ARTICLE

Analysis of the variation of age-specific life expectancies between sexes due to the COVID-19 pandemic in the National Capital Region, Philippines

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ABSTRACT

The COVID-19 pandemic was among the most catastrophic crises in the 21st century worldwide. The pandemic resulted in numerous deaths worldwide and posed an overwhelming public health problem. The Philippines was not spared from the effects of the virus. By 2023, the WHO declared the COVID-19 pandemic was no longer a global healthcare emergency. The country had at least 4,102,788 total cases and 66,453 total deaths. Given the rapid spread of SARS-CoV-2 in the most urbanized cities in the country, this study investigated the influence of COVID-19 mortality on the age-specific life expectancy between biological sexes in the National Capital Region (NCR). Using DOH's COVID-19 Tracker Data Drop, 13,814 records of deaths in NCR from January 2020 to April 2023 were obtained. Through descriptive analysis, the demographic patterns of the recorded deaths showed that 13.6% of deaths in NCR belong to the 70-74 age group, and 57.5% of deaths were males. Life table analysis revealed that COVID-19 deaths led to a drop in life expectancy to 62.6 years from the country's life expectancy of 70.4 in 2019. Females had higher life expectancies (64.2 years) than males (61.5 years).

INTRODUCTION

The COVID-19 pandemic was caused by the SARS-CoV-2 novel coronavirus. With its global emergence, it caused great health challenges. The pandemic's rapid spread led to widespread lockdown measures and restrictions, but it nevertheless caused extensive mortalities worldwide. The Philippines was one of the countries heavily affected by the COVID-19 pandemic. An overwhelming portion of the population was infected and died (Agrupis et al. 2021). As the disease had spread worldwide, and in the Philippines, there was a pattern that showed certain groups experienced a disproportionate burden from COVID-19 morbidity and mortality. There was a positive correlation between the active number of COVID-19 cases and the number of mortalities in the Philippines (Tadle 2020).

The COVID-19 outbreak reached all regions in the country, wherein the top five regions with the most mortality cases included NCR with 20.82% of the total COVID-19 mortalities in the Philippines, followed by Region III (13.2% of the total deaths), Region IV-A (10.12%), Region VII (10.06%), and Region VI (8.60%). Together, these five regions accounted for up to 62.77% of the total COVID-19 mortalities in the country. Correspondingly, of the 5 regions also had the highest number of deaths for each of the sexes in the same sequence.

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KEYWORDS

COVID-19, life expectancy, mortality, life tables, Population ecology, public health

According to the Philippine Statistics Authority, COVID-19 was consistently in the top 20 list of leading causes of death in the Philippines for three years. In 2020, COVID-19 was the fourteenth leading cause of death in the Philippines, accounting for 1.5% of total registered deaths. In 2021, COVID-19's rank skyrocketed and became the 3rd leading cause of death in the country, which accounted for 13.8% of the total deaths in the Philippines. For 2022, COVID-19-caused deaths declined by 84.9% from the previous year and were ranked eleventh, accounting for 1.9% of total registered deaths in 2022. By 2023, COVID-19 no longer ranked on the list, which was also the same year the WHO declared that COVID-19 was no longer considered a global health emergency.

COVID-19 mortality demographic patterns disclosed correlative vulnerabilities among people of older age, males, and individuals with comorbidities (Ceballos 2021). Consistent with preliminary findings by (Salamat et al. 2021) in the Philippines, mortality was also observed to be higher in patients who are male and ≥ 60 years old. Historical records from preceding pandemics demonstrated how outbreaks of highly infectious diseases could lead to a decline in life expectancy, prompting effective disease regulation (Islam et al. 2021; Aburto et al. 2021).

Much of the existing COVID-19 research focused on the clinical, psychological, and even economic aspects of the COVID-19 pandemic in contrast with the significant knowledge gaps on the population-level consequences, particularly regarding life expectancy fluctuations. This study was intended to measure the life expectancy as affected by the mortalities caused by the COVID-19 pandemic in the Philippines. Specifically, the study aimed to analyze how the COVID-19 pandemic affected the age-specific life expectancy and investigate the impact of the COVID-19 pandemic on the sex-specific life expectancy of the population in NCR, Philippines.

The study provided critical ecological evidence on the impacts of the COVID-19 pandemic at the population level in the Philippines, primarily via the analysis of age-specific life expectancy. The results highlighted the importance of resilient healthcare systems and science-based policies to mitigate large-scale fatalities for future outbreaks. By measuring the case fatalities across the age groups, this research contributed to the knowledge of how the COVID-19 pandemic affected countries at the population level.

MATERIALS AND METHODS

Research Design

This study applied cohort life table analysis to assess the impact of the COVID-19 pandemic on population life expectancy within an ecological and population study-based framework.

Study Population and Setting

This study evaluated the COVID-19 pandemic's fatality patterns in the National Capital Region (NCR), Philippines, which is the country's smallest and most densely populated region. NCR was also reported as the pandemic epicenter of the Philippines due to having the highest number of COVID-19 cases and fatalities nationwide. This analysis included all confirmed deaths due to the COVID-19 pandemic in NCR, which was recorded by the Department of Health (DOH)'s data drop retrieved in April 2023 (Department of Health (DOH) 2023).

Data Extraction

Data was extracted from DOH's formerly publicly available COVID-19 Case Tracker [https://doh.gov.ph/covid19tracker] which used to be a regularly updated Data Drop database, covering the study period from February 2020 until April 2023. The data was comprehensively consolidated from DOH's Epidemiology Bureau's COVID-19 Information System containing detailed case information demographic characteristics (i.e., age, sex, and region of residence), significant dates (i.e., specimen collection, results confirmation and release, and recovery or death), and clinical result (i.e., recovery or death).

The dataset was cleaned and processed using Microsoft Excel. Case selection was filtered to include only confirmed COVID-19 fatalities within the 2020-2023 study period, as verified by the death date. Albeit the raw data contained all confirmed COVID-19 cases from January 2020 to April 2023, the dataset showed that the earliest confirmed case was indicated on February 3, 2020 and the latest was on April 16, 2023, while the date of deaths ranged from February 1, 2020 to March 30, 2023. Cases with missing age fields and the cases of deaths of those not residing in the NCR were excluded from the analysis.

Data Processing and Analysis

A graphical representation of the extracted data was used to highlight the plausible relationships between variables. The computation of cohort life table analysis was done to analyze the mortality patterns, considering age and sex differences in COVID-19-linked fatalities.

Histograms were made to visualize the age distribution of COVID-19 case fatality rates, showing the frequency patterns between sexes and among the age groups. This validated the identification of the age group with the peak mortality incidence and showed the variation of case fatality frequencies among consecutive age groups. Pivot Tables in Microsoft Excel were used for data organization, wherein the dataset was categorized into age groups of 5-year intervals and sex, from the youngest case fatality, 0 to 4, to the oldest case fatality, 105 to 109.

Cohort life tables were the used demographic tool as they gave clear mortality patterns across the affected population, presenting valuable insights into life expectancy declines. This study was designed to present three cohorts of life tables: (1) overall population, (2) female-specific demographics, and (3) male-specific demographics. This approach led to the comparative analysis of sex-specific life expectancy disparities and enabled the observation against the pre-pandemic life expectancy.

Life table analysis is a process wherein solving for certain formulae of key demographic measures is necessary, including the number of deaths, age-specific mortality rates, and age-specific life expectancy. Key parameters used to calculate these measures were the age interval of the age group, x, which was five for this study to be consistent with the age group classification found in the Data Drop, and the number of individuals in the age group, n_x, which was the number of COVID-19 case fatalities.

With the information on the number of individuals per age group, the survivorship, l_x, is the proportion of the initial number of cases in the cohort, n_0, that outlives the start of the age group (Formula 1). Solving for the l_x standardized all cohorts to the initial number at n_0, which enabled the comparison of the cohorts of different preliminary numbers of cases.

$$l_x = \frac{n_x}{n_0} \tag{1}$$

Age-specific mortality, d_x, is the number of individuals who die within the age interval (Formula 2).

$$d_x = n_x - n_{x+1} \quad (2)$$

CONCLUSION AND OUTLOOK

The age-specific mortality rate, q_x, is the number of individuals at the start of the age group proportional to the number of individuals who died in that age group (Formula 3).

$$q_x = \frac{d_x}{n_x} \quad (3)$$

Age-specific life expectancy, e_x, is computed in three steps: computing for the L_x, T_x, and finally, e_x. L_x is the average number of individuals in the age group. It assumes that the mortality within the age group is distributed evenly along its interval (Formula 4).

$$L_x = \frac{(n_x + n_{x+1})}{2} \quad (4)$$

Then, the total years lived into the future by individuals in the age group, T_x, is calculated by determining the total of Lx (Formula 5).

$$T_x = \sum_{x=1}^{\infty} (L_x) \quad (5)$$

The last variable in the life table is the life expectancy, ex, for each age group (Formula 6). It is the average years an individual of an age group is predicted to live.

$$e_x = \frac{T_x}{n_x} \quad (6)$$

Comparative visualization of the age-specific life expectancy with DOH's life expectancy projections was generated to simplify the analysis of the changes in life expectancy between the years. This method facilitated a direct comparison between the life expectancy during the pandemic and the established life expectancy trajectory of the Philippines.

Table 1: Philippines' projected life expectancy in 5-calendar-year intervals from DOH's Health Status Population [Source: https://doh.gov.ph/population (Retrieved: April 2023)] (Department of Health (DOH) 2023)

Projected Life Expectancy	2015-2020	2020-2025	2025-2030
Male	68.81	70.01	71.01
Female	74.34	75.54	76.54

To also discern how the COVID-19 pandemic had affected the trajectory of life expectancy, the data results were contrasted with the DOH's Health Status Population's life expectancy projection for five-year intervals. The overall life expectancy findings were also paralleled by a representation of the Philippines' Life Expectancy from Birth from 1870 to 2020.

RESULTS AND DISCUSSION

Results

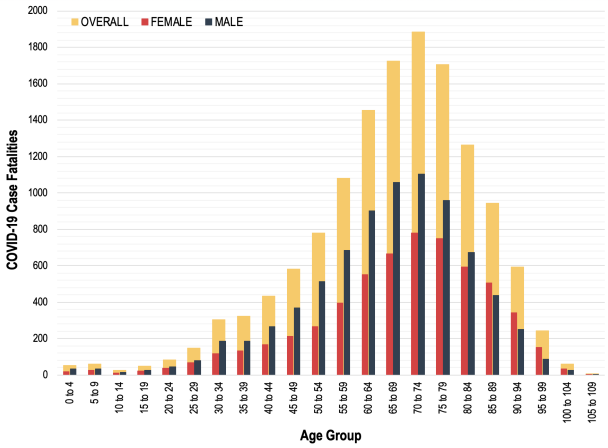

Figure 1: Histogram of the mortalities due to COVID-19 in the National Capital Region (NCR)

A total of 13,814 COVID-19 case fatalities were recorded in NCR. The age of reported fatalities ranged from 0 to 105 years old, with a mean of 63.0 and a median of 62.7 years. Older age groups (≥ 60 years old) represented 71.6% of all deaths, with the highest fatalities observed in the 70 to 74 age group (n=1,885;13.7%). In contrast, pediatric mortalities (≤18 years old) accounted for only 1.38% of total deaths.

Notably, case fatalities exhibited an acceleration among the younger age groups, with the deaths in the 15 to 19, 20 to 24, 25 to 29, and 30 to 34 age groups increasing by 1.8, 1.7, 1.8, and 2.03 times, respectively, compared to preceding age groups. This pattern indicated a disproportionately more rapid increase in COVID-19 mortality during early adulthood than in other life stages.

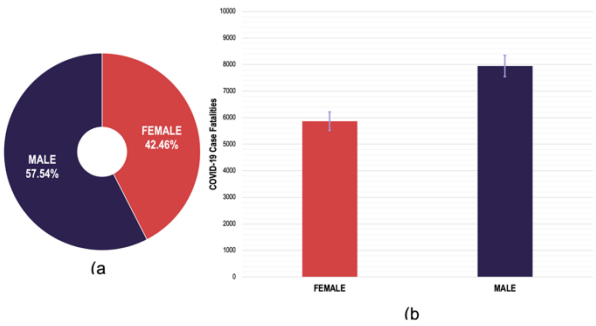

Figure 2: (a) The (pie graph) ratio of COVID-19 mortalities by sex. **(b)** Bar chart of COVID-19 mortality cases between sexes. Error bars represent the standard deviation.

COVID-19 case fatalities presented sex disparities, with males contributing to 7,948 deaths (57.5%) in contrast with 5,866 female deaths (42.5%). The overall male-to-female mortality ratio was 1.5:1, with the largest difference in the 5 to 9 age range (2:1 ratio). The sex disparity was consistent among all age groups, particularly in the middle-age groups (35 to 59 years; 1.6-1.8:1 ratio).

Both sexes exhibited peak mortality in the 70 to 74 age group (males: 1,104 deaths, 13.9% of total male deaths; females: 563 deaths, 13.3% of total female deaths). Albeit both sexes showed similar average mortality increases among the age groups (1.1x), the most significant increase in mortality happened in different life stages. For females, there was a 1.9-fold increase between the 10 to 14 and 15 to 19 age groups, as males showed a 2.3-fold

increase in mortality between the 25 to 29 and 30 to 34 age groups.

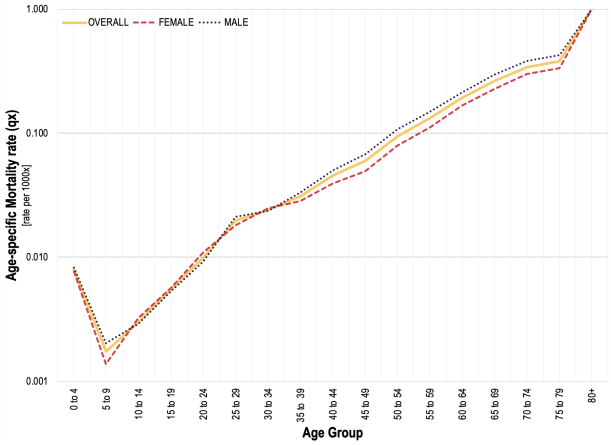

Figure 3: Log scale line chart of the age-specific mortality rate (qx) overall, in females and males.

Analysis of the age-specific mortality rate, qx, showed consistent sex disparities across age groups (reported per 1,000x). Males presented higher mortality rates than females in most age groups. Mortality rates initially grew from 0.31% overall (0.33% females, 0.29% males) in the 10 to 14 age group. Distinct peaks were observed in the 20 to 24 female age group (1.09%) and in the 25 to 29 age group for males (2.13%) and overall (2.00%).

Mortality rates significantly increased in the 50 to 54 age group (overall: 9.52%, female: 7.91%, male: 10.75%), with subsequent exponential increase until the 75 to 79 age group (overall: 38.00%, female: 33.69%, male: 42.67%). The most prominent difference in sex was found in the 75 to 79 age group, where the age-specific mortality rate for males exceeded that of females by 8.98%. Although females were observed to have marginally higher rates in the younger age groups, male mortality rates consistently exceeded female mortality rates in the older age groups, specifically in the senior life stages.

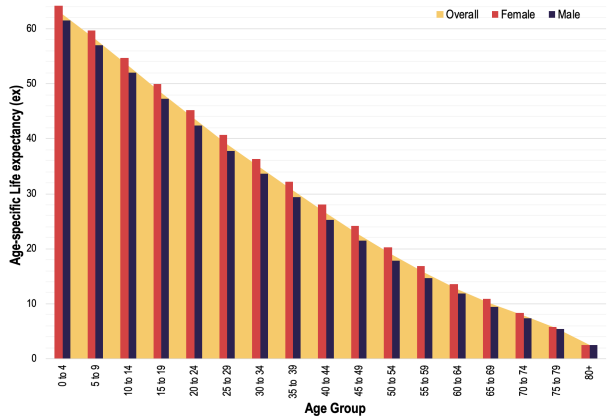

Figure 4: Chart showing the age-specific life expectancies overall and between males and females.

The overall life expectancy at birth in NCR was 62.6 years according to the COVID-19 case fatalities, with observed sex disparities. Females had higher life expectancies at 64.2 years compared to males at 61.5 years, showing an average difference of 2.1 years across age groups. The largest difference was found in the 35 to 39 age group (2.9 years difference), followed by the 0 to 4 age group (2.7 years difference).

Sex disparities in life expectancy were relatively consistent at 2.7 years from infancy until middle adulthood (0 to 54 years). However, this gap narrowed to an average of 1.1 years coming into older adulthood (55+ years). Albeit these differences, both sexes exhibited similar patterns across the age groups.

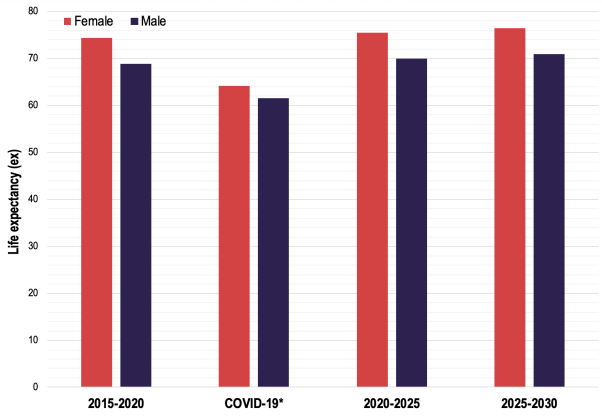

Figure 5: Bar chart showing the life expectancies from the study's results (COVID-19*) and the DOH's projected life expectancies.

Based on DOH's Health Status Population Projection (Table 1), the Philippines' life expectancy in 2020-2025 was projected to reach 70.01 for males and 75.54 for females. However, the analysis in this study showed a significant decline attributable to COVID-19 fatalities, with the assessed life expectancy dropping a mean of 9.9 years below the projections (8.51 years for males, 11.34 years for females). Notably, the overall life expectancy determined by the study of 62 years denoted reverting to the life expectancy recorded in the 1960s, as documented in Statista's Philippine demographic data from 1870 to 2020.

Discussion

The findings of the study revealed significant differences across age groups and between sexes in COVID-19 mortality in NCR. Elder populations (≥60 years) contributed to 71.6% of deaths, peaking at the 70 to 74 age group (13.7% of overall mortalities). This is consistent with (Bonaccio et al. 2023) meta-analysis that confirms age as a strong predictor of COVID-19 mortality globally. This also aligned with updated lower- and middle-income countries (LMIC) data describing retained age vulnerability even against the Omicron-variant dominance (Marthur et al. 2023). The age-specific mortality rate increase showed a 33.0% rate in the 75 to 79 age group, consistent with the Asian cohorts, where every ten years in age, there is a 2.4-fold increase in mortality risk (Wong et al. 2023).

Sex disproportion remained evident, with male mortalities surpassing female mortalities by 15.1%, emulating global meta-analyses proving male-to-female mortality ratios of 1.7:1 in LMICs (Peckham et al. 2022). Recent Philippine data also support this, where males have 1.9x higher risks of fatality (Santos 2024). Biological mechanisms between the two sexes also played a factor; X-chromosome-related immune deficiencies play an crucial role. (Takahashi et al. 2023) genomic analyses of Southeast Asian populations revealed that 5.1% of male COVID-19 severe cases have TLR7 variants, which damage type I interferon responses that are important for SARS-CoV-2 eradication. These point out that the disadvantages of males are linked to reduced immunity due to the X-linked chromosome. Relatively, vaccination reduced but did not eliminate the disparities. According to DOH's 2023 Annual Report, the male-to-female mortality ratio was sustained at 1.4:1. Based on OCTA's 2024 research, mortality at older age groups remained 4.2-fold higher than younger age groups despite priority vaccination efforts for the elderly (OCTA 2024).

The study showed a critical imbalance between sexes' age-specific mortality, with males in the 60 to 74 age groups having

the highest susceptibility to COVID-19 fatalities. Recent international studies also reflect this pattern, presenting males ≥70 years pose 2.3x higher mortality risk than females in the same age group (Bauer 2023). The case fatality ratio between males and females increases progressively with age, reaching the maximum at 2.1:1 in the 65 to 74 age group (Global Burden of Disease Collaborators 2024). This connects with (O'Driscoll et al. 2021) analysis, validating age as a predominant risk factor of COVID-19 mortality, exceeding other risk factors by 1.8-fold.

The mortality rates in the study increased exponentially from the middle age groups onwards, with a major surge at the 45 to 49 age group, a similar trend in LMICs where comorbidities amplify risks in middle-aged adult life stages (Mathur et al. 2023). By age group 60 to 74, males sustained 2.4-fold mortality rates higher than the 40 to 44 age group, consistent with (Wong et al. 2023) Asian demographic dataset presenting a 2.2-2.5x ten-year age risk plot. These mortality patterns can be supported by biological disparities between the sexes. Males of older age are more prone to a rapid decline of the immune system (Giefing-Kröll 2023) and larger amounts of ACE2 protein, which the coronavirus uses to infect cells (Samuel et al. 2023).

The decline to 62 years of life expectancy produced a 9.9-year difference from Philippine projections, last observed in the 1960s. This drop exceeded global approximates of 1.5-2.5 years lost for the years 2020 to 2022 (Schöley et al. 2022), highlighting the inflated effects of the COVID-19 pandemic to LMICs like the Philippines, wherein the healthcare system limitations amplify mortality risks (Al Jazeera et al. 2023).

CONCLUSION

This study noted the significant effects of COVID-19 mortalities on the age-specific life expectancies between sexes with three key outcomes: the older demographic (≥60 years) accounted for 71.6% of deaths with mortality rates 33.0% higher than the younger demographic, mortality risk rates were disproportionate towards males with a 1.5:1 male-to-female ratio that peaked at the 5 to 9 age group with 2:1, and the COVID-19 case fatalities revealed a life expectancy of 62.6 years, lower than what was projected and contradictory with the trajectory of the country's life expectancy.

The findings validated that the COVID-19 pandemic had affected the population further than an individual's drastic infection outcomes. The decline in life expectancy, specifically in the older male demographic, emphasizes how diseases accelerate existing health issues. The finding of increasing risks of mortality as age also increases provides support for prioritizing older adults in disease management programs, especially for respiratory diseases like COVID-19.

Opportunities for future research could also investigate the correlation of vaccination status, COVID-19 variants, and other socioeconomic factors with COVID-19 mortality patterns. Other longitudinal studies tracing recovery life expectancy can be important in understanding the COVID-19 pandemic's lasting effects on the population.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

CONTRIBUTIONS OF INDIVIDUAL AUTHORS

Tatoy and Licuanan conceived of the presented idea. Tatoy extracted the data, performed the analytic calculations, and interpreted the results. Tatoy wrote the manuscript with the consultation and support of Licuanan. Licuanan supervised the research.

REFERENCES

Aburto JM, Schöley J, Kashnitsky I, Zhang L, Rahal C, Missov TI, Mills MC, Dowd JB, Kashyap R. 2021. Quantifying impacts of the COVID-19 pandemic through life-expectancy losses: a population-level study of 29 countries. Int J Epidemiol. doi:10.1093/ije/dyab207. http://dx.doi.org/10.1093/ije/dyab207.

Agrupis KA, Smith C, Suzuki S, Villanueva AM, Ariyoshi K, Solante R, Telan EF, Estrada KA, Uichanco AC, Sagurit J, et al. 2021. Epidemiological and clinical characteristics of the first 500 confirmed COVID-19 inpatients in a tertiary infectious disease referral hospital in Manila, Philippines. Trop Med Health. 49(1):48. doi:10.1186/s41182-021-00340-0. http://dx.doi.org/10.1186/s41182-021-00340-0.

Al Jazeera H, Fung WT, Al Mossawi HJ, Banda J, Abdalla SM, Jiang Q. 2023. COVID-19 mortality and health system disruptions in low-income countries: a comparative analysis. BMJ Global Health. 8(4):e012393. doi:10.1136/bmjgh-2022-012393. https://doi.org/10.1136/bmjgh-2022-012393

Bauer P, Brugger J, König F. 2023. Sex-age mortality gradients in COVID-19: a global meta-regression. Scientific Reports. 13:12089. doi:10.1038/s41598-023-39253-9. https://doi.org/10.1038/s41598-023-39253-9

Bonaccio M, Costanzo S, Bracone F, Gialluisi A, Di Castelnuovo A, Ruggiero E, et al. 2023. Age-related mortality patterns across 27 countries during the COVID-19 pandemic: a descriptive analysis. JAMA Netw Open. 6(3):e231091. doi:10.1001/jamanetworkopen.2023.1091. https://doi.org/10.1001/jamanetworkopen.2023.1091

Ceballos R. 2021. Mortality analysis of early COVID-19 cases in the Philippines according to observed demographic and clinical characteristics. Recoletos Multidisciplinary Research Journal. 9(1):91–106. doi:10.32871/rmrj2109.01.09. https://rmrj.usjr.edu.ph/rmrj/index.php/RMRJ/article/view/1047.

Department of Health, Republic of the Philippines. 2023. Annual COVID-19 Surveillance Report: 2022-2023. Manila: DOH. [Government report; no DOI]

Department of Health (Philippines). 2023. Health Status Population Projection. Manila: DOH. [https://doh.gov.ph/population]

Giefing-Kröll C, Berger P, Lepperdinger G, Grubeck-Loebenstein B. 2023. The dichotomy of COVID-19 mortality in aging males: accelerated immunosenescence versus retained immune competence. Immunity & Ageing. 20(1):15.

doi:10.1186/s12979-023-00338-8. https://doi.org/10.1186/s12979-023-00338-8

Global Burden of Disease Collaborators. 2024. Age-sex COVID-19 mortality in 2023: a global analysis. Lancet. 403(10425):P102-118. doi:10.1016/S0140-6736(24)00005-0

Islam N, Jdanov DA, Shkolnikov VM, Khunti K, Kawachi I, White M, Lewington S, Lacey B. 2021. Effects of covid-19 pandemic on life expectancy and premature mortality in 2020: time series analysis in 37 countries. BMJ. 375:e066768. doi:10.1136/bmj-2021-066768. http://dx.doi.org/10.1136/bmj-2021-066768.

Mathur R, Rentsch CT, Morton CE, Hulme WJ, Schultze A, MacKenna B, et al. 2023. Regional and socioeconomic predictors of COVID-19 mortality in older adults across 9 LMICs: a cross-sectional analysis. Lancet Glob Health. 11(4):e518-e528. doi:10.1016/S2214-109X(23)00005-9. https://doi.org/10.1016/S2214-109X(23)00005-9

OCTA Research Group. 2024. COVID-19 Mortality and Vaccination Trends in Metro Manila: 2023 Year-End Report. Quezon City: OCTA Research. [URL: https://octaresearch.ph/wp-content/uploads/2024/01/2023-Year-End-Mortality-Report.pdf]

O'Driscoll M, Ribeiro Dos Santos G, Wang L, Cummings DAT, Azman AS, Paireau J, et al. 2021. Age-specific mortality and immunity patterns of SARS-CoV-2. Nature. 590(7844):140-145. doi:10.1038/s41586-020-2918-0. https://doi.org/10.1038/s41586-020-2918-0

Peckham H, Gruijter NM, Raine C, Radziszewska A, Ciurtin C, Wedderburn LR, et al. 2022. Male sex identified by global COVID-19 meta-analysis as a risk factor for death and ITU admission. Nat Commun. 13(1):463. doi:10.1038/s41467-022-28143-9. https://doi.org/10.1038/s41467-022-28143-9

Salamat MS, G. Malundo AF, Abad CL, Sandejas JC, Planta JE, Poblete J, Cañal JP, Santos J, Alejandria M. 2021. Characteristics and factors associated with mortality of 200 COVID-19 patients at a Philippine COVID-19 tertiary referral center. Acta Med Philipp. 55(2). doi:10.47895/amp.v55i2.2845. http://dx.doi.org/10.47895/amp.v55i2.2845.

Samuel RM, Majd H, Richter MN, Ghazizadeh Z, Zekavat SM, Navickas A, et al. 2023. Androgen signaling regulates SARS-CoV-2 receptor levels and is associated with severe COVID-19 in males. Nature Communications. 14(1):2681. doi:10.1038/s41467-023-38009-3. https://doi.org/10.1038/s41467-023-38009-3

Santos JV, Dela Cruz CS, Uy MA, Punzalan FE. 2024. Sex disparities in COVID-19 outcomes: a nationwide case-control study from the Philippines. Acta Med Philipp. 58(1):112-125. doi:10.47895/amp.vi0.5432. https://doi.org/10.47895/amp.vi0.5432

Schöley J, Aburto JM, Kashnitsky I, Kniffka MS, Zhang L, Jaadla H, et al. 2022. Life expectancy changes since COVID-19. Nature Human Behaviour. 6(12):1649-1659. doi:10.1038/s41562-022-01450-3. https://doi.org/10.1038/s41562-022-01450-3

Statista. 2023. Life expectancy at birth in the Philippines from 1870 to 2020 [Dataset].

Tadle JA, Regalado CM, De Jesus RJ, Van Buladaco M. 2020. Correlational analysis of COVID-19 number of daily new cases and number of daily deaths per day: A case in the Philippines. SSRN Electron J. doi:10.2139/ssrn.3624526. http://dx.doi.org/10.2139/ssrn.3624526.

Takahashi T, Ellingson MK, Lucas C, Klein J, Israelow B, Silva J, et al. 2023. X-chromosome-linked TLR7 polymorphisms underlie heightened COVID-19 mortality in Southeast Asian males. Cell Reports Medicine. 4(5):101034. doi:10.1016/j.xcrm.2023.101034. https://doi.org/10.1016/j.xcrm.2023.101034

Wong NS, Leung CC, Lee SS. 2023. Age-dependent progression of COVID-19 mortality in Asian populations: a systematic review and meta-analysis. Int J Infect Dis. 126:1-9. doi:10.1016/j.ijid.2022.10.034. https://doi.org/10.1016/j.ijid.2022.10.034