Title: Excess mortality during and after SARS-Cov-2 pandemic in Japan: Updated until November 2023

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ICMJE Statement

Contributors TS was responsible for the organization and coordination of the study. JK was the chief investigator and responsible for the data setting. YO developed the estimation model. All authors contributed to the writing of the final manuscript.

Abstract

Background: On May 8, 2023, COVID-19 had been reclassified from notifiable diseases to disease monitored by sentinel surveillance defined in the Infectious Diseases Control Law. Accordingly, response for pandemic of COVID-19 in Japan had been discontinued.

Object: We sought to quantify excess mortality using the National Institute of Infectious Diseases (NIID) model for all cause of death to evaluate pathogenicity of SARS-CoV-2 after pandemic of COVID-19.

Method: We applied the NIID model to deaths of all causes from 1987 up through November, 2023 for the whole of Japan and up through September, 2023 for Tokyo.

Results: After July, 2023, excess morality was observed while response for pandemic of COVID-19 in Japan had been discontinued. These were 1867, 10613, 10934, and 6918 excess morality and these mean 1.64, 9.19, 9.80, and 5.67% of the base line. Even in Tokyo, 365 excess mortality which means 3.65% of the baseline was observed.

Discussion and Conclusion: Excess mortality while response for pandemic of COVID-19 in Japan had been discontinued were smaller than excess morality in 2022, however, larger than in 2020 and 2021. Therefore, it was not able to ignore.

1. Introduction

On May 8, 2023, COVID-19 had been reclassified from notifiable diseases to disease monitored by sentinel surveillance defined by Act on the Prevention of Infectious Diseases and Medical Care for Patients with Infectious Diseases. Accordingly, response for pandemic of COVID-19 in Japan had been discontinued.

Before COVID-19 outbreak, excess mortality has mainly been used to assess the social effects of influenza activity [3–8]. However, since the emergence of COVID-19, excess mortality attributable to COVID-19 has been attracting attention [9] as a measure of the total effects of the disease because it can reflect cases which have not been identified as test positive.

In Japan, excess mortality was estimated using the National Institute of Infectious Diseases (NIID) model [10], which has been the official procedure for more than ten years. It was applied to two data sources: the national monthly deaths of all causes and the respective weekly pneumonia and influenza deaths in the 21 largest cities and their total. The latter is published regularly in Japanese during the influenza season as https://www.niid.go.jp/niid/ja/flu-m/2112-idsc/jinsoku/131-flu-jinsoku.html. Unfortunately, that publication ceased in March 2020 because it is intended for influenza. The first peak in Japan was April 3, 2020[11]: excess mortality cannot be detected until March. Instead, we applied NIID model to the all causes of death in the whole of Japan to evaluate impact of the outbreak of COVID-19.

2. Method

Excess mortality is defined as the difference between the actual number of deaths and an epidemiological threshold. The epidemiological threshold is defined as the upper bound of the 95% confidence interval (CI) of the baseline. The baseline is defined as the number of deaths that are likely to have occurred if an influenza outbreak had not occurred. Therefore, if the actual deaths are fewer than the epidemiological threshold, then excess mortality is not inferred.

The data used for this study were monthly deaths of all causes from 1987 through November 2023 for the whole of Japan and September 2023 for Tokyo [12]. NIID model, the Stochastic Frontier Estimation [13–19], is presented as

$log\ D_t = \alpha + \beta T_t + \gamma T_t^2 + \Sigma \eta_i M_{it} + \varepsilon_t$ and (1)

$\varepsilon_t = \nu_t + |\omega_t|$, (2)

where D_t represents all causes of death in month/year t, T_t denotes the linear time trend, and M_{it} is the dummy variable for a month, which is one if t is the i-th month and otherwise zero. Moreover, ν_t and ω_t are stochastic variables as $\nu_t \sim N(0, \mu^2)$ and $\omega_t \sim N(0, \xi^2)$; they are mutually independent. Although ν_t represents stochastic disturbances, ω_t denotes non-negative deaths attributable to influenza. These disturbance terms in this model are parameterized by two parameters: ξ/μ and $(\mu^2+\xi^2)^{0.5}$. If the null hypothesis $\xi/\mu=0$ is not rejected, then the Stochastic Frontier Estimation model is inappropriate.

Study areas were the whole of Japan and its capital, Tokyo. Study period foe estimation was from 1987 to November 2023 for the whole of Japan and up through September, 2023 for Tokyo. We adopted 5% as significant level.

3. Results

Table 1 summarized the estimation results in the whole of Japan and Table 2 for Tokyo. Figure 1 presents observed deaths, the estimated baseline, and its threshold in Japan. Figure 2 specifically depicts the period since emerging COVID-19. We found 12 and 104 excess mortality in August and October, 2020, and 260, 135, 4106, 5853 and 584 in May, June, August, September and October, 2021. In February, March, May -July 2022, 9705, 5396, 337, 748 and 2214 excess mortality was observed, respectively. These were 0.0, 0.1, 0.2, 0.1, 3.8, 5.5, 0.5, 7.8, 4.2, 0.3, 0.7 and 2.0 % of the baseline.

Especially, in August 2022 to January 2023, 18845, 14133, 8300, 6702, 18426 and 18404 excess mortality was observed, which means 16.8, 13.0,7.0, 13.7 and 12.7% of the baseline. In these six months, 84811 excess mortality were observed. It means that approximately 74% of total excess mortality during the COVID-19 pandemic was occurred in this six months. After July, 2023, excess morality was observed since response for pandemic in Japan had been discontinued. These were 1867, 10613, 10934, 6918 and 2642 excess morality and these mean 1.64, 9.19, 9.80, 5.67 and 2.1% of the base line.

Figure 3 and 4 showed the estimated result in Tokyo. We found 595 excess mortality in August and 150 excess mortality in September, 76 in October, 458 in December, 2020, 44 in January, 60 in April, and 762, 942 and 130 in August to October, 2021 which were 6.3, 1.7, 0.8, 4.1, 0.4, 0.6, 8.0, 10.2 and 1.3% of the baseline. Additionally, there were 1427, 1201, 166, 228, 184, 212, 2069, 970, 703, 543, 1444 and 1363 excess morality in February, 2022 to January, 2023. It mean 13, 11, 1.6, 2.3, 1.0, 2.2 , 21.0, 10.2, 6.8, 5.1, 12.3 and 11.0 % of the baseline. The largest excess mortality in Tokyo during the COVD-19 pandemic was 2069, which was more than 20% of the baseline and 18.9% of total of excess mortality in this pandemic, in August 2022. After pandemic, since July, 2023, 365, 941, and 1021 excess mortality which means 3.9, 9.3 and 10.5% of the baseline was observed.

4. Discussion

We found huge number of excess mortality even after response for pandemic of COVID-19 had been discontinued on May 8, 2023. Its magnitude was smaller than excess mortality in 2022, however, larger than excess mortality in 2020 and 2021. It may be sufficiently substantial to response for saving life especially among elderly people.

An international comparison of excess mortality caused by COVID-19 was published [20]. In this article, it reported 112 thousand excess mortality in Japan. It was about six times larger than the number of deaths confirmed COVID-19 infection. Conversely, we found about 27 thousand excess mortality in the same period. It was slightly larger than the number of deaths confirmed COVID-19 infection, however, it was almost comparable. In this sense, the international comparison may underestimate the baseline and overestimate excess mortality. It is well known bias in the careless estimation foe excess mortality [21]. Hence, international comparison might be less precise estimation than this study. Overestimation of excess mortality might mislead to inappropriate policy or counter measures and inflate its disease burden.

5. Conclusion

We found substantial excess mortality since response for pandemic of COVID-19 had been discontinued on May 8, 2023. These were smaller than excess morality in 2022, however larger than in 2020 and 2021. Therefore, it was not able to ignore.

The present study is based on the authors' opinions: it does not reflect any stance or policy of their professionally affiliated bodies.

6. Acknowledgement

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7. Conflict of interest

The authors have no conflict of interest to declare.

8. Ethical considerations

All information used for this study was published on the web site of MHLW [12]. Therefore, no ethical issue is presented.

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Table 1 NIID Model estimation results since 1987 until Novemer 2023 in Japan

Explanatory variables	Estimated coefficients	*p*-value
Constant	11.12	<0.0004
Time trend	0.001537	<0.0004
Time trend ^{2}	0.0000009763	0.423
January	0.07075	<0.0004
February	-0.05631	<0.0004
March	-0.01671	0.053
April	-0.1027	<0.0004
May	-0.1247	<0.0004
June	-0.2126	<0.0004
July	-0.1776	<0.0004
August	-0.1710	<0.0004
September	-0.2083	<0.0004
October	-0.1197	<0.0004
November	-0.08768	<0.0004
ξ/μ	2.386	<0.0004
$(\mu^2+\xi^2)^{0.5}$	0.04934	<0.0004

Note: The number of observations was 442. The estimated log likelihood was 915.5. ξ^2 denotes the variance of the non-negative disturbance term. μ^2 is the variance of the disturbance term.

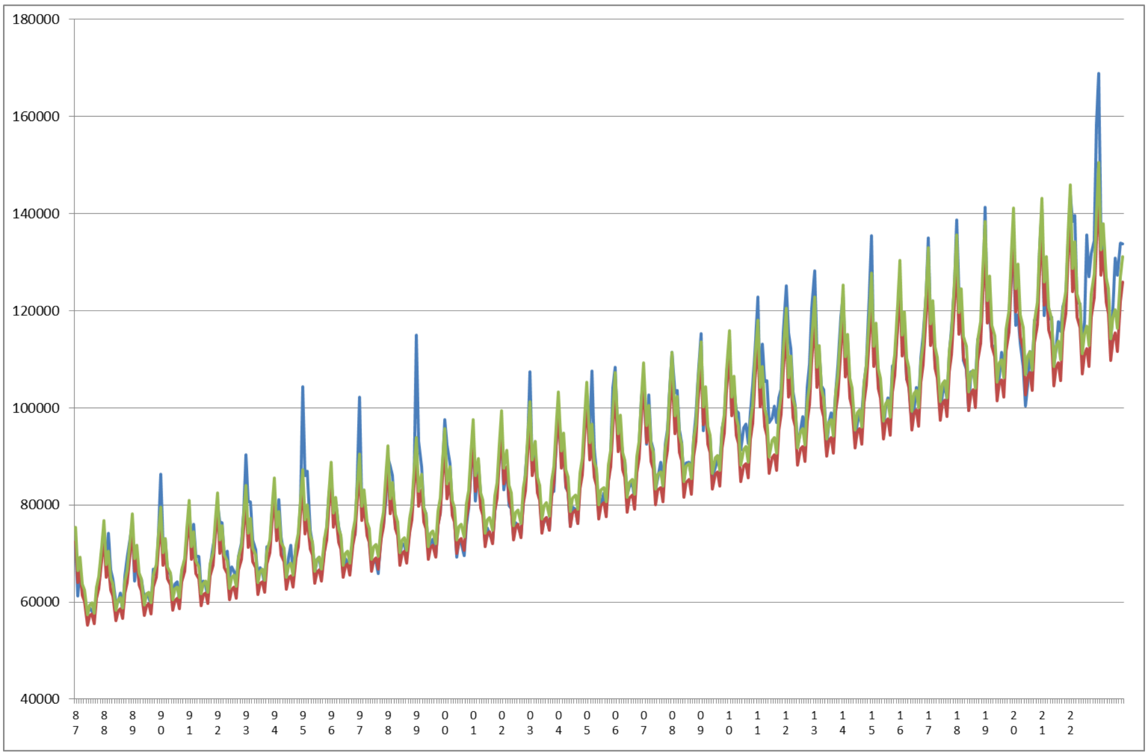
Table 2 NIID Model estimation results since 1987 until September 2023 in Tokyo

Explanatory variables	Estimated coefficients	*p*-value
Constant	8.55	<0.0004
Time trend	0.00186	<0.0004
Time trend ^{2}	$-0.726*10^{-6}$	0.001
January	0.0759	<0.0004
February	0.137	<0.0004
March	0.0292	0.015
April	0.0479	<0.0004
May	-0.0271	0.111
June	-0.0584	<0.0004
July	-0.111	<0.0004
August	-0.0664	<0.0004
September	-0.0719	<0.0004
October	-0.108	<0.0004
November	-0.0253	0.102
ξ/μ	2.44	<0.0004
$(\mu^2+\xi^2)^{0.5}$	0.0684	<0.0004

Note: The number of observations was 438. The estimated log likelihood was 817.9. ξ^2 denotes the variance of the non-negative disturbance term. μ^2 is the variance of the disturbance term.

Figure 1: Observations of the estimated baseline and threshold since 1987 until November 2023 in Japan

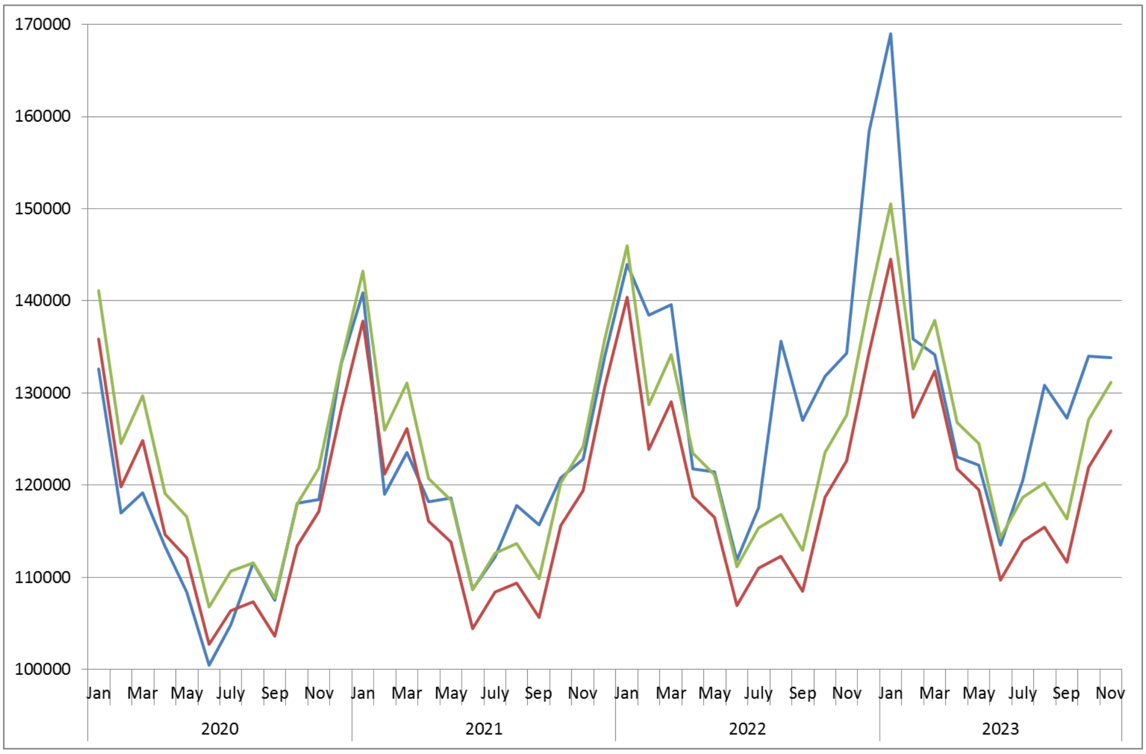
(persons)



Month/Year

Note: The blue line represents observations. The red line represents the estimated baseline. The green line shows its threshold.

Figure 2: Observation of the estimated baseline and threshold since January 2020 in Japan (persons)

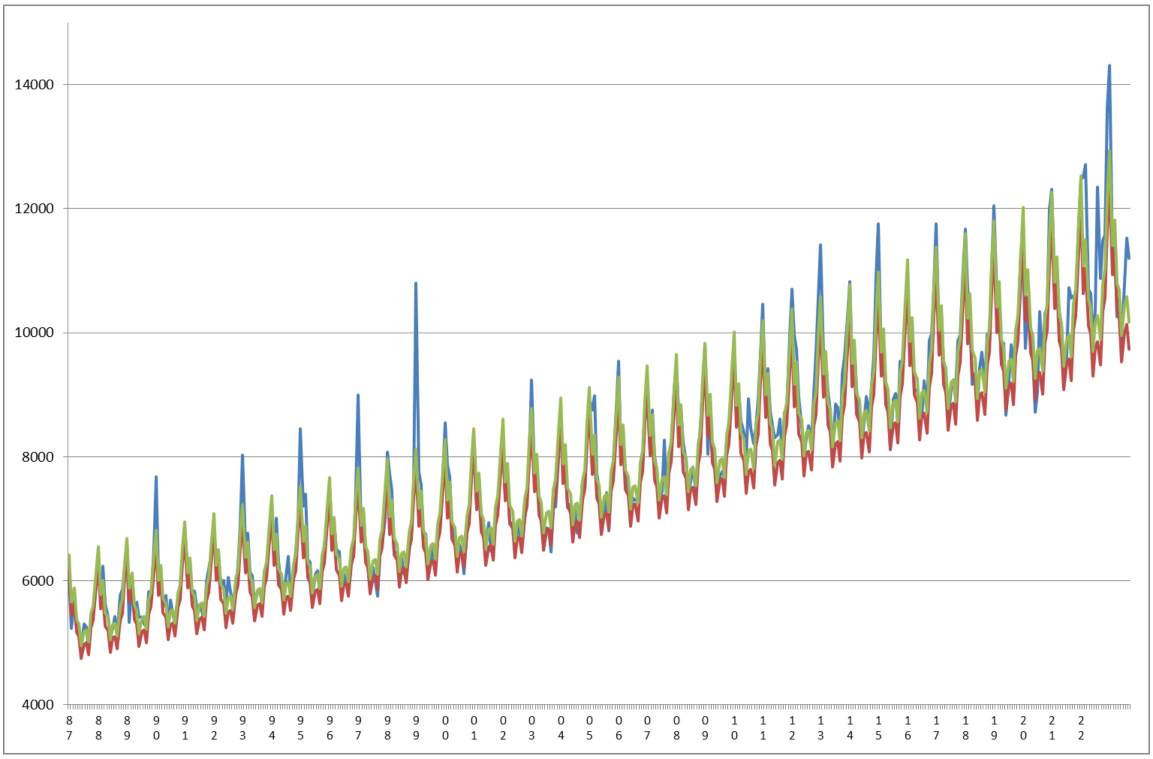


Month/Year

Note: The blue line represents observations. The red line represents the estimated baseline. The green line shows its threshold.

Figure 3: Observations of the estimated baseline and threshold since 1987 until September 2023 in Tokyo

(persons)

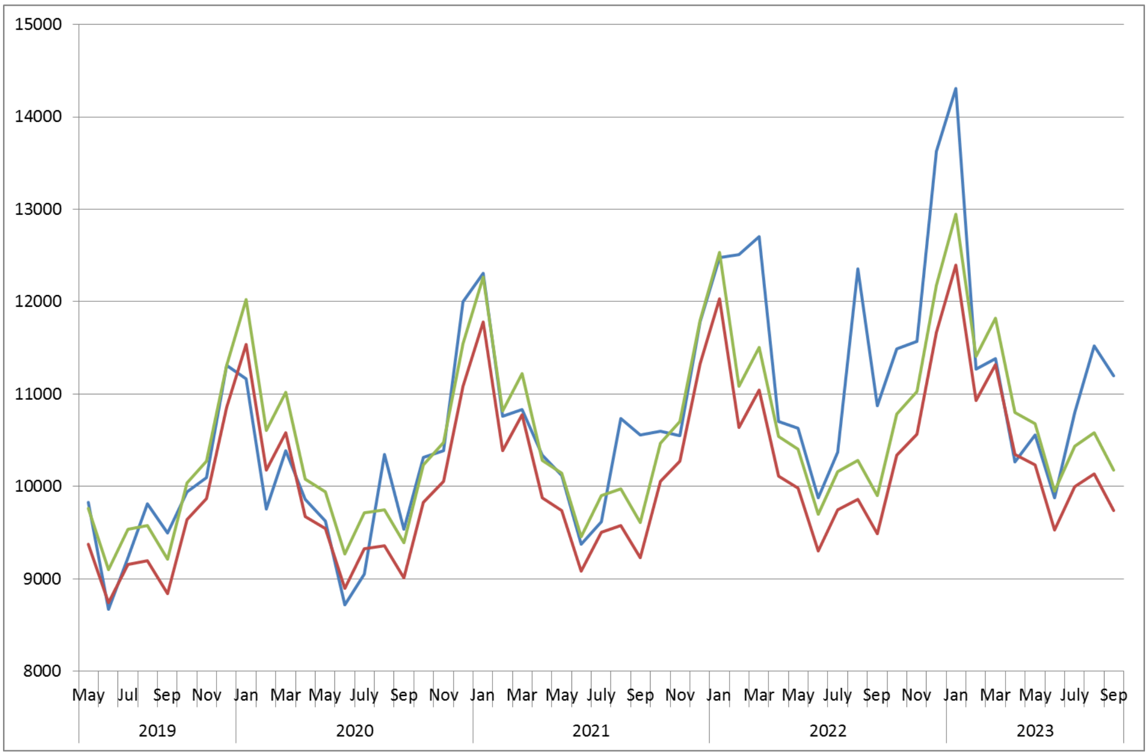


Month/Year

Note: The blue line represents observations. The red line represents the estimated baseline. The green line shows its threshold.

Figure 4: Observation of the estimated baseline and threshold since May 2019 until July, 2023 in Tokyo

(persons)



Month/Year

Note: The blue line represents observations. The red line represents the estimated baseline. The green line shows its threshold.