001 |
| 2 | Haiti(n=220)♂ | Male<br>Female | 62.7%<br>37.3% | 1.7 | (1.3, 2.3) | *0.0002 |
| 3 | Canada(n=9032)♀ | Male<br>Female | 45.8%<br>54.2% | 0.9 | (0.6, 1.1) | 0.26 |
| 4 | Dominican Republic(n=1710)♂ | Male<br>Female | 66%<br>34% | 1.9 | (1.4, 2.6) | *<0.0001 |
| 5 | Guatemala(n=2940)♂ | Male<br>Female | 72.4%<br>27.6% | □2.5 | (1.8, 3.4) | *<0.0001 |
| 6 | Jamaica(n=45)♂ | Male<br>Female | 57.8%<br>42.2% | 1.4 | (1, 1.8) | *0.02 |
| 7 | Mexico(n=72752)♂ | Male<br>Female | 64.3%<br>35.7% | 1.8 | (1.3, 2.4) | *<0.0001 |
| 8 | Panama(n=373)♂ | Male<br>Female | 68%<br>32% | □2.1 | (1.5, 2.9) | *<0.0001 |
| 9 | USA(n=138861)♂ | Male<br>Female | 54%<br>46% | 1.2 | (0.9, 1.6) | 0.26 |

[*p<0.05, statistically significant; □Relative Risk (RR)>2, statistically significant;♂=Higher incidence of male; ♀= Higher incidence of female; ∝=Equal incidence in male & female]

**Table 4: COVID-19 gender-based mortality data in Australia and South-American countries**

| | Countries | | Australia<br>Cases n (%) | RR | 95% CI | P- value |
|---|---|---|---|---|---|---|
| 1 | Australia(n=685)♀ | Male<br>Female | 48.9%<br>51.1% | 0.9 | (0.7, 1.3) | 0.78 |
| | | | **South America** | | | |
| | **Countries** | | **Cases n (%)** | **RR** | **95% CI** | **P- value** |
| 1 | Argentina(n=8597)♂ | Male<br>Female | 57%<br>43% | 1.3 | (1, 1.8) | *0.04 |
| 2 | Brazil(n=122753)♂ | Male<br>Female | 58.1%<br>41.9% | 1.4 | (1, 1.8) | *0.02 |
| 3 | Chile(n=294)♂ | Male<br>Female | 60%<br>40% | 1.5 | (1.1, 2) | *0.005 |
| 4 | Colombia(n=23478)♂ | Male<br>Female | 64.2%<br>35.8% | 1.8 | (1.3, 2.4) | *<0.0001 |
| 5 | Ecuador(n=10922)♂ | Male<br>Female | 66.5%<br>33.5% | □2.0 | (1.5, 2.8) | *<0.0001 |
| 6 | Peru(n=30710)♂ | Male<br>Female | 70.2%<br>29.8% | □2.3 | (1.7, 3.2) | *<0.0001 |

[*p<0.05, statistically significant; □Relative Risk (RR)>2, statistically significant;♂=Higher incidence of male; ♀= Higher incidence of female; ∝=Equal incidence in male & female]

**Table 5: COVID-19 gender-based mortality data in African countries**

| Countries | | | Cases n (%) | RR | 95% CI | P- value |
|---|---|---|---|---|---|---|
| 1 | Botswana(n=10)♀ | Male | 30% | 0.4 | (0.3, 0.6) | *<0.0001 |
| | | Female | 70% | | | |
| 2 | Burkina Faso(n=55)♂ | Male | 74.5% | □3 | (2.1, 4.3) | *<0.0001 |
| | | Female | 25.5% | | | |
| 3 | Cabo Verde(n=45)♂ | Male | 60% | 1.5 | (1.1, 2) | *0.005 |
| | | Female | 40% | | | |
| 4 | Eswatini(n=101)♂ | Male | 58.4% | 1.4 | (1, 1.8) | *0.02 |
| | | Female | 41.6% | | | |
| 5 | Kenya(n=285)♂ | Male | 75% | □3 | (2.1, 4.3) | *<0.0001 |
| | | Female | 25% | | | |
| 6 | Liberia(n=82)♂ | Male | 64.5% | 1.9 | (1.4, 2.5) | *<0.0001 |
| | | Female | 35.5% | | | |
| 7 | Malawi(n=177)♂ | Male | 77.4% | □3.3 | (2.3, 4.9) | *<0.0001 |
| | | Female | 22.6% | | | |
| 8 | Morocco(n=401)♂ | Male | 67% | □2.03 | (1.5, 2.8) | *<0.0001 |
| | | Female | 33% | | | |
| 9 | South Africa(n=2745)♂ | Male | 53% | 1.1 | (0.9, 1.5) | 0.39 |
| | | Female | 47% | | | |
| 10 | Tunisia(n=77)♂ | Male | 68.8% | □2.2 | (1.6, 3.1) | *<0.0001 |
| | | Female | 31.2% | | | |
| 11 | Uganda(n=26)♂ | Male | 65% | 1.9 | (1.4, 2.5) | *<0.0001 |
| | | Female | 35% | | | |

[*p<0.05, statistically significant; □Relative Risk (RR)>2, statistically significant;♂=Higher incidence of male; ♀= Higher incidence of female; ∝=Equal incidence in male & female]

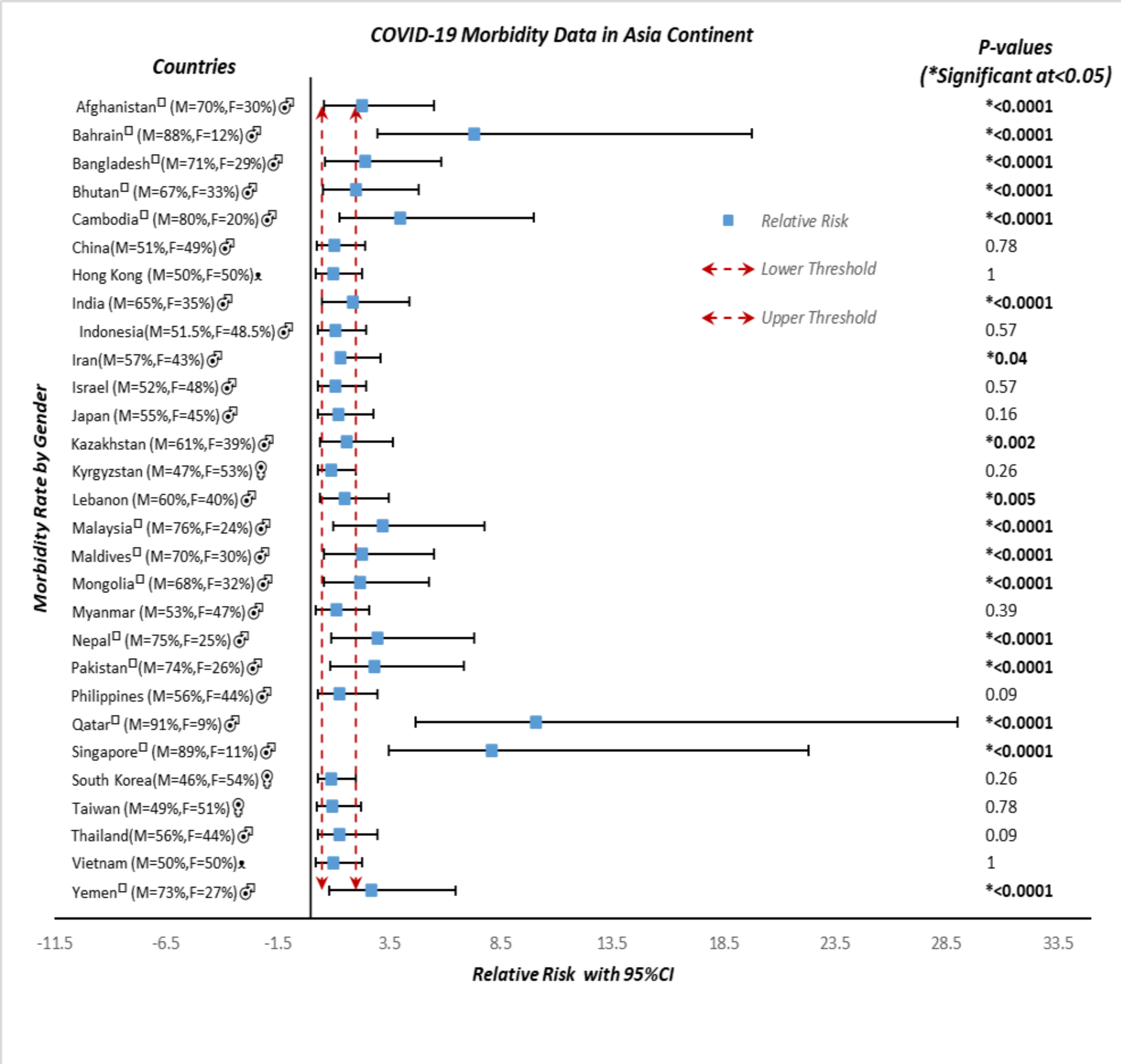
rates were higher above 80 years of age from COVID-19 infection in the North American country(Mexico) and the variables were found to be a weakly positively correlated [$r$ (degree of freedom) = (the R statistic, $p$ = $p$-value): $r(.08) = .24$, $p < .51$]. However, the results were not significant at $p < .05$ in both of these American countries.

Figure 7 depicts the correlation between age-specific morbidity & mortality rate per 100000 population from COVID-19 in Australia and three European countries (England, Italy and Spain). Surprisingly, most of the infected cases were above 20 years of age; whereas, the mortality rate was found to be higher above 80 years in Australia. The variables age-specific morbidity & mortality rate per 100000 population were found to be weakly positively correlated [$r$ (degree of freedom) = (the R statistic, $p$ = $p$-value): $r$ (.07) =.02, $p$ <.968] in Australia and was not statistically significant at $p < .05$. Population above 80 years of age were most susceptible for morbidity from COVID-19 infection ;whereas, mortality rate was found to be higher above 90 years in three European countries (England, Italy and Spain); Moreover, the variables (Morbidity and mortality) were strongly positively correlated with statistically significant findings {[$r$ (degree of freedom) = (the R statistic, $p$ = $p$-value): [$r$ (.07) =.98, $p$ < .00001]; [$r$ (.08) =.98, $p$ < .00001] and $r$ (.08) =.98, $p$ < .00001]}.

## DISCUSSION

Gender and age-specific pattern of infection is key for understanding and explaining differences in COVID-19 transmission and fatality across different countries worldwide (Dowd *et al.*, 2020). The present study reconstructed COVID-19 mortality and morbidity rates by gender and age from officially reported data across several countries from Asia, Europe, Australia, Africa and America.

At first, the present study revealed the susceptibility to COVID-19 in explaining the gender-specific distribution of morbidity by COVID-19 across several countries worldwide. In most of the analyzed countries in Asia, America and Africa, men diagnosed with COVID-19 substantially outnumber infected women with statistically significant findings (*p=<0.05, † *RR>2*). Women accounted for 60% of cases across 40 European countries, out




*[*p<0.05, statistically significant; □Relative Risk (RR)>2, statistically significant;* ♂=Higher incidence of male; ♀= Higher incidence of female; ᵅ =Equal incidence in male & female]

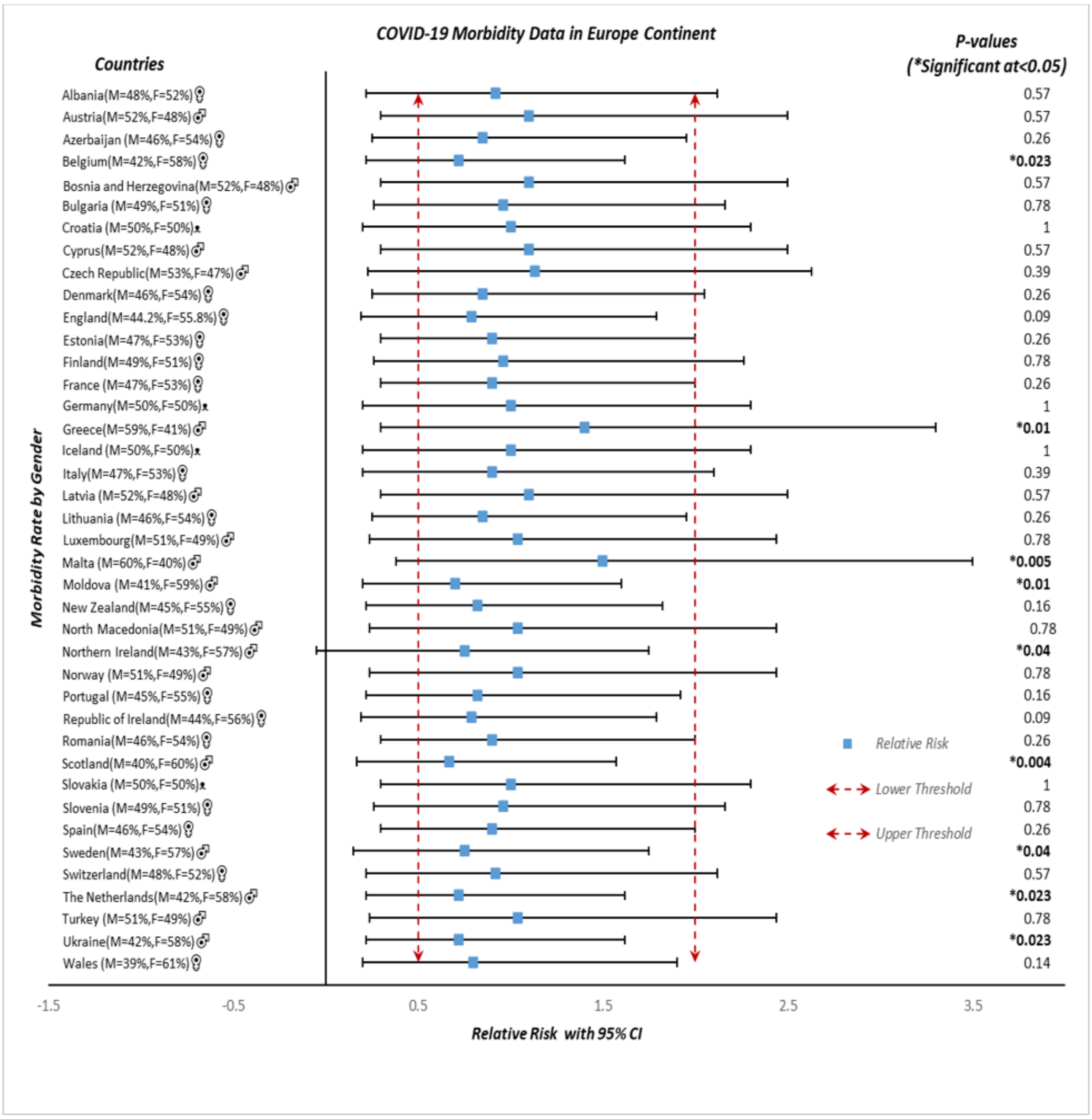
**Figure 1: COVID-19 gender-based morbidity data in Asia**

of which 17.5% showed statistically significant and 51% cases with statistically non-significant findings in Australia with data on sex-specific infections.

Then this study analyzed the susceptibility to COVID-19 in explaining the gender-specific distribution of mortality by COVID-19 across several countries from Asia, Europe, Australia, Africa, and America. Surprisingly, except in Australia, men diagnosed most fatality rate, accounted for 94.7% Asian countries, 79.4% European countries, 88.9% North American countries and 90.9% African Countries accordingly. However, 42.1% of Asian countries, 22.2% North American countries, all the South American countries and 5.5% African countries showed men susceptibility to death from COVID-19 infection.

Finally, the present study correlated age-specific COVID-19 morbidity & mortality data from some Asian, European, Australian, and American countries. In this study, higher rates of mortality and morbidity were observed above 50 years of age in the analyzed countries of Asia, Europe and America and those countries showed steeply rising infection rate with age. Moreover, the variables (Morbidity and Mortality) were lowest among children and adolescents aged 0-19. However, the variables were strongly positively correlated ($p$=<.05) only in one Asian country (Philippines) and all the analyzed European countries (England, Italy and Spain). Australia showed an irregular profile, which



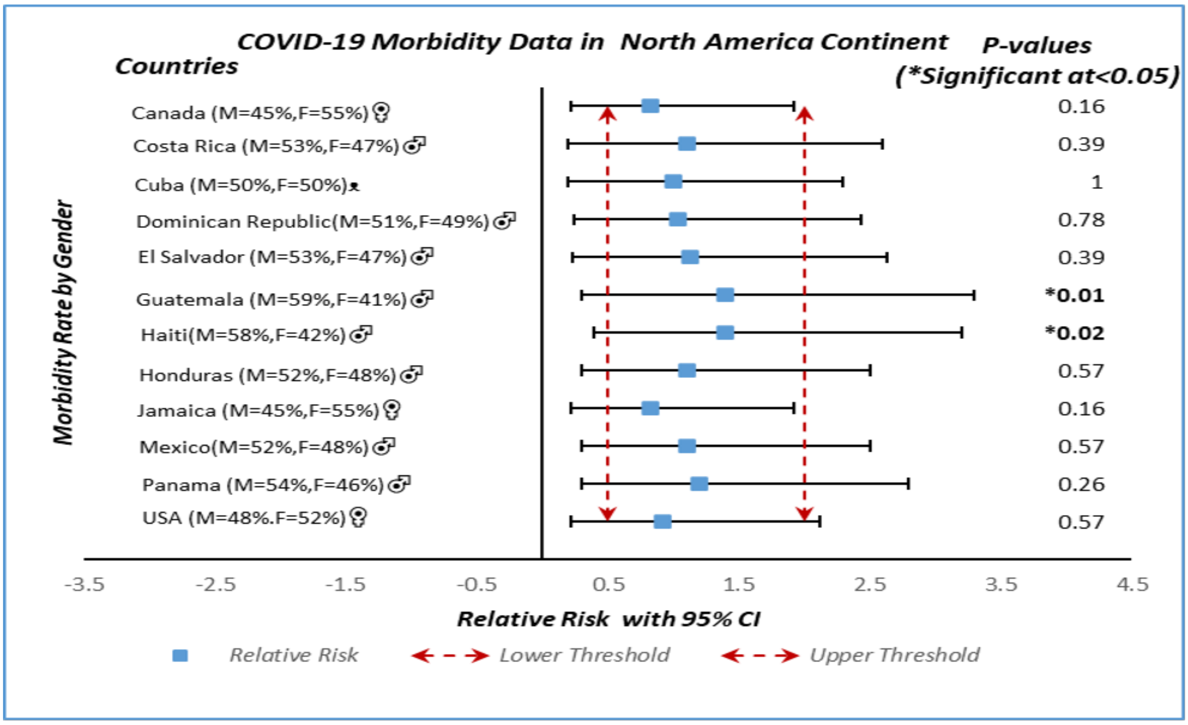

*[*p<0.05, statistically significant; ᵅRelative Risk (RR)>2, statistically significant; ♂=Higher incidence of male; ♀= Higher incidence of female; ᵅ =Equal incidence in male & female]*

**Figure 2: COVID-19 gender-based morbidity data in Europe**

showed higher mortality rates above 20 years of age, whereas fatality rate was found to be higher above 80 years of age. However, the variables age-specific morbidity & mortality rate per 100000 population were found to be weakly positively correlated in Australia.

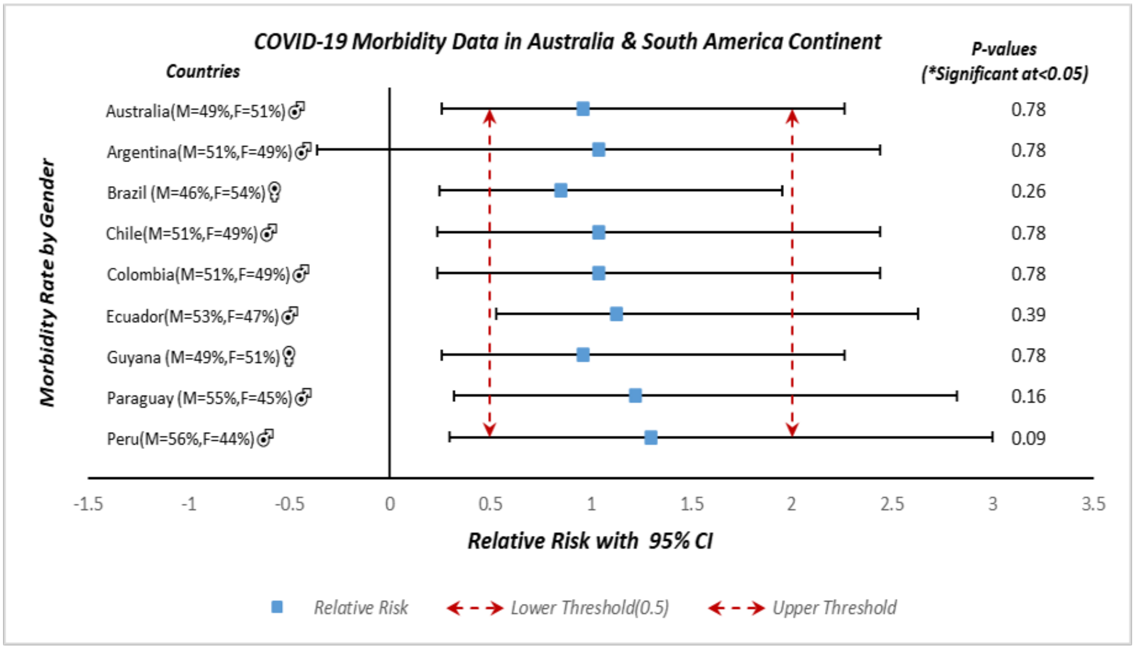
This study revealed the significant correlation between the older age and the study variables (morbidity/mortality from COVID-19) in most of the countries worldwide, although Australia showed higher morbidity among the younger age group. Supporting this evidence, some studies showed older men were more susceptible to severe symptoms from any infectious disease (ICNARC, 2020).

In this study male population were more susceptible to morbidity and mortality from COVID-19 in most of the Asian, American and African countries; whereas, Australia showed opposite findings, where the variables were higher in the female population and European countries showed higher morbidity among female but fatality were found more among the male population. Similar findings were showed in some studies which revealed men are more likely




*[*p<0.05, statistically significant; □Relative Risk (RR)>2, statistically significant;* ♂=Higher incidence of male; ♀= Higher incidence of female; α =Equal incidence in male & female]

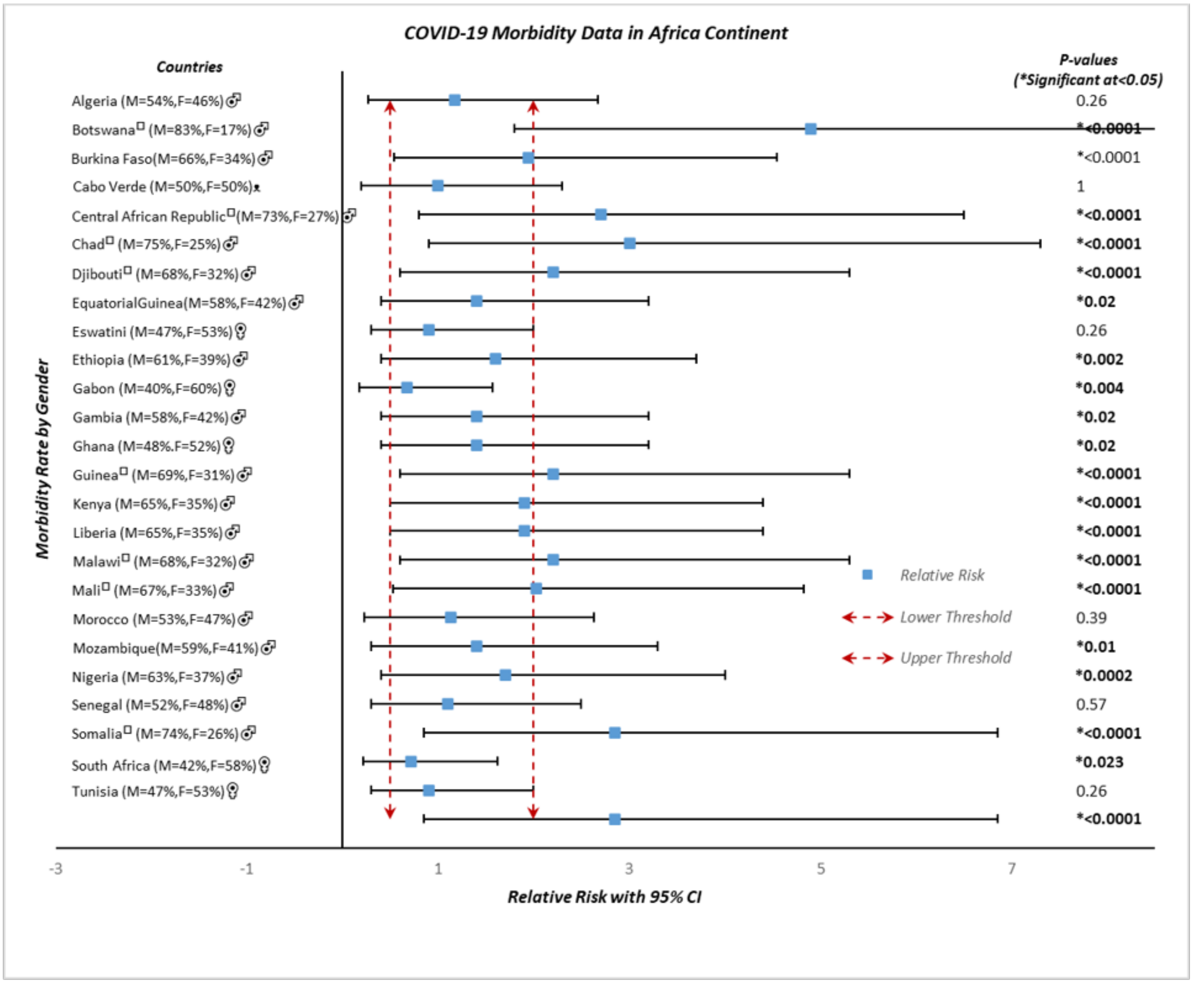
**Figure 3: COVID-19 gender-based morbidity data in North America**




*[*p<0.05, statistically significant; □Relative Risk (RR)>2, statistically significant;* ♂=Higher incidence of male; ♀= Higher incidence of female; α =Equal incidence in male & female]

**Figure 4: COVID-19 gender-based morbidity data in Australia and South America**



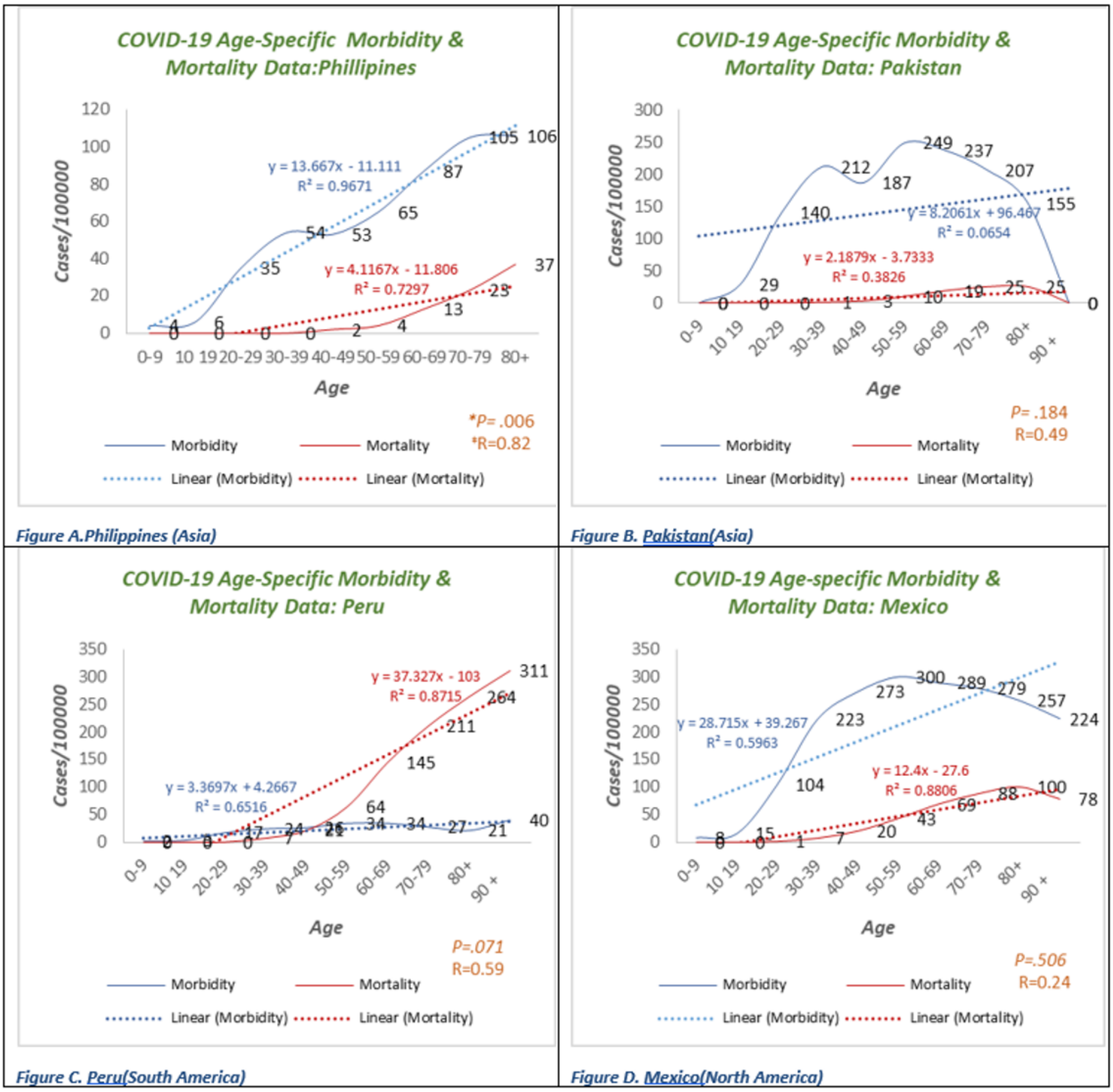

*[*p<0.05, statistically significant; □Relative Risk (RR)>2, statistically significant; ♂=Higher incidence of male; ♀= Higher incidence of female; α =Equal incidence in male & female]*

**Figure 5: COVID-19 gender-based morbidity data in Africa**

to die from or with COVID-19 than women (Jordan *et al.*, 2020; Zhou *et al.*, 2020). Women's higher life expectancy could have been playing a major role for their lower fatality (Sobotka *et al.*, 2020). This study found that both male and female are almost equally susceptible to morbidity and fatality from COVID-19 across several countries worldwide. Working environment or occupational status has a major role in exposure and spreading of any infectious disease (Sobotka *et al.*, 2020). Elderly people are considered vulnerable, especially when they are associated with co-morbidities.

Although the analyzed countries of this study include both the low- and high-income countries from different continents, the study revealed almost the same pattern of age and gender-specific mortality and morbidity irrespective of different geographical locations and climate. So, it proves that not the coronavirus alone itself is a factor for the morbidity or fatality, but also the virus and its surrounding environment is playing a key role behind this. The factors that make the people more vulnerable include comorbidities, socioeconomic status, education, living and housing arrangements and pre-existing conditions ( UNDP, 2020). Besides, regional traditions and habits are also playing a crucial role in shaping these age and gender differences regarding mortality and morbidity from COVID-19 infections; however, we can't ignore poverty and crowded environment to be the key issues (Davies *et al.*, 2020; Mogi and Spijker, 2020). Therefore, an aware family member, good social networks and support from the neighbourhood can make an impossible to possible to fight any emergency devastating situation like COVID-19.

This study also revealed the lower morbidity and mortality rates from COVID-19 among the children and adolescents aged 0-19. Early evidence also sup-




*[*p<0.05, statistically significant; ‡Correlation is significant at 0.05 level; R= Pearson Correlation Coefficient]*

**Figure 6: Correlation between age-specific morbidity and mortality rate from COVID-19 in Asian and American countries**

ports this findings, which showed that children and adolescent are far less likely to be infected by COVID-19 than adults; however, they are asymptomatic, or they may show flu or gastrointestinal like symptoms even when they are affected (Gudbjartsson *et al.*, 2020). The likely reasons for children and adolescents faring better than adults is that because of possessing less Angiotensin-converting enzyme II (ACE-2) receptors in their lower airways (lungs), thereby making their immune systems better able to control the virus by inhibiting the virus to invade a cell, start causing further complications and eliminating it (Fernandes, 2020; Pappas, 2020). Furthermore, one study in China showed that because of having fewer chronic cardiovascular and respiratory comorbidities, children are more likely to be resistant to severe coronavirus infection than adults (Dong *et al.*, 2020). Nevertheless, children should not be ignored when it comes to coping with the economic and social effects of COVID-19. Their health

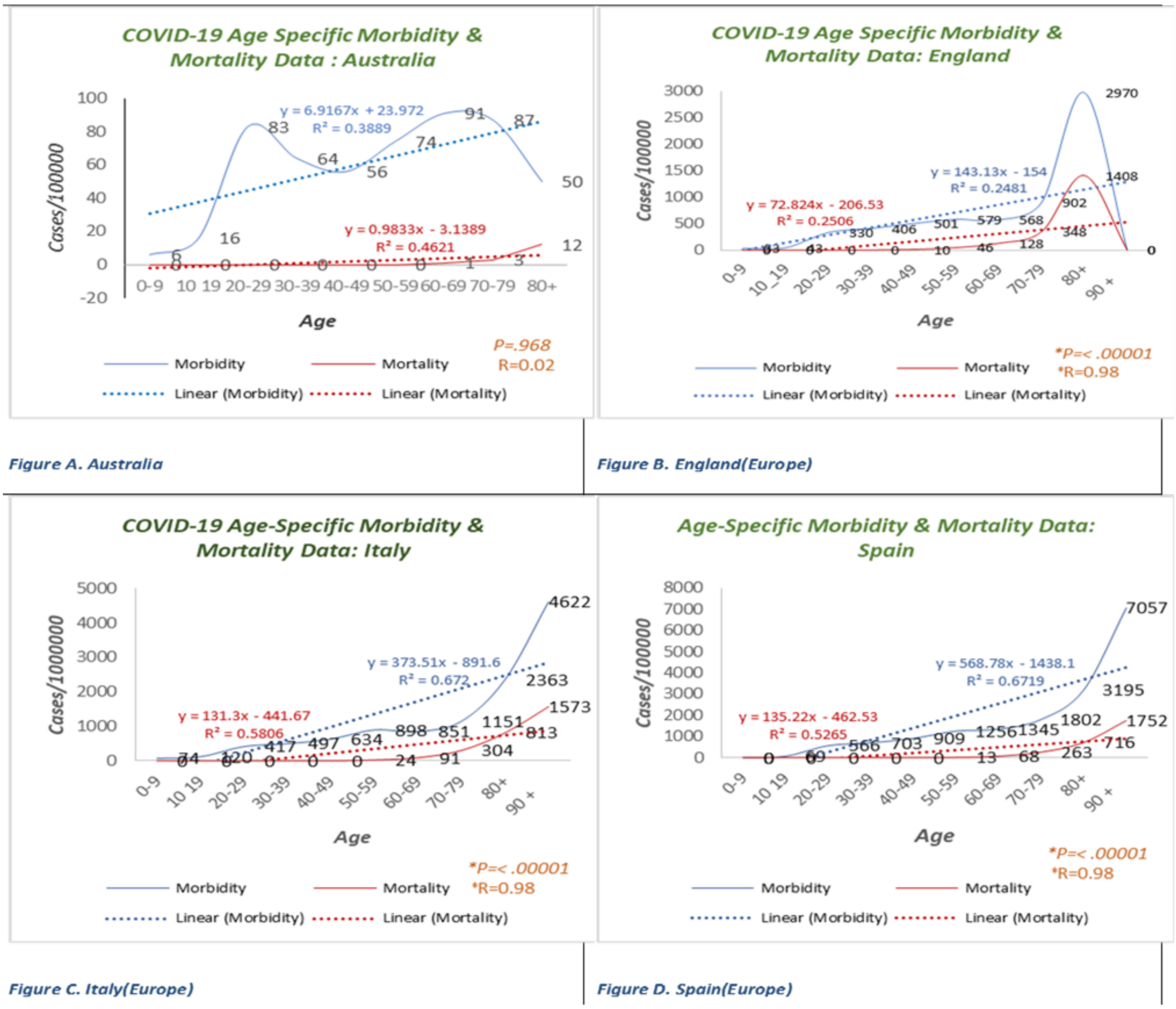



*Figure A. Australia* *Figure B. England(Europe)*

*Figure C. Italy(Europe)* *Figure D. Spain(Europe)*

*[*p<0.05, statistically significant; ‡Correlation is significant at 0.05 level; R= Pearson Correlation Coefficient.]*

**Figure 7: Correlation between age-specific morbidity and mortality rate from COVID-19 in Australia and European countries**

and wellbeing are badly affected by this pandemic COVID-19 infection in several ways, such as child maltreatment which is directly related with child psychological development (OECD, 2019; Thompson, 2014).

The factors that are putting them in more vulnerable situations include overcrowded housing and poor nutrition, which made social distancing and proper self-isolation nearly unmanageable (Almond *et al.*, 2018; Hoynes *et al.*, 2016).

Further research is needed to clarify to what extent the identified gender and age-specific morbidity and mortality from COVID-19 infections reflect the underlying demographic trends worldwide.

## CONCLUSION

Identifying the exact demographic trends of COVID-19 growth worldwide will require a more detailed analysis and understanding of the virus. It is likely to be biological factors, behavioural factors, or a combination of both. Coronavirus pointed out some challenges which seem to be very alarming. Despite possessing awareness, maintaining social distancing and personal hygiene in all middle and low-income countries as well as in many developed countries is still a big issue, where overcrowded residential areas, housing condition and occupational environment are role players for the disease transmission. Despite having higher technologies and quality of the health care system, are the 21$^{st}$-century people prepared enough to battle against a new strain of coronavirus? Besides creating public awareness, more upgraded genetic research is required to explore the real gaps and to strengthen the community for battling any pandemic like COVID-19 without facing millions of deaths in future.

**Conflict of Interest**

The authors declare that they have no conflict of interest for this study.

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