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# Age-Stratified Risk of Severe COVID-19 for People With Disabilities in Korea: Nationwide Study Considering Disability Type

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## ABSTRACT

**Background:** Understanding disparities in severe coronavirus disease 2019 (COVID-19) outcomes between people with disabilities (PwD) and people without disabilities (PwoD) is crucial, particularly when considering the heterogeneity within PwD and age differences. This study aimed to compare severe COVID-19 outcomes including deaths between PwD and PwoD with analyses stratified by age group and further examined by disability type.

**Methods:** This retrospective, population-based cohort study used linked data from national COVID-19 cases and health insurance for individuals aged ≥ 19 years with COVID-19 from January 2020 to October 2022 in the Republic of Korea. Severe outcomes included severe cases and deaths, with logistic regression analysis of the risk disparities between PwD and PwoD based on age group and disability types. The subgroup analysis considered epidemic periods, accounting for the severe acute respiratory syndrome coronavirus 2 variant circulation.

**Results:** The risk of severe COVID-19 outcomes and deaths among PwD varied by age and disability type. While severe outcomes were most prevalent in the older age groups for both PwD and PwoD, younger PwD faced a markedly higher risk—up to eightfold—compared to PwoD. The risk of disability status was greater than that of comorbidities in the 19–39 age group. Among disability types, individuals with internal organs-related and intellectual disabilities showed higher risk disparities with PwoD in severe outcomes than other types of disabilities. Throughout the pandemic, the disparity in death risk remained similar, with a slight increase in disparity during the omicron period for all severe outcomes in the age groups 19–39 and 40–64 years.

**Conclusion:** Prioritizing younger PwD, along with older age groups and people with comorbidities, is crucial in addressing public health crises. Risk-based prioritization is important to reduce overall risk. This includes prioritizing people with nternal organs-related and intellectural disabilities, who face higher health risks among PwD during a pandemic when resources are limited and time is of the essence.

**Keywords:** SARS-CoV-2; People With Disabilities; Severity; Fatality; Disability Types; Age Stratification

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## INTRODUCTION

People with disabilities (PwD) are more vulnerable to health risks than people without disabilities (PwoD).[1] During the coronavirus disease 2019 (COVID-19) pandemic, several countries including England, the Republic of Korea, and the United States consistently reported a higher risk of death among PwD, despite variations in the definition of disability.[2-4]

Regarding the diversity of health statuses and contributing factors, numerous studies have explored health disparities by disability type pre- and during pandemic.[5-7] A Korean study conducted before the pandemic found that the overall age-standardized mortality rate (SMR) was 2.7 times higher in PwD than in PwoD. For people with specific disabilities, including respiratory or hepatic impairment and intestinal or urinary fistulas, the SMR was 10-fold higher than that in PwoD.[8] Socioeconomic status also varied by disability type, with 24.7% people with intestinal or urinary fistulas and 61.1% people with epilepsy disorders accounting for the lowest income group in their respective cohorts. During the pandemic, a US study found that people with intellectual and developmental disabilities (IDDs) and mobility disabilities faced a higher risk of invasive mechanical ventilation and mortality.[9]

Disability types predominantly differ across age groups, leading to variation in health outcomes. Adjusting for age is crucial when comparing the health statuses of PwD and PwoD. Studies show that hearing impairment, with a lower SMR than other types of disability, is more prevalent in older adults, while intellectual disability, with a higher SMR, is more common in young and middle-aged adults.[8,10,11] During the COVID-19 pandemic, risk factors for severe outcomes differed by age, with older age being the most notable risk factor.[12] Given these differences, age stratified analyses are more appropriate than using age as an effect modifier, provided the sample size is large enough.[12] Some studies highlight higher risk disparities in younger age groups but often focus on specific disability types, primarily IDDs, or aggregate all types.[6,13,14] Comprehensible assessments that consider various disabilities and age concurrently are limited. Nationwide data from the Republic of Korea, including all confirmed COVID-19 cases, enable stratified analysis with a sufficient sample size. Linking these data with health insurance information, including sociodemographic and disability status, provides a detailed analysis of vulnerability to severe COVID-19 outcomes, focusing on disability types with age stratification.

Throughout the pandemic, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) continuously mutated, altering its virulence.[15] This study examined evolving risk disparities of severe COVID-19 outcomes, considering effects of the virus's virulence on PwD and PwoD according to disability status and type. All analyses were stratified by age group and epidemic period-related SARS-CoV-2 variants.

## METHODS

### Study design and participants

This retrospective population-based cohort study used nationwide data and included individuals aged ≥ 19 years with COVID-19 in the Republic of Korea from January 20, 2020, to October 29, 2022. According to the Infectious Disease Control and Prevention Act, the Korea Diseases Control and Prevention Agency (KDCA) received reports of all confirmed cases that

tested positive through polymerase chain reaction tests in the entire period or rapid antigen tests from March 14, 2022 onwards.[16]

The reported data were combined with the COVID-19 vaccination information from the National Immunization Registry of KDCA. The combined data were linked to the National Health Information Database (NHID) of the Korean National Health Insurance Service.[17] By linking KDCA and NHID data, this study excluded unmatched cases, as well as individuals without health insurance level or with errors in disability status (**Supplementary Fig. 1**).

## Variables

Study outcomes were two levels of severe COVID-19 outcomes: a wide range of severe outcomes, including severe and critical status and deaths ('all severe outcomes' hereafter), and a narrow range, including only deaths. Severe and critical cases were defined as those requiring high-flow oxygenation, non-invasive or invasive ventilation, extracorporeal membrane oxygenation, or continuous renal replacement treatment during isolation due to the COVID-19 according to the World Health Organization (WHO) and monitored by KDCA.[18,19] Death was defined as a reported COVID-19-related death based on clinician statements under the Infectious Disease Control and Prevention Act.[16]

Disability is defined as official registration with the government under the Act on Welfare of Persons with Disabilities.[20] The 15 main disability types were classified into four groups: physical disabilities with external bodily functions (physical disabilities, brain lesion disorders, visual and hearing impairment, language disabilities, facial disfigurement) and with internal organs (renal, cardiac, hepatic and respiratory impairment, intestinal/urinary fistula, epilepsy disorder), and mental disabilities with psychological development disorder (intellectual disabilities and autistic disorder) and with mental disease. In cases with multiple disability types, the most severe type was considered.

Potential explanatory factors that could be confounders and modifiers were included: demographic characteristics (age and sex), socioeconomic status with health insurance status, and comorbidities. To adjust for variation in the host immune status and virulence of SARS-CoV-2, we included COVID-19 vaccination, reinfection status, and epidemic periods related to SARS-CoV-2 variants in the model. Additionally, we conducted stratified analyses by epidemic periods to assess the differential impact of SARS-CoV-2 variants on severe outcomes between PwD and PwoD. Based on the time of COVID-19 confirmation, health insurance status was categorized into 11 groups, including medical aid and quintiles for self-employed and employee groups. The first quintile represented the lowest income. Comorbidities included diabetes, hypertension, kidney, pulmonary, cardiovascular, liver and neurological diseases, cancer, and others (such as mental and behavior disorders, malnutrition, and obesity). Vaccination was the last vaccination status 14 days before the COVID-19 confirmation. Reinfection was testing positive 45–90 days after the previous confirmation, with symptoms and exposure to confirmed cases or an overseas travel history or 90 days after the previous confirmation, regardless of symptoms. Epidemic periods were classified based on > 50% circulating variants of SARS-CoV-2 among tested samples by reported date: pre-delta (January 20, 2020, to July 24, 2021), delta (July 25, 2021, to January 15, 2022), and omicron (January 16, 2022, to October 29, 2022). Age-stratified models were analyzed, recognizing age as a strong effect modifier ($P < 0.001$).

### Statistical analysis

The analyses were stratified by three age groups: 19–39 ('young-age group'), 40–64 ('middle-age group'), and ≥ 65 years ('old-age group'). For the descriptive analysis, frequency, percentage, and mean age were used. To evaluate the risk of severe COVID-19 outcomes by age group and epidemic period, age- and sex-standardized case severity rate (aCSR) and case fatality rate (aCFR) were calculated. Using the number of confirmed cases as the denominator, aCSR was calculated with the number of severe cases, critical cases, and deaths as the numerator, and aCFR with the number of deaths as the numerator. Direct standardization was conducted using the total number of confirmed cases within the 5-year age group as the standard population.

To evaluate the risk of disability for severe outcomes of COVID-19, we conducted multiple logistic regression analyses with adjustment for explanatory factors, calculating adjusted odds ratios (aORs) for disability. The analysis examined the overall risk of disability and the specific risk for each disability type. Additionally, the disability risk for severe outcomes was calculated across different epidemic periods. All models were considered with the 95% confidence interval (CI). All statistical analyses were performed using the SAS Enterprise Guide 8.2 (8.2.0.1201; SAS Institute, Cary, NC, USA).

### Ethics statement

This study utilized secondary and deidentified individual data, exemption from Institutional Review Board (IRB) review and approval was received from the Korea Diseases Control and Prevention Agency IRB (IRB No. 2023-04-12). The research number of the study is NHIS-2024-1-033.

## RESULTS

### Baseline demographics

Of 25,504,288 confirmed cases of COVID-19, 19,035,753 individuals with COVID-19 aged ≥ 19 years were included after linkage with NHID (**Supplementary Fig. 1**). Overall, PwD accounted for 5.2% (992,485); the old-age group had the highest proportion of PwD at 15.9%, and the young-age group had the lowest proportion at 1.5% (**Table 1**). Compared to PwoD, more PwD were old (≥ 65 years; 54.1% for PwD, 15.7% for PwoD), of low socioeconomic status (Medical aid; 19.0% for PwD, 1.8% for PwoD), and had comorbidities, except liver disease in the old-age group. PwD in the young-age and middle-age groups had a higher booster vaccination rate than PwoD. Simultaneously, the proportion of PwD that were not vaccinated was also higher than that of PwoD in all age groups. Despite PwD was 5.2% of overall cases, PwD among severe/critical cases and deaths were 28.3% and 32.6%, respectively, and had the highest proportion, at 44.8%, of deaths, in the 19–39-year age group.

Among PwD of all ages, physical and hearing disabilities were the most common (**Supplementary Table 1**). However, the young-age group showed different patterns, in that intellectual disabilities were the most common at 46.6%, followed by physical disabilities at 17.3%.

### aCSR and aCFR

Over the entire period, the aCSR and aCFR were higher in PwD than in PwoD in all age groups (**Tables 2** and **3**). The aCSR was 2.1 and 6.4 per 1,000 in PwoD and PwD, respectively; 3.05 times higher than that in PwD. The aCFR was 1.2 and 3.3 per 1,000 in PwoD and PwD, respectively;


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**Table 1.** Characteristics of coronavirus disease 2019 confirmed cases among people with and without disability based on age group (N = 19,035,753)

| Characteristics | Total | Sub-total | | 19–39 yr | | 40–64 yr | | ≥ 65 yr | |
|---|---|---|---|---|---|---|---|---|---|
| | | Disabled | Non-disabled | Disabled | Non-disabled | Disabled | Non-disabled | Disabled | Non-disabled |
| Total | 19,035,753 (100.0) | 992,485 (100.0) | 18,043,268 (100.0) | 105,403 (100.0) | 7,080,971 (100.0) | 350,513 (100.0) | 8,132,919 (100.0) | 536,569 (100.0) | 2,829,378 (100.0) |
| Sex | | | | | | | | | |
| Male | 8,544,857 (44.9) | 540,987 (54.5) | 8,003,864 (44.4) | 66,558 (63.2) | 3,404,447 (48.1) | 219,386 (62.6) | 3,451,454 (42.4) | 255,043 (47.5) | 1,147,963 (40.6) |
| Female | 10,490,903 (55.1) | 451,498 (45.5) | 10,039,404 (55.6) | 38,845 (36.9) | 3,676,524 (51.9) | 131,127 (37.4) | 4,681,465 (57.6) | 281,526 (52.5) | 1,681,415 (59.4) |
| Age, yr | | | | | | | | | |
| Mean ± SD | 47.0 ± 17.5 | 64.0 ± 17.4 | 46.0 ± 17.0 | 29.5 ± 6.0 | 29.2 ± 5.9 | 54.6 ± 7.0 | 51.0 ± 7.2 | 77.0 ± 7.8 | 73.7 ± 7.4 |
| 19–29 | 3,742,319 (19.7) | 52,457 (5.3) | 3,689,862 (20.5) | 52,457 (49.8) | 3,689,862 (52.1) | - | - | - | - |
| 30–39 | 3,444,055 (18.1) | 52,946 (5.3) | 3,391,109 (18.8) | 52,946 (50.2) | 3,391,109 (47.9) | - | - | - | - |
| 40–49 | 3,777,735 (19.9) | 91,216 (9.2) | 3,686,519 (20.4) | - | - | 91,216 (26.0) | 3,686,519 (45.3) | - | - |
| 50–59 | 3,192,632 (16.8) | 145,942 (14.7) | 3,046,690 (16.9) | - | - | 145,942 (41.6) | 3,046,690 (37.5) | - | - |
| 60–69 | 2,683,981 (14.1) | 228,304 (23.0) | 2,455,677 (13.6) | - | - | 113,355 (32.3) | 1,399,710 (17.2) | 114,949 (21.4) | 1,055,967 (37.3) |
| 70–79 | 1,356,070 (7.1) | 214,707 (21.6) | 1,141,363 (6.3) | - | - | - | - | 214,707 (40.0) | 1,141,363 (40.3) |
| ≥ 80 | 838,961 (4.4) | 206,913 (20.9) | 632,048 (3.5) | - | - | - | - | 206,913 (38.6) | 632,048 (22.3) |
| Insurance level | | | | | | | | | |
| Medical aid | 518,573 (2.7) | 188,371 (19.0) | 330,202 (1.8) | 22,218 (21.1) | 65,347 (0.9) | 91,890 (26.2) | 115,890 (1.4) | 74,263 (13.8) | 148,965 (5.3) |
| Self-employed 1Q | 740,525 (3.9) | 63,759 (6.4) | 676,766 (3.8) | 5,044 (4.8) | 260,495 (3.7) | 17,069 (4.9) | 265,510 (3.3) | 41,646 (7.8) | 150,761 (5.3) |
| Self-employed 2Q | 785,899 (4.1) | 39,939 (4.0) | 745,960 (4.1) | 3,207 (3.0) | 305,687 (4.3) | 13,493 (3.9) | 319,701 (3.9) | 23,239 (4.3) | 120,572 (4.3) |
| Self-employed 3Q | 813,715 (4.3) | 39,927 (4.0) | 773,788 (4.3) | 3,059 (2.9) | 266,251 (3.8) | 13,952 (4.0) | 369,092 (4.5) | 22,916 (4.3) | 138,445 (4.9) |
| Self-employed 4Q | 822,826 (4.3) | 37,449 (3.8) | 785,377 (4.4) | 2,530 (2.4) | 226,267 (3.2) | 12,689 (3.6) | 388,375 (4.8) | 22,230 (4.1) | 170,735 (6.0) |
| Self-employed 5Q | 884,960 (4.7) | 49,053 (4.9) | 835,907 (4.6) | 1,930 (1.8) | 152,716 (2.2) | 13,508 (3.9) | 395,207 (4.9) | 33,615 (6.3) | 287,984 (10.2) |
| Employee 1Q | 2,628,052 (13.8) | 145,686 (14.7) | 2,482,366 (13.8) | 24,460 (23.2) | 862,018 (12.2) | 46,943 (13.4) | 1,175,235 (14.5) | 74,283 (13.8) | 445,113 (15.7) |
| Employee 2Q | 2,874,411 (15.1) | 119,315 (12.0) | 2,755,096 (15.3) | 14,399 (13.7) | 1,119,303 (15.8) | 43,562 (12.4) | 1,256,319 (15.5) | 61,354 (11.4) | 379,474 (13.4) |
| Employee 3Q | 3,000,522 (15.8) | 101,979 (10.3) | 2,898,543 (16.1) | 10,759 (10.2) | 1,374,925 (19.4) | 35,019 (10.0) | 1,191,955 (14.7) | 56,201 (10.5) | 331,663 (11.7) |
| Employee 4Q | 2,968,045 (15.6) | 105,565 (10.6) | 2,862,480 (15.9) | 9,746 (9.3) | 1,317,672 (18.6) | 31,436 (9.0) | 1,212,382 (14.9) | 64,383 (12.0) | 332,426 (11.8) |
| Employee 5Q | 2,998,225 (15.8) | 101,442 (10.2) | 2,896,783 (16.1) | 8,051 (7.6) | 1,130,290 (16.0) | 30,952 (8.8) | 1,443,253 (17.8) | 62,439 (11.6) | 323,240 (11.4) |
| Comorbidities | | | | | | | | | |
| Diabetes | 2,057,426 (10.8) | 279,417 (28.2) | 1,778,009 (9.9) | 5,274 (5.0) | 90,482 (1.3) | 78,062 (22.3) | 847,569 (10.4) | 196,081 (36.5) | 839,958 (29.7) |
| Hypertension | 4,054,768 (21.3) | 493,097 (49.7) | 3,561,671 (19.7) | 7,310 (6.9) | 159,715 (2.3) | 124,825 (35.6) | 1,726,614 (21.2) | 360,962 (67.3) | 1,675,342 (59.2) |
| Kidney disease | 568,311 (3.0) | 112,525 (11.3) | 455,786 (2.5) | 4,411 (4.2) | 78,339 (1.1) | 34,875 (10.0) | 191,427 (2.4) | 73,239 (13.7) | 186,020 (6.6) |
| Pulmonary disease | 771,610 (4.1) | 135,579 (13.7) | 636,031 (3.5) | 5,889 (5.6) | 167,458 (2.4) | 30,963 (8.8) | 212,258 (2.6) | 98,727 (18.4) | 256,315 (9.1) |
| Cardiovascular disease | 2,719,626 (14.3) | 411,258 (41.4) | 2,308,368 (12.8) | 6,905 (6.6) | 138,450 (2.0) | 93,061 (26.6) | 953,870 (11.7) | 311,292 (58.0) | 1,216,048 (43.0) |
| Liver disease | 2,014,978 (10.6) | 152,499 (15.4) | 1,862,479 (10.3) | 9,814 (9.3) | 344,199 (4.9) | 62,370 (17.8) | 1,059,295 (13.0) | 80,315 (15.0) | 458,985 (16.2) |
| Neurologic disease | 3,142,390 (16.5) | 443,165 (44.7) | 2,699,225 (15.0) | 28,967 (27.5) | 366,960 (5.2) | 125,989 (35.9) | 1,215,496 (15.0) | 288,209 (53.7) | 1,116,769 (39.5) |
| Cancer | 784,316 (4.1) | 80,075 (8.1) | 704,241 (3.9) | 1,837 (1.7) | 66,375 (0.9) | 20,585 (5.9) | 366,736 (4.5) | 57,653 (10.7) | 271,130 (9.6) |
| Others | 3,414,332 (17.9) | 467,492 (47.1) | 2,946,840 (16.3) | 40,380 (38.3) | 740,671 (10.5) | 135,324 (38.6) | 1,199,115 (14.7) | 291,788 (54.4) | 1,007,054 (35.6) |

(continued to the next page)

**Table 1.** (Continued) Characteristics of coronavirus disease 2019 confirmed cases among people with and without disability based on age group (N = 19,035,753)

| Characteristics | Total | Sub-total | | 19–39 yr | | 40–64 yr | | ≥ 65 yr | |
|---|---|---|---|---|---|---|---|---|---|
| | | Disabled | Non-disabled | Disabled | Non-disabled | Disabled | Non-disabled | Disabled | Non-disabled |
| Vaccination | | | | | | | | | |
| Unvaccinated | 1,124,760 (5.9) | 76,132 (7.7) | 1,048,628 (5.8) | 8,301 (7.9) | 497,582 (7.0) | 24,319 (6.9) | 406,603 (5.0) | 43,512 (8.1) | 144,443 (5.1) |
| Incomplete | 265,675 (1.4) | 11,763 (1.2) | 253,912 (1.4) | 1,243 (1.2) | 128,754 (1.8) | 4,495 (1.3) | 101,108 (1.2) | 6,025 (1.1) | 24,050 (0.9) |
| Complete | 5,519,212 (29.0) | 116,823 (11.8) | 5,402,389 (29.9) | 22,837 (21.7) | 3,151,398 (44.5) | 52,471 (15.0) | 2,046,728 (25.2) | 41,515 (7.7) | 204,263 (7.2) |
| Booster | 12,126,106 (63.7) | 787,767 (79.4) | 11,338,339 (62.8) | 73,022 (69.3) | 3,303,237 (46.7) | 269,228 (76.8) | 5,578,480 (68.6) | 445,517 (83.0) | 2,456,622 (86.8) |
| Period | | | | | | | | | |
| Pre-delta | 154,445 (0.8) | 8,833 (0.9) | 145,612 (0.8) | 881 (0.8) | 52,257 (0.7) | 3,582 (1.0) | 70,587 (0.9) | 4,370 (0.8) | 22,768 (0.8) |
| Delta | 368,726 (1.9) | 21,732 (2.2) | 346,994 (1.9) | 1,760 (1.7) | 127,020 (1.8) | 8,100 (2.3) | 157,447 (1.9) | 11,872 (2.2) | 62,527 (2.2) |
| Omicron | 18,512,582 (97.3) | 961,920 (96.9) | 17,550,662 (97.3) | 102,762 (97.5) | 6,901,694 (97.5) | 338,831 (96.7) | 7,904,885 (97.2) | 520,327 (97.0) | 2,744,083 (97.0) |
| Reinfection | | | | | | | | | |
| Yes | 328,150 (1.7) | 21,980 (2.2) | 306,170 (1.7) | 2,368 (2.3) | 144,037 (2.0) | 7,221 (2.1) | 116,898 (1.4) | 12,391 (2.3) | 45,235 (1.6) |
| Severe outcomes | | | | | | | | | |
| Severe and critical | 26,687 (0.1) | 7,553 (0.8) | 19,134 (0.1) | 187 (0.2) | 767 (0.0)* | 1,556 (0.4) | 5,026 (0.1) | 5,810 (1.1) | 13,341 (0.5) |
| Death | 27,269 (0.1) | 8,885 (0.9) | 18,384 (0.1) | 82 (0.1) | 101 (0.0)** | 937 (0.3) | 1,645 (0.0)* | 7,866 (1.5) | 16,638 (0.6) |
| Disability type (main) | | | | | | | | | |
| Physical: External bodily functions | 780,540 (4.1) | 780,540 (78.7) | - | 39,605 (37.6) | - | 253,426 (72.3) | - | 487,509 (90.9) | - |
| Physical: Internal organs | 65,438(0.3) | 65,438(6.6) | - | 4,255(4.0) | - | 30,521(8.7) | - | 30,662(5.7) | - |
| Mental: Psychological development disorder | 97,591(0.5) | 97,591(9.8) | - | 57,344 (54.4) | - | 33,782(9.6) | - | 6,465(1.2) | - |
| Mental: Mental disease | 48,916 (0.3) | 48,916 (4.9) | - | 4,199 (4.0) | - | 32,784 (9.4) | - | 11,933 (2.2) | - |

Values are presented as number (%).
SD = standard deviation, Q = quintile (1Q: lowest)
*$P$ < 0.1, **$P$ < 0.01.

**Table 2.** Age and sex adjusted case severity rate of coronavirus disease 2019 confirmed cases among people with and without disability by age group

| Epidemic period | Age group, yr | Non-disabled | | | | Disabled | | | | Risk difference | Risk ratio (95% CI) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total | Severe/critical + deaths | CSR, per 1,000 | aCSR, per 1,000 | Total | Severe/critical + deaths | CSR, per 1,000 | aCSR, per 1,000 | | |
| Total | Total | 18,043,268 | 32,424 | 1.8 | 2.1 | 992,485 | 14,135 | 14.2 | 6.4 | 4.3 | 3.05 (2.96–3.14) |
| | 19–39 | 7,080,971 | 834 | 0.1 | 0.1 | 105,403 | 247 | 2.3 | 2.0 | 1.9 | 19.74 (17.04–22.87) |
| | 40–64 | 8,132,919 | 6,041 | 0.7 | 0.8 | 350,513 | 2,198 | 6.3 | 5.2 | 4.4 | 6.82 (6.45–7.21) |
| | ≥ 65 | 2,829,378 | 25,549 | 9.0 | 9.7 | 536,569 | 11,690 | 21.8 | 18.2 | 8.4 | 1.87 (1.83–1.91) |
| Pre-delta | Total | 145,612 | 4,214 | 28.9 | 31.3 | 8,833 | 1,067 | 120.8 | 56.6 | 25.2 | 1.80 (1.63–2.00) |
| | 19–39 | 52,257 | 131 | 2.5 | 2.5 | 881 | 13 | 14.8 | 14.6 | 12.1 | 5.84 (3.10–11.00) |
| | 40–64 | 70,587 | 1,357 | 19.2 | 17.5 | 3,582 | 202 | 56.4 | 45.6 | 28.1 | 2.60 (2.14–3.16) |
| | ≥ 65 | 22,768 | 2,726 | 119.7 | 127.7 | 4,370 | 852 | 195.0 | 173.8 | 46.1 | 1.36 (1.25–1.48) |
| Delta | Total | 346,994 | 7,781 | 22.4 | 23.2 | 21,732 | 2,247 | 103.4 | 51.2 | 28.0 | 2.21 (2.05–2.39) |
| | 19–39 | 127,020 | 444 | 3.5 | 3.4 | 1,760 | 31 | 17.6 | 17.0 | 13.7 | 5.05 (3.39–7.52) |
| | 40–64 | 157,447 | 2,364 | 15.0 | 14 | 8,100 | 442 | 54.6 | 46.9 | 32.9 | 3.35 (2.94–3.81) |
| | ≥ 65 | 62,527 | 4,973 | 79.5 | 88.5 | 11,872 | 1,774 | 149.4 | 135.0 | 46.4 | 1.52 (1.44–1.61) |
| Omicron | Total | 17,550,662 | 20,429 | 1.2 | 1.4 | 961,920 | 10,821 | 11.2 | 5.0 | 3.6 | 3.55 (3.43–3.68) |
| | 19–39 | 6,901,694 | 259 | 0.0* | 0.0* | 102,762 | 203 | 2.0 | 2.0 | 1.9 | 52.62 (43.59–63.54) |
| | 40–64 | 7,904,885 | 2,320 | 0.3 | 0.3 | 12.68 | 11.80 | 13.64 | 3.8 | 3.5 | 12.68 (11.80–13.64) |
| | ≥ 65 | 2,744,083 | 17,850 | 6.5 | 7.1 | 2.01 | 1.95 | 2.06 | 14.2 | 7.1 | 2.01 (1.95–2.06) |

aCSR = age- and sex-standardized case severity rate, CI = confidence interval.
*$P$ < 0.1.

2.70 times higher than that in PwD. The aCSR and aCFR were highest in the old-age group, whereas the disparities between PwD and PwoD were highest in the young-age group. As the pandemic progressed, the aCSR and aCFR decreased, while the disparity between PwD and PwoD increased. Among 15 disability types, aCSR and aCFR were higher in people with renal, cardiac, and respiratory impairment, and brain lesion disorder (**Supplementary Table 1**).

**Table 3.** Age and sex adjusted case fatality rate of coronavirus disease 2019 confirmed cases among people with and without disability by age group

| Epidemic period | Age group, yr | Non-disabled | | | | Disabled | | | | Risk difference | Risk ratio (95% CI) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total | Deaths | CFR, per 1,000 | aCFR, per 1,000 | Total | Deaths | CFR, per 1,000 | aCFR, per 1,000 | | |
| Total | Total | 18,043,268 | 18,384 | 1.0 | 1.2 | 992,485 | 8,885 | 9.0 | 3.3 | 2.1 | 2.70 (2.60–2.80) |
| | 19–39 | 7,080,971 | 101 | 0.0[a*] | 0.0[*] | 105,403 | 82 | 0.8 | 0.8 | 0.8 | 55.52 (41.20–74.81) |
| | 40–64 | 8,132,919 | 1,645 | 0.2 | 0.2 | 350,513 | 937 | 2.7 | 2.2 | 2.0 | 10.46 (9.55–11.45) |
| | ≥ 65 | 2,829,378 | 16,638 | 5.9 | 6.4 | 536,569 | 7,866 | 14.7 | 11.6 | 5.2 | 1.81 (1.76–1.86) |
| Pre-delta | Total | 145,612 | 1,461 | 10.0 | 12.3 | 8,833 | 552 | 62.5 | 24.6 | 12.3 | 2.01 (1.73–2.32) |
| | 19–39 | 52,257 | 10 | 0.2 | 0.2 | 881 | 2 | 2.3 | 3.5 | 3.3 | 17.76 (3.88–81.26) |
| | 40–64 | 70,587 | 138 | 2.0 | 1.7 | 3,582 | 66 | 18.4 | 15.6 | 13.9 | 9.07 (6.22–13.23) |
| | ≥ 65 | 22,768 | 1,313 | 57.7 | 64.6 | 4,370 | 484 | 110.8 | 92.3 | 27.7 | 1.43 (1.28–1.59) |
| Delta | Total | 346,994 | 3,116 | 9.0 | 10.1 | 21,732 | 1,283 | 59.0 | 23.6 | 13.5 | 2.34 (2.12–2.59) |
| | 19–39 | 127,020 | 24 | 0.2 | 0.2 | 1,760 | 10 | 5.7 | 5.9 | 5.7 | 32.53 (14.78–71.59) |
| | 40–64 | 157,447 | 398 | 2.5 | 2.2 | 8,100 | 157 | 19.4 | 15.3 | 13.1 | 6.81 (5.47–8.48) |
| | ≥ 65 | 62,527 | 2,694 | 43.1 | 50.9 | 11,872 | 1,116 | 94.0 | 82.2 | 31.4 | 1.62 (1.50–1.74) |
| Omicron | Total | 17,550,662 | 13,807 | 0.8 | 1.0 | 961,920 | 7,050 | 7.3 | 2.7 | 1.7 | 2.82 (2.70–2.94) |
| | 19–39 | 6,901,694 | 67 | 0.0[**] | 0.0[**] | 102,762 | 70 | 0.7 | 0.7 | 0.7 | 70.52 (50.10–99.26) |
| | 40–64 | 7,904,885 | 1,109 | 0.1 | 0.1 | 12.68 | 714 | 2.1 | 1.7 | 1.6 | 12.03 (10.82–13.38) |
| | ≥ 65 | 2,744,083 | 12,631 | 4.6 | 5.0 | 2.01 | 6,266 | 12.0 | 9.4 | 4.4 | 1.87 (1.81–1.93) |

aCFR = age- and sex-standardized case fatality rate, CI = confidence interval.
[*]$P < 0.1$, [**]$P < 0.01$.

## Risk disparities of severe outcomes with adjusting explanatory factors

After adjusting explanatory factors, the risk disparities of all severe outcomes and deaths between PwD and PwoD were decreased, but the risk remained higher in PwD with all severe outcomes (aOR, 1.49; CI, 1.46–1.52) and deaths (aOR, 1.40; CI, 1.36–1.44; **Tables 4** and **5**). The risk of disability was highest in the young-age group (all severe outcomes, aOR, 8.02; CI, 6.64–9.68; deaths, aOR, 11.26; CI, 7.57–16.75) and lowest in the old-age group (all severe outcomes, aOR, 1.31; CI, 1.28–1.34; deaths, aOR, 1.27; CI, 1.24–1.31).

In the overall age model, older age was the most critical risk factor for all severe outcomes among the explanatory variables, followed by pulmonary (aOR, 3.44; CI, 3.37–3.52) and kidney (aOR, 1.71; CI, 1.66–1.75) diseases, and the virulence of virus (delta period, aOR, 2.02; CI, 1.94–2.11). These factors had a greater impact on all severe outcomes than disability status (aOR, 1.49; CI, 1.46–1.52). The pattern in the old age group (≥ 65 years) was consistent with that of the overall age model. However, the younger age groups showed different trends. In the 19–39 age group, disability status was the most significant risk factor, and in the 40–64 age group, pulmonary disease (aOR, 4.53; CI, 4.30–4.77) was the primary risk factor, with disability status (aOR, 2.35; CI, 2.20–2.50) being the second most significant. A similar pattern was observed in the death model, although in those aged 40–64, low-income level (Medicaid aOR, 5.84; CI, 4.71–7.24) showed a higher risk of deaths than disability status (aOR, 2.38; CI, 2.16–2.63).

The risk of severe outcomes differed by disability type (**Tables 6-9**, **Supplementary Fig. 2**). Among 15 disability types across all severe outcomes, epilepsy disorder (aOR, 3.45; CI, 2.31–5.17), renal (aOR, 2.97; CI, 2.79–3.15), and respiratory impairment (aOR, 2.88; CI, 2.47–3.36) exhibited a comparatively higher risk in all severe outcomes. Meanwhile, people with hearing impairment were at comparatively lower risk (aOR, 1.08; CI, 1.03–1.13), and those with facial disfigurement and autistic disorder had a low number of events (< 10), limiting statistical calculation. When considering deaths alone, people with hepatic impairment (aOR, 2.92; CI, 2.11–4.05), renal impairment (aOR, 2.44; CI, 2.25–2.63), and intellectual disabilities (aOR, 2.74; CI, 2.35–3.19) showed comparatively higher risk than other disability types. However,


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**Table 4.** aOR of all severe outcomes among people with and without disability based on age group

| Variables | Total | | 19–39 | | 40–64 | | ≥ 65 | |
|---|---|---|---|---|---|---|---|---|
| | aOR[a] | 95% CI | aOR[a] | 95% CI | aOR[a] | 95% CI | aOR[a] | 95% CI |
| Disabled | | | | | | | | |
| Non-disabled | Ref. | | Ref. | | Ref. | | Ref. | |
| Disabled | 1.49 | 1.46–1.52 | 8.02 | 6.64–9.68 | 2.35 | 2.20–2.50 | 1.31 | 1.28–1.34 |
| Sex | | | | | | | | |
| Male | Ref. | | Ref. | | Ref. | | Ref. | |
| Female | 0.57 | 0.56–0.58 | 0.72 | 0.64–0.82 | 0.49 | 0.47–0.52 | 0.60 | 0.58–0.61 |
| Age, yr | | | | | | | | |
| 19–29 | Ref. | | Ref. | | - | | - | |
| 30–39 | 2.25 | 1.97–2.56 | 1.98 | 1.73–2.26 | - | | - | |
| 40–49 | 4.54 | 4.03–5.11 | - | | Ref. | | - | |
| 50–59 | 10.93 | 9.76–12.24 | - | | 1.98 | 1.86–2.11 | - | |
| 60–69 | 23.74 | 21.25–26.53 | - | | 3.17 | 2.96–3.39 | Ref. | |
| 70–79 | 50.33 | 45.02–56.26 | - | | - | | 1.83 | 1.77–1.90 |
| ≥ 80 | 115.80 | 103.61–129.43 | - | | - | | 4.23 | 4.08–4.39 |
| Income level | | | | | | | | |
| Medical aid | 1.48 | 1.43–1.54 | 1.49 | 1.10–2.01 | 2.07 | 1.87–2.29 | 1.24 | 1.18–1.29 |
| Self-employed 1st quintile (lowest) | 1.34 | 1.28–1.40 | 1.15 | 0.85–1.56 | 1.86 | 1.67–2.08 | 1.19 | 1.13–1.25 |
| Self-employed 2nd quintile | 1.32 | 1.26–1.39 | 1.20 | 0.90–1.60 | 1.70 | 1.52–1.91 | 1.18 | 1.12–1.25 |
| Self-employed 3rd quintile | 1.26 | 1.20–1.33 | 1.24 | 0.91–1.68 | 1.64 | 1.46–1.84 | 1.13 | 1.06–1.19 |
| Self-employed 4th quintile | 1.22 | 1.16–1.28 | 1.25 | 0.91–1.71 | 1.63 | 1.45–1.82 | 1.08 | 1.01–1.14 |
| Self-employed 5th quintile (highest) | 1.05 | 1.00–1.10 | 1.32 | 0.92–1.88 | 1.39 | 1.23–1.56 | 0.94 | 0.89–0.99 |
| Employee 1st quintile (lowest) | 1.15 | 1.11–1.20 | 1.06 | 0.82–1.36 | 1.37 | 1.24–1.51 | 1.07 | 1.02–1.12 |
| Employee 2nd quintile | 1.08 | 1.04–1.13 | 0.93 | 0.72–1.20 | 1.13 | 1.02–1.26 | 1.06 | 1.02–1.11 |
| Employee 3rd quintile | 1.01 | 0.97–1.06 | 0.90 | 0.70–1.16 | 1.05 | 0.95–1.18 | 1.00 | 0.95–1.05 |
| Employee 4th quintile | 1.01 | 0.96–1.05 | 0.89 | 0.69–1.15 | 0.99 | 0.89–1.11 | 1.00 | 0.95–1.04 |
| Employee 5th quintile (highest) | Ref. | | Ref. | | Ref. | | Ref. | |
| Comorbidities | | | | | | | | |
| Diabetes | 1.39 | 1.36–1.42 | 2.35 | 1.89–2.94 | 1.68 | 1.59–1.77 | 1.30 | 1.27–1.33 |
| Hypertension | 1.07 | 1.04–1.09 | 1.65 | 1.33–2.04 | 1.19 | 1.13–1.25 | 0.99 | 0.96–1.01 |
| Kidney disease | 1.71 | 1.66–1.75 | 1.72 | 1.32–2.24 | 2.52 | 2.35–2.70 | 1.60 | 1.55–1.64 |
| Pulmonary disease | 3.44 | 3.37–3.52 | 5.28 | 4.55–6.12 | 4.53 | 4.30–4.77 | 3.15 | 3.08–3.22 |
| Cardiovascular disease | 1.21 | 1.19–1.24 | 1.97 | 1.60–2.41 | 1.40 | 1.33–1.48 | 1.15 | 1.12–1.18 |
| Liver disease | 0.94 | 0.92–0.97 | 1.49 | 1.25–1.79 | 1.06 | 1.00–1.12 | 0.88 | 0.85–0.91 |
| Neurologic disease | 1.13 | 1.11–1.16 | 1.81 | 1.53–2.14 | 1.28 | 1.21–1.35 | 1.06 | 1.04–1.09 |
| Cancer | 1.49 | 1.45–1.53 | 2.76 | 2.10–3.63 | 2.36 | 2.21–2.51 | 1.33 | 1.29–1.37 |
| Others | 1.78 | 1.74–1.82 | 1.39 | 1.19–1.62 | 1.47 | 1.40–1.55 | 1.76 | 1.71–1.80 |
| Vaccination | | | | | | | | |
| Unvaccinated | Ref. | | Ref. | | Ref. | | Ref. | |
| 1 or 2 doses | 0.25 | 0.24–0.26 | 0.10 | 0.08–0.12 | 0.14 | 0.13–0.15 | 0.36 | 0.35–0.37 |
| ≥ 3 doses | 0.10 | 0.10–0.10 | 0.08 | 0.06–0.10 | 0.07 | 0.06–0.07 | 0.11 | 0.11–0.11 |
| Reinfection | | | | | | | | |
| None | Ref. | | Ref. | | Ref. | | Ref. | |
| Reinfected | 0.65 | 0.60–0.70 | 0.78 | 0.48–1.27 | 0.88 | 0.74–1.04 | 0.60 | 0.55–0.65 |
| Period | | | | | | | | |
| Pre-delta | Ref. | | Ref. | | Ref. | | Ref. | |
| Delta | 2.02 | 1.94–2.11 | 2.85 | 2.35–3.46 | 2.38 | 2.22–2.55 | 1.62 | 1.54–1.70 |
| Omicron | 0.26 | 0.25–0.27 | 0.19 | 0.15–0.23 | 0.22 | 0.20–0.23 | 0.30 | 0.28–0.31 |

aOR = adjusted odds ratio, CI = confidence interval.
[a]Each aOR is adjusted for all other variables listed in the table within each age stratum.

people with hearing impairment showed no significant disparity with PwoD (aOR, 1.02; CI, 0.97–1.08), and those with facial disfigurement, epilepsy disorder, and autistic disorder had a low number of events (< 10), limiting statistical calculation.

People aged ≥ 65 years and PwD involving internal organs, including hepatic impairment (aOR, 2.11; CI, 1.34–3.32) and renal impairment (aOR, 2.04; CI, 1.87–2.23), demonstrated a higher risk disparity of death than other types of PwD. The 40–64-year age group showed a higher risk for

**Table 5.** aOR of deaths among people with and without disability based on age group

| Variables | Total | | 19–39 yr | | 40–64 yr | | ≥ 65 yr | |
|---|---|---|---|---|---|---|---|---|
| | aOR[a] | 95% CI | aOR[a] | 95% CI | aOR[a] | 95% CI | aOR[a] | 95% CI |
| Disabled | | | | | | | | |
| Non-disabled | Ref. | | Ref. | | Ref. | | Ref. | |
| Disabled | 1.40 | 1.36–1.44 | 11.26 | 7.57–16.75 | 2.38 | 2.16–2.63 | 1.27 | 1.24–1.31 |
| Sex | | | | | | | | |
| Male | Ref. | | Ref. | | Ref. | | Ref. | |
| Female | 0.62 | 0.61–0.64 | 0.67 | 0.49–0.91 | 0.45 | 0.42–0.50 | 0.65 | 0.63–0.66 |
| Age, yr | | | | | | | | |
| 19–29 | Ref. | | Ref. | | - | | - | |
| 30–39 | 1.89 | 1.39–2.57 | 1.35 | 0.98–1.86 | - | | - | |
| 40–49 | 5.50 | 4.19–7.20 | - | | Ref. | | - | |
| 50–59 | 20.11 | 15.56–25.98 | - | | 2.52 | 2.22–2.85 | - | |
| 60–69 | 55.70 | 43.28–71.70 | - | | 3.92 | 3.44–4.46 | Ref. | |
| 70–79 | 162.97 | 126.68–209.67 | - | | - | | 2.36 | 2.24–2.50 |
| ≥ 80 | 480.99 | 374.01–618.56 | - | | - | | 7.10 | 6.74–7.47 |
| Income level | | | | | | | | |
| Medical aid | 1.74 | 1.66–1.83 | 4.72 | 2.11–10.58 | 5.84 | 4.71–7.24 | 1.43 | 1.36–1.51 |
| Self-employed 1st quintile (lowest) | 1.44 | 1.36–1.52 | 4.03 | 1.73–9.41 | 4.59 | 3.63–5.80 | 1.28 | 1.21–1.36 |
| Self-employed 2nd quintile | 1.41 | 1.32–1.50 | 2.89 | 1.17–7.12 | 3.76 | 2.94–4.81 | 1.27 | 1.19–1.36 |
| Self-employed 3rd quintile | 1.29 | 1.21–1.38 | 5.43 | 2.36–12.51 | 3.19 | 2.48–4.10 | 1.17 | 1.09–1.26 |
| Self-employed 4th quintile | 1.21 | 1.13–1.29 | 4.78 | 2.00–11.43 | 3.25 | 2.53–4.16 | 1.09 | 1.01–1.17 |
| Self-employed 5th quintile (highest) | 0.94 | 0.88–1.00 | [a] | [a] | 2.21 | 1.70–2.88 | 0.86 | 0.81–0.92 |
| Employee 1st quintile (lowest) | 1.26 | 1.20–1.33 | 2.20 | 0.97–5.01 | 2.63 | 2.10–3.29 | 1.19 | 1.13–1.25 |
| Employee 2nd quintile | 1.20 | 1.14–1.27 | 1.57 | 0.67–3.68 | 2.11 | 1.67–2.67 | 1.17 | 1.10–1.24 |
| Employee 3rd quintile | 1.12 | 1.06–1.19 | 1.69 | 0.73–3.92 | 1.94 | 1.52–2.48 | 1.09 | 1.03–1.16 |
| Employee 4th quintile | 1.07 | 1.01–1.13 | 1.15 | 0.46–2.86 | 1.70 | 1.32–2.18 | 1.04 | 0.98–1.10 |
| Employee 5th quintile (highest) | Ref. | | Ref. | | Ref. | | Ref. | |
| Comorbidities | | | | | | | | |
| Diabetes | 1.30 | 1.26–1.33 | 2.93 | 1.89–4.54 | 1.69 | 1.54–1.84 | 1.24 | 1.21–1.27 |
| Hypertension | 0.98 | 0.95–1.01 | 0.81 | 0.50–1.33 | 1.00 | 0.92–1.09 | 0.94 | 0.92–0.97 |
| Kidney disease | 1.62 | 1.57–1.68 | 2.06 | 1.26–3.38 | 2.25 | 2.02–2.51 | 1.57 | 1.52–1.63 |
| Pulmonary disease | 2.86 | 2.79–2.94 | 2.85 | 1.96–4.14 | 4.09 | 3.73–4.47 | 2.73 | 2.65–2.80 |
| Cardiovascular disease | 1.20 | 1.17–1.23 | 3.33 | 2.28–4.88 | 1.60 | 1.46–1.75 | 1.14 | 1.11–1.17 |
| Liver disease | 0.91 | 0.88–0.95 | 1.41 | 0.95–2.12 | 1.16 | 1.06–1.28 | 0.86 | 0.83–0.89 |
| Neurologic disease | 1.20 | 1.17–1.23 | 2.16 | 1.50–3.10 | 1.41 | 1.29–1.54 | 1.03 | 1.00–1.06 |
| Cancer | 0.91 | 0.88–0.95 | 6.59 | 4.30–10.10 | 4.34 | 3.96–4.75 | 1.39 | 1.34–1.45 |
| Others | 2.16 | 2.10–2.23 | 2.22 | 1.56–3.16 | 1.85 | 1.69–2.02 | 2.07 | 2.00–2.13 |
| Vaccination | | | | | | | | |
| Unvaccinated | Ref. | | Ref. | | Ref. | | Ref. | |
| 1 or 2 doses | 0.35 | 0.34–0.36 | 0.14 | 0.09–0.21 | 0.24 | 0.22–0.27 | 0.59 | 0.54–0.63 |
| ≥ 3 doses | 0.11 | 0.11–0.11 | 0.09 | 0.06–0.13 | 0.09 | 0.08–0.10 | 0.37 | 0.35–0.38 |
| Reinfection | | | | | | | | |
| None | Ref. | | Ref. | | Ref. | | Ref. | |
| Reinfected | 0.56 | 0.51–0.62 | [b] | [b] | 0.85 | 0.66–1.09 | 0.54 | 0.49–0.60 |
| Period | | | | | | | | |
| Pre-delta | Ref. | | Ref. | | Ref. | | Ref. | |
| Delta | 1.94 | 1.83–2.07 | 2.38 | 1.20–4.72 | 2.84 | 2.40–3.37 | 1.78 | 1.67–1.90 |
| Omicron | 0.45 | 0.43–0.48 | 0.62 | 0.33–1.17 | 0.67 | 0.57–0.79 | 0.43 | 0.41–0.46 |

aOR = adjusted odds ratio, CI = confidence interval.
[a]Each aOR is adjusted for all other variables listed in the table within each age stratum.
[b]aOR values were not presented due to insufficient event number (less than 10).

PwD related to brain lesion disorder (aOR, 3.68; CI, 3.15–4.31) of external bodily function, intellectual disability (aOR, 3.22; CI, 2.53–4.11) of psychological development disorder and renal impairment (aOR, 3.11; CI, 2.56–3.77) of internal organs in COVID-19-related deaths. Among the 19–39-year age group, most types of disability had a low number of events, making statistical calculation challenging. However, a higher risk of death was observed among people with brain lesion disorder disabilities (aOR, 19.58; CI, 10.99–34.87) and

**Table 6.** Overall aORs of severe outcomes and deaths based on 15 disability types for all ages

| Disability type | No. | Severe cases + deaths, % | aOR[a] | 95% CI | Deaths, % | aOR | 95% CI |
|---|---|---|---|---|---|---|---|
| Without disabilities | 18,043,268 | 32,424 (0.18) | Ref. | | 18,384 (0.10) | Ref. | |
| Physical: External bodily functions | | | | | | | |
| Physical disabilities | 422,632 | 4,138 (0.98) | 1.21 | 1.17–1.26 | 2,648 (0.63) | 1.17 | 1.12–1.22 |
| Brain lesion disorder | 105,227 | 3,399 (3.23) | 2.13 | 2.04–2.22 | 2,212 (2.10) | 2.06 | 1.96–2.16 |
| Visual impairment | 90,565 | 1,009 (1.11) | 1.26 | 1.18–1.35 | 660 (0.73) | 1.22 | 1.12–1.33 |
| Hearing impairment | 154,253 | 2,481 (1.61) | 1.08 | 1.03–1.13 | 1,694 (1.10) | 1.02 | 0.97–1.08 |
| Language disabilities | 6,899 | 99 (1.43) | 1.34 | 1.08–1.67 | 62 (0.90) | 1.33 | 1.01–1.74 |
| Facial disfigurement | 964 | 6 (0.62) | [b] | [b] | 3 (0.31) | [b] | [b] |
| Physical: Internal organs | | | | | | | |
| Renal impairment | 44,302 | 1,781 (4.02) | 2.97 | 2.79–3.15 | 943 (2.13) | 2.44 | 2.25–2.63 |
| Cardiac impairment | 2,465 | 68 (2.76) | 2.66 | 2.02–3.49 | 33 (1.34) | 1.92 | 1.33–2.79 |
| Respiratory impairment | 4,141 | 224 (5.41) | 2.88 | 2.47–3.36 | 89 (2.15) | 1.70 | 1.35–2.13 |
| Hepatic impairment | 6,010 | 79 (1.31) | 2.72 | 2.14–3.44 | 39 (0.65) | 2.92 | 2.11–4.05 |
| Intestinal/Urinary fistula | 5,657 | 111 (1.96) | 1.29 | 1.05–1.59 | 81 (1.43) | 1.37 | 1.09–1.74 |
| Epilepsy disorder | 2,863 | 27 (0.94) | 3.45 | 2.31–5.17 | 9 (0.31) | [b] | [b] |
| Mental: Psychological development disorder | | | | | | | |
| Intellectual disabilities | 89,126 | 358 (0.40) | 2.67 | 2.38–2.99 | 193 (0.22) | 2.74 | 2.35–3.19 |
| Autistic disorder | 8,465 | 5 (0.06) | [b] | [b] | 2 (0.02) | [b] | [b] |
| Mental: Mental disease | | | | | | | |
| Mental disabilities | 48,916 | 350 (0.72) | 1.43 | 1.27–1.60 | 217 (0.44) | 1.70 | 1.48–1.96 |

aOR = adjusted odds ratio, CI = confidence interval.
[a]aOR for disability status is adjusted for all variables included in **Table 3**.
[b]aOR values are not presented due to insufficient events (less than 10).

**Table 7.** aORs of severe outcomes and deaths based on 15 disability types in age group of 19–39 years

| Disability type | No. | Severe cases + deaths, % | aOR[a] | 95% CI | Deaths, % | aOR | 95% CI |
|---|---|---|---|---|---|---|---|
| Without disabilities | 7,080,971 | 834 (0.01) | Ref | | 101 (0.00)[**] | Ref | |
| Physical: External bodily functions | | | | | | | |
| Physical disabilities | 18,243 | 40 (0.22) | 8.26 | 5.87–11.62 | 10 (0.05) | 11.07 | 5.58–21.99 |
| Brain lesion disorder | 7,295 | 57 (0.78) | 14.74 | 10.55–20.59 | 24 (0.33) | 19.58 | 10.99–34.87 |
| Visual impairment | 7,766 | 7 (0.09) | [b] | [b] | 1 (0.01) | [b] | [b] |
| Hearing impairment | 5,408 | 3 (0.06) | [b] | [b] | 2 (0.04) | [b] | [b] |
| Language disabilities | 723 | 0 (0.00) | - | - | 0 (0.00) | - | - |
| Facial disfigurement | 170 | 0 (0.00) | - | - | 0 (0.00) | - | - |
| Physical: Internal organs | | | | | | | |
| Renal impairment | 2,546 | 26 (1.02) | 4.05 | 2.38–6.89 | 7 (0.27) | | |
| Cardiac impairment | 487 | 4 (0.82) | [b] | [b] | 2 (0.41) | [b] | [b] |
| Respiratory impairment | 84 | 2 (2.38) | [b] | [b] | 0 (0.00) | - | - |
| Hepatic impairment | 344 | 4 (1.16) | [b] | [b] | 3 (0.87) | [b] | [b] |
| Intestinal/Urinary fistula | 201 | 2 (1.00) | [b] | [b] | 1 (0.50) | [b] | [b] |
| Epilepsy disorder | 593 | 6 (1.01) | [b] | [b] | 2 (0.34) | [b] | [b] |
| Mental: Psychological development disorder | | | | | | | |
| Intellectual disabilities | 49,158 | 87 (0.18) | 9.09 | 6.92–11.95 | 27 (0.05) | 12.20 | 7.19–20.68 |
| Autistic disorder | 8,186 | 5 (0.06) | [b] | [b] | 2 (0.02) | [b] | [b] |
| Mental: Mental disease | | | | | | | |
| Mental disabilities | 4,199 | 4 (0.10) | [b] | [b] | 1 (0.02) | [b] | [b] |

aOR = adjusted odds ratio, CI = confidence interval.
[a]aOR for disability status is adjusted for all variables included in **Table 3**.
[b]aOR values are not presented due to insufficient events (less than 10).
[**]$P < 0.01$.

intellectual disabilities (aOR, 12.20; CI, 7.19–20.68). In all age groups, people with language disabilities and facial disfigurement showed no significant disparities or limited number of events in risk of death.

Regarding the epidemic periods, the risk disparity between PwD and PwoD for all severe outcomes in the omicron period increased in all age groups, particularly in the young-age group (**Fig. 1**). For deaths only, risk disparities were similar across periods.


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**Table 8.** aORs of severe outcomes and deaths based on 15 disability types in age group of 40–64 years

| Disability type | No. | Severe cases + deaths, % | aOR | 95% CI | Deaths, % | aOR | E95% CI |
|---|---|---|---|---|---|---|---|
| Without disabilities | 8,132,919 | 6,041 (0.07) | Ref. | | 1,645 (0.02) | Ref. | |
| Physical: External bodily functions | | | | | | | |
| Physical disabilities | 159,550 | 480 (0.30) | 1.65 | 1.49–1.82 | 201 (0.13) | 1.90 | 1.63–2.22 |
| Brain lesion disorder | 31,530 | 532 (1.69) | 3.62 | 3.24–4.04 | 255 (0.81) | 3.68 | 3.15–4.31 |
| Visual impairment | 33,476 | 95 (0.28) | 1.59 | 1.28–1.98 | 37 (0.11) | 1.61 | 1.14–2.27 |
| Hearing impairment | 25,367 | 71 (0.28) | 1.56 | 1.22–2.01 | 29 (0.11) | 1.79 | 1.22–2.61 |
| Language disabilities | 2,987 | 19 (0.64) | 1.97 | 1.17–3.30 | 8 (0.27) | [b] | [b] |
| Facial disfigurement | 516 | 1 (0.19) | [b] | [b] | 0 (0.00) | - | - |
| Physical: Internal organs | | | | | | | |
| Renal impairment | 21,925 | 579 (2.64) | 4.47 | 3.94–5.07 | 213 (0.97) | 3.11 | 2.56–3.77 |
| Cardiac impairment | 785 | 23 (2.93) | 7.05 | 4.37–11.38 | 7 (0.89) | [b] | [b] |
| Respiratory impairment | 1,210 | 39 (3.22) | 4.84 | 3.39–6.92 | 9 (0.74) | [b] | [b] |
| Hepatic impairment | 3,366 | 37 (1.10) | 2.45 | 1.71–3.52 | 16 (0.48) | 2.08 | 1.24–3.49 |
| Intestinal/Urinary fistula | 1,408 | 7 (0.50) | [b] | [b] | 4 (0.28) | [b] | [b] |
| Epilepsy disorder | 1,827 | 16 (0.88) | 3.87 | 2.23–6.70 | 4 (0.22) | [b] | [b] |
| Mental: Psychological development disorder | | | | | | | |
| Intellectual disabilities | 33,505 | 152 (0.45) | 2.81 | 2.35–3.37 | 80 (0.24) | 3.22 | 2.53–4.11 |
| Autistic disorder | 277 | 0 (0.00) | - | - | 0 (0.00) | - | - |
| Mental: Mental disease | | | | | | | |
| Mental disabilities | 32,784 | 147 (0.45) | 1.44 | 1.19–1.73 | 74 (0.23) | 1.69 | 1.31–2.18 |

aOR = adjusted odds ratio, CI = confidence interval.
[a]aOR for disability status is adjusted for all variables included in **Table 3**.
[b]aOR values are not presented due to insufficient events (less than 10).

**Table 9.** aORs of severe outcomes and deaths based on 15 disability types in age group ≥ 65 years

| Disability type | No. | Severe cases + deaths, % | aOR[a] | 95% CI | Deaths, % | aOR | 95% CI |
|---|---|---|---|---|---|---|---|
| Without disabilities | 2,829,378 | 25,549 (0.90) | Ref. | | 16,638 (0.59) | Ref. | |
| Physical: External bodily functions | | | | | | | |
| Physical disabilities | 244,839 | 3,618 (1.48) | 1.12 | 1.08–1.16 | 2,437 (1.00) | 1.11 | 1.06–1.16 |
| Brain lesion disorder | 66,402 | 2,810 (4.23) | 1.85 | 1.77–1.93 | 1,933 (2.91) | 1.85 | 1.76–1.95 |
| Visual impairment | 49,323 | 907 (1.84) | 1.19 | 1.11–1.28 | 622 (1.26) | 1.18 | 1.08–1.28 |
| Hearing impairment | 123,478 | 2,407 (1.95) | 1.04 | 0.99–1.09 | 1,663 (1.35) | 1.00 | 0.95–1.05 |
| Language disabilities | 3,189 | 80 (2.51) | 1.22 | 0.96–1.55 | 54 (1.69) | 1.25 | 0.94–1.67 |
| Facial disfigurement | 278 | 5 (1.80) | [b] | [b] | 3 (1.08) | [b] | [b] |
| Physical: Internal organs | | | | | | | |
| Renal impairment | 19,831 | 1,176 (5.93) | 2.24 | 2.09–2.41 | 723 (3.65) | 2.04 | 1.87–2.23 |
| Cardiac impairment | 1,193 | 41 (3.44) | 1.69 | 1.20–2.38 | 24 (2.01) | 1.48 | 0.96–2.28 |
| Respiratory impairment | 2,847 | 183 (6.43) | 2.48 | 2.10–2.93 | 80 (2.81) | 1.61 | 1.27–2.04 |
| Hepatic impairment | 2,300 | 38 (1.65) | 2.07 | 1.48–2.90 | 20 (0.87) | 2.11 | 1.34–3.32 |
| Intestinal/Urinary fistula | 4,048 | 102 (2.52) | 1.26 | 1.02–1.55 | 76 (1.88) | 1.36 | 1.07–1.73 |
| Epilepsy disorder | 443 | 5 (1.13) | [b] | [b] | 3 (0.68) | [b] | [b] |
| Mental: Psychological development disorder | | | | | | | |
| Intellectual disabilities | 6,463 | 119 (1.84) | 1.47 | 1.21–1.78 | 86 (1.33) | 1.65 | 1.32–2.07 |
| Autistic disorder | 2 | 0 (0.00) | - | - | 0 (0.00) | - | - |
| Mental: Mental disease | | | | | | | |
| Mental disabilities | 11,933 | 199 (1.67) | 1.37 | 1.18–1.59 | 142 (1.19) | 1.60 | 1.34–1.90 |

aOR = adjusted odds ratio, CI = confidence interval.
[a]aOR for disability status is adjusted for all variables included in **Table 3**.
[b]aOR values are not presented due to insufficient events (less than 10).

## DISCUSSION

This nationwide retrospective cohort study, encompassing all adult confirmed cases of COVID-19 until October 2022, revealed that PwD were consistently at higher risk of severe COVID-19 outcomes than PwoD. Although the risk disparities between PwD and PwoD decreased after adjusting for explanatory factors, the risk remained higher for PwD. The risk of severe outcomes was highest in the old-age group, in both PwD and PwoD, whereas that

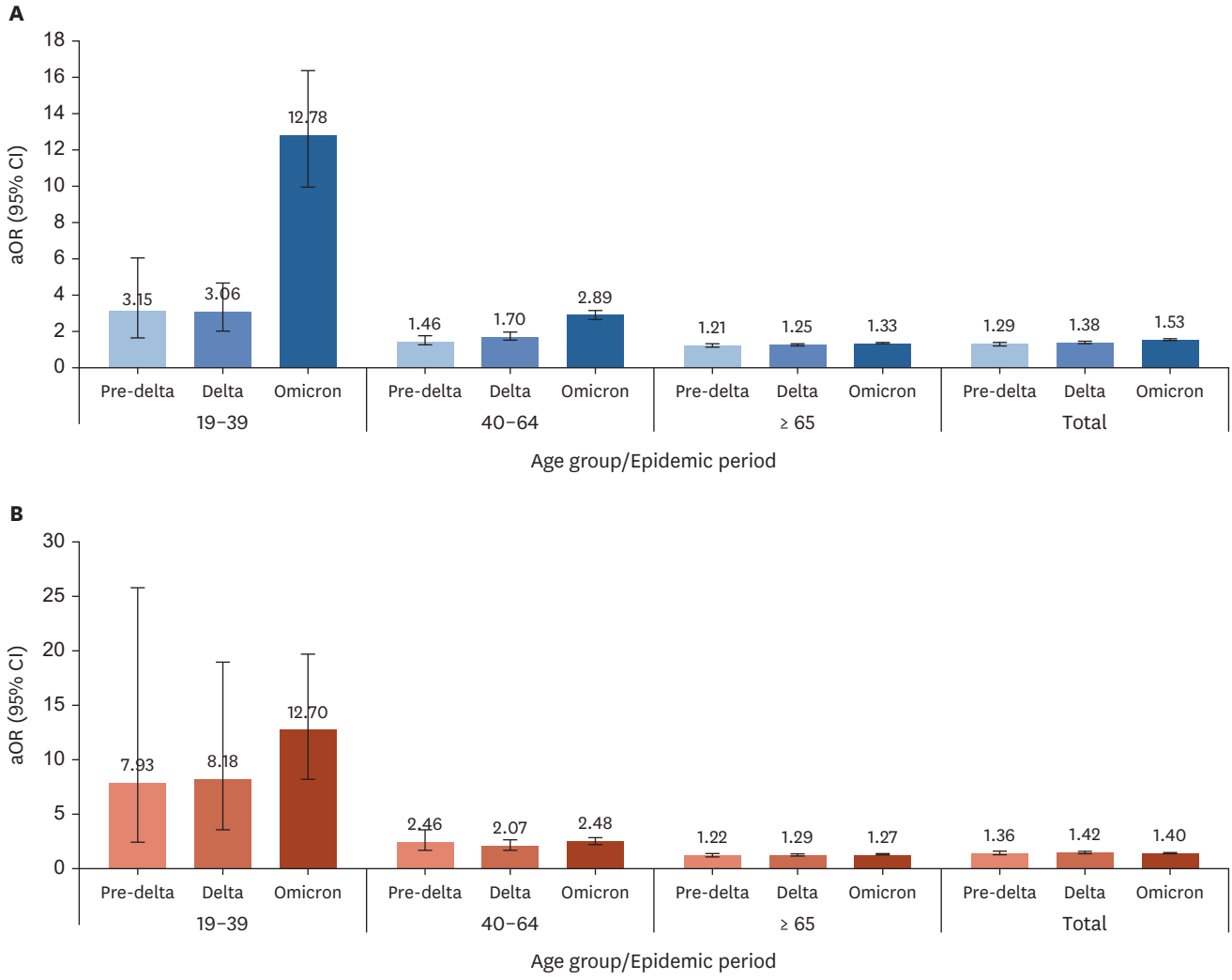


**Fig. 1.** Adjusted odds ratios of severe outcomes and deaths among people with and without disability based on age groups and circulating variant period, all severe outcomes (**A**), deaths (**B**).
aOR = adjusted odds ratio, CI = confidence interval.

of disparity was more marked in the young-age groups. Among 15 disability types, people with hepatic or renal impairment, intellectual disability, and brain lesion disorder showed a comparatively higher risk, while people with hearing impairment, facial disfigurement, epilepsy, and autistic disorder showed no significant disparities or a low number of events, limiting statistical calculation. As COVID-19 severity decreased in the omicron period, the risk of severe outcomes also declined in both PwD and PwoD. However, the risk disparity of all severe outcomes increased slightly in the young-age group.

This study revealed that the risk disparities between PwD and PwoD decreased after adjusting for explanatory factors associated with severe outcomes of COVID-19. This finding suggests that health vulnerability is associated with a higher prevalence of comorbidities and low socioeconomic status, which are recognized risk factors for severe COVID-19.[21] In the real world, PwD often experiences multiple risk factors, potentially leading to higher risk and greater disparity with PwoD.[1] Moreover, barriers to accessing healthcare services, as suggested by the WHO, could contribute to an increased risk of severe COVID-19.[22-25]


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During the pandemic, a Korean study reported that PwD experienced larger reductions in claims for medical services than PwoD did.[26] These collateral impacts worsened pre-existing health conditions and could have led to more severe outcomes following COVID-19.[27] A delay in COVID-19 diagnosis due to disability could exacerbate its progression in people with dementia, Down syndrome, cerebral palsy, and spinal cord injury; their disability could have obscured respiratory symptoms. People with intellectual disabilities could experience difficulty in recognizing or expressing their symptoms, and people with impaired mobility could face challenges in accessing diagnostic facilities.[28]

Older age remains the most critical risk factor for severe COVID-19 outcomes, consistent with both our findings and previous studies,[20] with comorbidities also being well-established risk factors. However, our analysis highlights that, among adults younger than 64 years of age, disability status posed as a significant risk factor comparable to that of comorbidities, although the impact varied depending on disability type. This finding was observed in overall types of disability and IDD studies in several countries.[2,6,13,29,30] Herein, young-age and middle-age groups (19–64 years) showed greater differences in socioeconomic status and comorbidities by disability status compared to the old-age group, which could have contributed to disparities in severe outcomes. A WHO survey indicated higher unmet care needs among PwD aged 50–59 compared to those aged ≥ 60 years, with significant differences in healthcare service needs between PwD and PwoD.[31] Disruptions in healthcare services due to COVID-19 could have greater impact on younger PwD than on PwoD.[32]

Age-specific and disability-type analyses provided detailed insights into risk disparities, particularly in young adults. Overall, higher risks of COVID-19 deaths were observed for most internal organ and intellectual disabilities compared to other disabilities. The old-age group showed a higher risk for most internal organ disabilities. However, individuals aged 19–64 years demonstrated elevated risks for both internal organs and intellectual disabilities, and brain lesions. The latter two disabilities may account for greater differences in risks for severe outcomes observed in young-age groups by disabilities. In the US study with overall age, IDD showed the highest risk for invasive mechanical ventilation and in-hospital deaths among PwD with mobility, vision, and hearing impairment, compared with PwoD.[9] Intellectual disabilities are more prevalent in young adults, who have more health risk factors and more healthcare needs than PwoD. Additionally, they show a lower average age at death, indicating that age-related impacts on severe COVID-19 outcomes may apply earlier.[8,30,33-35] Combined factors of COVID-19 severe outcomes, such as age, comorbidities, and healthcare disruption during the COVID-19 pandemic likely had a disproportionately greater impact on people with intellectual disabilities exacerbating health disparities.[12,21,23,26,27] For people with brain-lesion disorders, respiratory dysfunction, which contributes significantly to morbidity, mortality, high demand for medical intervention, and regular follow-up, can lead to severe COVID-19 outcomes.[36,37] Meanwhile, people with facial disfigurement, epilepsy disorder, and autistic disorder had fewer deaths, limiting statistical analysis. These findings highlight that not all disability types pose the same risk of severe COVID-19 outcomes. Therefore, targeted protective measures should be prioritized for PwD, including those with intellectual disabilities, brain lesions, physical disabilities, and renal impairment, particularly in younger populations.

This study provides valuable insights into public health. First, prioritizing PwD in the public-health crisis response is crucial, alongside well-known priorities for older adults and individuals with comorbidities. PwD of internal organs may already be prioritized due to their underlying diseases. However, PwD at high risk of severe outcomes who do not meet these

criteria, such as people with intellectual disability are suggested to be included in the priority group. Second, understanding health risks of PwD through consistent monitoring is essential for policy development. The lack of regular data collection on PwD hinders risk assessment and identification of risk factors associated with health outcomes in this vulnerable group.[38] During crises, when timely and labor-intensive data collection is challenging, linking previously collected data, including sociodemographic information, with new data can help identify PwD rapidly. Including disability variables in regularly monitored basic tables, alongside age and sex, can raise awareness of the need to protect the health of vulnerable groups.

The strength of this study is its nationwide scope, covering all registered PwD with COVID-19. It delineated risk disparities by age, disability types, and epidemic period, adjusting factors beyond variations in baseline health status. Nonetheless, this study had some limitations. First, it only included formally registered PwD; unregistered PwD could misclassified as PwoD. However, with 94.1% PwD registered nationwide based on 2017 statistics,[39] the risk of misclassification was minimized. Additional considerations also include potential discrepancies with other disability statistics due to differences in the timing of disability information, as this analysis used health insurance data. Second, severity information relied on hospital reports, possibly missing severe cases due to delayed or omitted reporting. This underestimation likely affected both PwD and PwoD groups similarly. Future studies should review medical history to better define severity and minimize underestimation.

During the COVID-19 pandemic, PwD faced higher risk of severe COVID-19 outcomes compared to PwoD. Including PwD in high-risk groups alongside older adults could minimize health impact from public health crises. Risk-based prioritization of vulnerable groups, such as young PwD, people with internal organ and intellectual disability, helps mitigate disparities in risk between PwD and PwoD, considering their health vulnerability and demand of healthcare services by disability types.

## SUPPLEMENTARY MATERIALS

### Supplementary Table 1

Age- and sex-adjusted case severity rates and case fatality rates of COVID-19 confirmed cases among people with and without 15 types of disabilities

### Supplementary Fig. 1

Flowchart of the selection of the study population.

### Supplementary Fig. 2

aORs of severe outcomes and deaths based on age groups and four type of disabilities, all severe outcomes (**A**), deaths (**B**).

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