Tokyo and New York: A Study in the Contrasting Effects of Socioeconomic Status on Coronavirus Disease 2019 Outcomes

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Objectives: It is still not known why cases of coronavirus disease 2019 (COVID-19) during the first wave in Tokyo have fallen without lockdown restrictions. People with low socioeconomic status are not dominant among coronavirus disease 2019 patients in Tokyo in contrast with New York, where the opposite demographics have been in play. Thus, we set out to examine the association between socioeconomic status and the rate of coronavirus disease 2019 infections using public data from Tokyo.

Design: We obtained data from each of the 23 wards of Tokyo, showing population size, density, age, sex, number of graduates, income, and hospital attendance numbers. Coronavirus disease 2019 infections were gathered for 2 separate days: April 9, 2020, when new daily coronavirus disease 2019 infections were at their peak during the first wave in Japan; and May 9, 2020, to observe any changes in incidence over the preceding month.

Setting: The primary outcome was set as the number of coronavirus disease 2019 infections per 100,000 population.

Interventions: None.

Measurements and Main Results: By conducting simple linear regression modeling, the incidence of cases on April 9 was associated significantly with four variables: population age greater than 65 years (%), university rate, hospital, and income. Using these four variables, multivariate linear regression analyses demonstrated that only income remained significant ($p = 0.006$ at April 9 and $p = 0.03$ at May 9). This indicates that the highest case numbers were dominant in high-income areas, and affected fewer patients in districts in the low-income areas.

Conclusions: The result of the current study is exactly opposite to the data from New York. This may be considered one of the main reasons why the rate of death and new patients of coronavirus disease 2019 has been so low in Tokyo. That is, appropriate hygienic status, free access to hospital by ambulance, and universal health insurance system may contribute to the outcome in such low-income areas.

Key Words: coronavirus disease 2019; New York; Tokyo

It is still not known why cases of coronavirus disease 2019 (COVID-19) during the first wave in Tokyo have fallen without lockdown restrictions (1). From our experience as emergency physicians at a general hospital in Tokyo (2), we have noted that people with low socioeconomic status (SES) are not dominant among COVID-19 patients in the city. This may explain the falling case numbers, in contrast with other cities such as New York, where the opposite demographics have been in play (3).

Thus, we set out to examine the association between SES and the rate of COVID-19 infections using public data from Tokyo, and also briefly discuss the reason for low COVID-19 case rates.

MATERIALS AND METHODS

We obtained data from each ward, showing population size, density, age, sex, number of graduates, income, and hospital attendance numbers in Tokyo. Income was defined as total taxable earnings divided by the number of taxpayers, and was obtained from the website of the Ministry of Internal Affairs and Communications (4).

COVID-19 infections were gathered for 2 separate days: April 9, 2020, when new daily COVID-19 infections were at their peak during the first wave in Japan; and May 9, 2020, to observe any changes in incidence over the preceding month (1).

The primary outcome was set as the number of COVID-19 infections per 100,000 population.

Twenty-three wards were divided into high, moderate, and low tertiles, based separately on income and cases of COVID-19 per 100,000 population.

As the comparison of analysis in Tokyo, we obtained the number of patients with COVID-19 who were hospitalized per 100,000

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population, the number of deaths related to COVID-19 per 100,000 population, and household median income across the five boroughs (the Bronx, Brooklyn, Manhattan, Queens, and Staten Island) in New York City (3). Simple linear regression analysis was performed to examine the correlation between the number of patients with COVID-19 who were hospitalized per 100,000 population, the number of deaths related to COVID-19 per 100,000 population, and household median income among five New York City boroughs.

All data were analyzed using Stata Version 14.0 (StataCorp LP, College Station, TX). Institutional review board approval was not sought due to the use of publicly available deidentified data, in accordance with the institution’s usual policy.

**RESULTS**

The demographics of each of the 23 wards are shown in Table 1. By conducting simple linear regression modeling, the incidence of cases on April 9 was associated significantly with four variables: population age greater than 65 years (%), university rate \((p = 0.02)\), hospital \((p = 0.01)\), and income \((p = 0.001)\). Using these four variables, multivariate linear regression analyses demonstrated that only income remained significant \((p = 0.006 \text{ at April } 9 \text{ and } p = 0.03 \text{ at May } 9)\). Tokyo was identified as having eight central wards that are high-income wards, and seven low-income wards surrounding them (Fig. 1A). Figure 1B shows COVID-19 cases per 100,000 population at their peak. This indicates that the highest case numbers were dominant in high-income areas, and

**TABLE 1. Baseline Characteristics of 23 Wards**

| No. | Name  | Total Population, \(n^a\) | Population Density (\(/\text{km}^2\))^b | Age, Mean (yr)^c | ≥ 65 yr old (%)^d | Sex, Males (%)^e | Percent of High School Students Proceeding to University (%)^f | Recuperation Hospital, \(n^d\) | Income ($/yr)^g |
|-----|-------|--------------------------|--------------------------------------|------------------|------------------|-----------------|----------------------------------------|------------------|---------------|
| 1   | Chiyoda | 65,942 | 5,655 | 42.7 | 17.6 | 50.2 | 78.8 | 1 | 88,274 |
| 2   | Chūō   | 168,361 | 16,490 | 42.3 | 16.1 | 47.6 | 60.2 | 0 | 59,305 |
| 3   | Minato | 260,379 | 12,782 | 42.9 | 17.5 | 47.2 | 74 | 1 | 104,213 |
| 4   | Shinjuku | 348,452 | 19,125 | 43.9 | 19.6 | 50.1 | 71.3 | 1 | 48,479 |
| 5   | Bunkyō | 226,114 | 20,028 | 43.3 | 19.1 | 47.6 | 73.6 | 2 | 57,022 |
| 6   | Taitō | 202,431 | 20,023 | 46.1 | 23.5 | 51.2 | 54.6 | 5 | 38,975 |
| 7   | Sumida | 274,896 | 19,963 | 45.2 | 22.7 | 49.5 | 69.1 | 5 | 34,713 |
| 8   | Kōtō | 521,835 | 12,994 | 44.0 | 21.1 | 49.3 | 59.9 | 6 | 39,590 |
| 9   | Shinagawa | 401,704 | 17,588 | 44.2 | 20.2 | 49.1 | 69.4 | 6 | 43,272 |
| 10  | Meguro | 281,474 | 19,187 | 43.9 | 19.9 | 47.3 | 70.4 | 5 | 56,263 |
| 11  | Ōta | 734,493 | 12,075 | 44.8 | 22.1 | 49.6 | 53.8 | 14 | 39,503 |
| 12  | Setagaya | 917,486 | 15,805 | 44.6 | 20.4 | 47.4 | 68.4 | 8 | 50,930 |
| 13  | Shibuya | 229,671 | 15,200 | 44.9 | 19.6 | 48.0 | 75 | 6 | 74,870 |
| 14  | Nakano | 335,234 | 21,503 | 44.6 | 20.6 | 50.4 | 68.2 | 4 | 38,604 |
| 15  | Suginami | 574,118 | 16,856 | 44.9 | 22.1 | 48.0 | 73.6 | 10 | 43,485 |
| 16  | Toshima | 290,246 | 22,309 | 43.7 | 19.7 | 50.1 | 67.7 | 4 | 40,103 |
| 17  | Kita | 353,908 | 17,172 | 46.3 | 25.5 | 49.7 | 66.9 | 6 | 34,442 |
| 18  | Arakawa | 217,146 | 21,373 | 45.0 | 23.1 | 49.6 | 44.7 | 9 | 33,844 |
| 19  | Itabashi | 571,357 | 17,733 | 45.0 | 22.8 | 49.1 | 65.4 | 23 | 33,729 |
| 20  | Nerima | 739,435 | 15,379 | 44.3 | 21.9 | 48.5 | 58.5 | 8 | 38,705 |
| 21  | Adachi | 691,298 | 12,982 | 45.6 | 24.6 | 50.1 | 40.3 | 18 | 31,678 |
| 22  | Katsushika | 464,550 | 13,349 | 45.7 | 24.6 | 50.0 | 43.7 | 8 | 32,103 |
| 23  | Edogawa | 700,079 | 14,030 | 43.0 | 20.4 | 50.4 | 60.7 | 8 | 33,449 |

*Total population and population density were obtained from the website of the Statistics Division, Bureau of General Affairs, in 2020.
Age and sex were obtained from the website of the Statistics Bureau, Ministry of Internal Affairs and Communications, in 2015.
Percentage of high school students proceeding to university was obtained from the website of the Statistics Division, Bureau of General Affairs, in 2019.
Total number of hospitals was obtained from the website of the Bureau of Social Welfare and Public Health, Tokyo Metropolitan Government, in 2018.
Income was defined as taxable income/number of taxpayers, and was obtained from the website of the Ministry of Internal Affairs and Communications in 2017. Income was calculated at a rate of 107 yen per dollar.
affected fewer patients in the districts of the low-income areas. The number of cases after 1 month of the peak is shown in Figure 1C, with the same tendency again observed.

There was a negative correlation between the number of patients with COVID-19 who were hospitalized per 100,000 population and household median income ($R^2 = 0.663$ and $p = 0.094$) (Fig. 2A), and a strong negative correlation between the number of deaths related to COVID-19 per 100,000 population and household median income among five New York City boroughs ($R^2 = 0.817$ and $p = 0.035$) (Fig. 2B).

**Figure 1.** Incomes and cases in coronavirus disease 2019 (COVID-19) per 100,000 persons in 23 wards, Tokyo. A. Incomes in central Tokyo (23 wards) ($/yr). Twenty-three wards were divided into three income categories—high (eight wards), moderate (eight wards), and low (seven wards)—based on calculated income. B. Cases in COVID-19 per 100,000 population at peak level in first wave (April 9, 2020). Twenty-three wards were divided in three categories such as high (eight wards), moderate (eight wards), and low (seven wards) based on cases in COVID-19 per 100,000 persons. C. Cases of COVID-19 per 100,000 population 1 mo after peak levels in first wave (May 9, 2020). Twenty-three wards were divided in three categories such as high (eight wards), moderate (eight wards), and low (seven wards) based on cases in COVID-19 per 100,000 persons.

**Figure 2.** The number of patients with coronavirus disease 2019 (COVID-19) who were hospitalized per 100,000 population, the number of deaths related to COVID-19 per 100,000 population, and household median income across the five boroughs in New York City. A. Relationship between the number of patients with COVID-19 who were hospitalized per 100,000 population and the household median income. There was a negative correlation between the number of patients with COVID-19 who were hospitalized per 100,000 population and the household median income. B. Relationship between the total number of deaths related to COVID-19 per 100,000 population and the household median income. There was a negative correlation between the total number of deaths related to COVID-19 per 100,000 population and household median income.
DISCUSSION AND CONCLUSIONS
In this study, the dominant distribution of COVID-19 cases was shown to be in high-income areas and had still not spread into districts with low incomes even 1 month after peak levels in Tokyo.

In an analysis of COVID-19 demographics in New York, the number of deaths and hospitalizations associated with the disease was seen to be highest in the Bronx, a low-income area, and lowest in wealthy Manhattan (3), leading the authors to consider that SES may contribute to the outcomes of COVID-19 patients. The result of the current study is exactly opposite to the data from New York. This may be considered one of the main reasons why the rate of death and new cases of COVID-19 has been so low in Tokyo. That is, appropriate hygienic status, free access to hospital by ambulance, and universal health insurance system may contribute to the outcome in such low-income areas.

Appropriate public health management for preventing an explosive rise in COVID-19 cases in such low-income areas is required not only in Japan but also all over the world. If an explosive rise in COVID-19 cases occurs in those areas where the first COVID-19 attack was controlled well, including Tokyo, then those cities will also fall into crisis situations easily. Currently, Tokyo is in the midst of a second wave of infection. A trend similar to the first wave has been observed, and an explosive rise in COVID-19 cases in low-income areas is not dominant in Tokyo (Supplemental Figure, http://links.lww.com/CCX/A318).

The main limitation of the current study was the lack of a dataset that would have enabled us to examine death rates in Tokyo. Second, multivariable analysis adjusting unique demographic, SES, and community characteristics was not performed due to the small number of five New York City boroughs. Finally, 23 wards were divided into three income categories based on the calculated income only for the purpose of the study, and we do not intend to slander specific individuals or areas at all.

Further study is required to clarify the low rate of death and cases of COVID-19 patients in Tokyo.

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