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Original Research

Indirect impact of the COVID-19 pandemic on the incidence of non–COVID-19 infectious diseases: a region-wide, patient-based database study in Japan



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ABSTRACT

Objectives: The COVID-19 pandemic has forced people to change many behaviours, including physical distancing, hygiene measures and lifestyles. This study aimed to evaluate the indirect impact of the COVID-19 pandemic on the incidence of non–COVID-19 infections and medical care costs/visits using health insurance claims.

Study design: This was an observational study using patient-based administrative claims covering approximately 800,000 insured persons and their dependents in the Mie Prefecture in Japan.

Methods: This study identified non–COVID-19 infectious disease incidences, number of outpatient visits and healthcare costs between 2017 and 2021. Each year was divided into quarters. The adjusted incidence rate ratios (IRRs) during the pandemic (January 2020 to September 2021) and during the pre-pandemic period (January 2017 to December 2019) were determined using Poisson regression.

Results: The adjusted influenza IRRs from April 2020 were close to zero. The incidence of upper respiratory tract infections and bacterial pneumonia was significantly reduced (IRRs range: 0.39–0.73 and 0.43–0.84, respectively). Gastrointestinal and urinary tract infection incidences decreased by approximately 30% and 10%, respectively. In contrast, sexually transmitted infections (STIs), including syphilis, gonococcal infection and *Chlamydia trachomatis* infection, did not decrease during the pandemic but increased significantly between April and June 2021 (adjusted IRR, 1.37; 95% confidence interval, 1.18–1.60). The adjusted IRRs for outpatient visits and healthcare costs were 0.86–0.93 and 0.91–0.97, respectively.

Conclusions: In contrast to other infections, STIs did not decrease during the COVID-19 pandemic. The IRR of STIs during the pandemic period is an area of public health concern. Appropriate screening and medical consultations are strongly recommended.

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Introduction

COVID-19 was first identified in Wuhan, China, in December 2019 and has spread worldwide, resulting in a global pandemic.¹ The emergence of COVID-19 led to the implementation of

physical/social distancing measures, such as lockdowns, restrictions on movement between countries and wearing masks in many regions, which had a substantial impact population behaviours and lifestyles. Healthcare institutions, including clinics and hospitals, have been forced to redeploy resources to cope with COVID-19, thus impacting their ability to provide other healthcare services.² Furthermore, the COVID-19 pandemic and physical/social distancing changed behaviours around attending medical appointments.^{3,4} As a result of these factors, the COVID-19 pandemic had an indirect impact on the incidences of other infectious

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diseases.^{5–9} A previous report using claims data from 262 Japanese hospitals found a 48% reduction in the number of inpatient cases of community-acquired pneumonia.⁵ Similar studies from Italy and England also reported an indirect impact on the incidence of community-acquired infections.^{7,8} However, previous reports were mostly limited to hospital-based studies and lacked data regarding outpatient settings. Studies using patient-based databases covering all medical care provided to individuals are warranted to evaluate epidemics of infectious diseases.

The first case of COVID-19 in Japan was reported in January 2020. The Japanese government declared a nationwide state of emergency between April and May 2020 and between January and February 2021, and quasi-emergency measures were implemented several times, depending on the prefecture. Under these measures, citizens were requested to stay home, and business services, such as restaurants or mass-gathering events, were restricted or suspended.¹⁰ In Japan, many citizens have been wearing masks outside their homes and implementing physical/social distancing measures since the COVID-19 outbreak. To evaluate the indirect impact of the COVID-19 pandemic on the incidence of other infectious diseases, this investigation conducted a descriptive study using a region-wide patient-based claims database in Japan.

Methods

Data sources

An observational study was conducted using the administrative health insurance claims database of the Mie Prefecture, which is in the central region of Japan and had a population of approximately 1.8 million between January 2017 and September 2021. In Japan, all citizens are enrolled in a universal health coverage insurance programme provided by the social insurance system (for employees aged <75 years), the national health insurance system (for self-employed or unemployed people aged <75 years) and the late elders' health insurance system (for people aged ≥75 years). The database used in the present study covers approximately 800,000 residents in the Mie Prefecture (44% of the population) who were beneficiaries of the National Health Insurance or the Late Elders' Health Insurance System. Accordingly, participants in this study were likely to be older than the general Japanese population. The database comprises medical and pharmacy claims. Medical and pharmacy claims are linked using anonymised identification numbers, which are specifically generated by combining sex, birthdate and insurance identification numbers. Monthly information on patient demographics, including year and month of birth, sex, diagnosis, date of diagnosis, medical procedures and medications are provided. Diagnoses were recorded by physicians of each medical facility and coded according to the International Classification of Diseases and Related Health Problems, 10th Revision (ICD-10). This study was conducted in accordance with the Declaration of Helsinki and was approved by the Ethics Committee of Jichi Medical University Hospital (approval number 21-198). The requirement for informed consent was waived owing to the retrospective study design and use of anonymised data.

Data preparation and measures

Medical and pharmacy claims in the database were linked using the unique identification number for each individual, and incidences of non-COVID-19 infectious diseases were identified. The non-COVID-19 infectious diseases analysed in the study were as follows: influenza, upper respiratory tract infection (URI), bacterial pneumonia, gastrointestinal infections, urinary tract infection (UTI), syphilis, gonococcal infection and *Chlamydia trachomatis* infection. Each non-COVID-19 infectious disease was defined by

ICD-10 codes as follows: influenza (J10, J11), URI (J00–J069), bacterial pneumonia (J13–J16, J18), gastrointestinal infections (A00–A05, A08, A09), UTI (N10, N12, N151, N300, N309, N390), syphilis (A51–A53), gonococcal infection (A54) and *C. trachomatis* infection (A55, A56). Of these infections, syphilis, gonococcal and *C. trachomatis* infections were defined as a combination of ICD-10 codes and diagnostic tests (serological testing for syphilis and chlamydia, nucleic acid amplification or antigen detection testing for *Neisseria gonorrhoeae* and *C. trachomatis*) within 7 days of the date of diagnosis. Similarly, bacterial pneumonia and UTI were defined as a combination of ICD-10 codes and systemic antibiotic prescriptions (Anatomical Therapeutic Chemical classification code J01) within 7 days of the date of diagnosis. The diagnosis code of the same disease appearing within 90 days was considered the same event and excluded. Sexually transmitted infections (STIs) are defined as the total number of syphilis, gonococcal and *C. trachomatis* infections. Admission due to bacterial pneumonia was defined as a combination of ICD-10 codes, systemic antibiotic prescription within 7 days of diagnosis and admission within 7 days of diagnosis; the proportion of hospitalisations for bacterial pneumonia was calculated. If the incidence per month was less than 10, an accurate number of incidences would not be disclosed to protect personal confidence. Furthermore, data on the total number of outpatient visits and healthcare costs were extracted from medical and pharmacy claims.

Data analyses

Monthly crude incidences and trends for non-COVID-19 infectious diseases, the number of outpatient visits and healthcare costs were described. The study duration was divided into two periods: before (January 2017 to December 2019) and during (January 2020 to September 2021) the COVID-19 pandemic. Each year was divided into quarters (January to March, April to June, July to September and October to December), and event incidences in the pandemic period were compared with the prepandemic period. The incidences were adjusted for the annual number, age and sex of the insured persons and their dependents. Adjusted incidence rate ratios (IRRs) were estimated using Poisson regression. The proportion of hospitalisations for bacterial pneumonia was compared before and during the COVID-19 pandemic using the Chi-squared test. All hypothesis tests were two tailed, with a significance level of 5%. All statistical analyses were performed using R (version 4.1.1; R Foundation for Statistical Computing, Vienna, Austria).

Results

A total of 800,444 insured individuals and their dependents were identified in 2017. Of these, 53,197 (6.6%), 242,733 (30.3%) and 504,514 (63.0%) were aged <20 years, 20–64 years and ≥65 years, respectively. The trend in the annual number of insured persons, including their dependents, is shown in [Supplementary Table S1](#).

[Fig. 1](#) shows the trends of monthly crude incidences of non-COVID-19 infectious diseases from January 2017 to September 2021. Influenza events declined dramatically, almost to the point of cessation, from April 2020. In the influenza season, 33,862 and 23,145 events were identified during the 2017–2018 and 2018–2019 seasons, respectively, whereas 11,878 events occurred during the 2019–2020 season, and only 65 events were identified during the 2020–2021 season. During the COVID-19 pandemic, the number of URI and bacterial pneumonia events also decreased by half compared with prepandemic numbers.

The monthly crude incidences of non-COVID-19 infectious diseases, number of outpatient visits and healthcare costs are shown in [Supplementary Table S2](#). The average number of

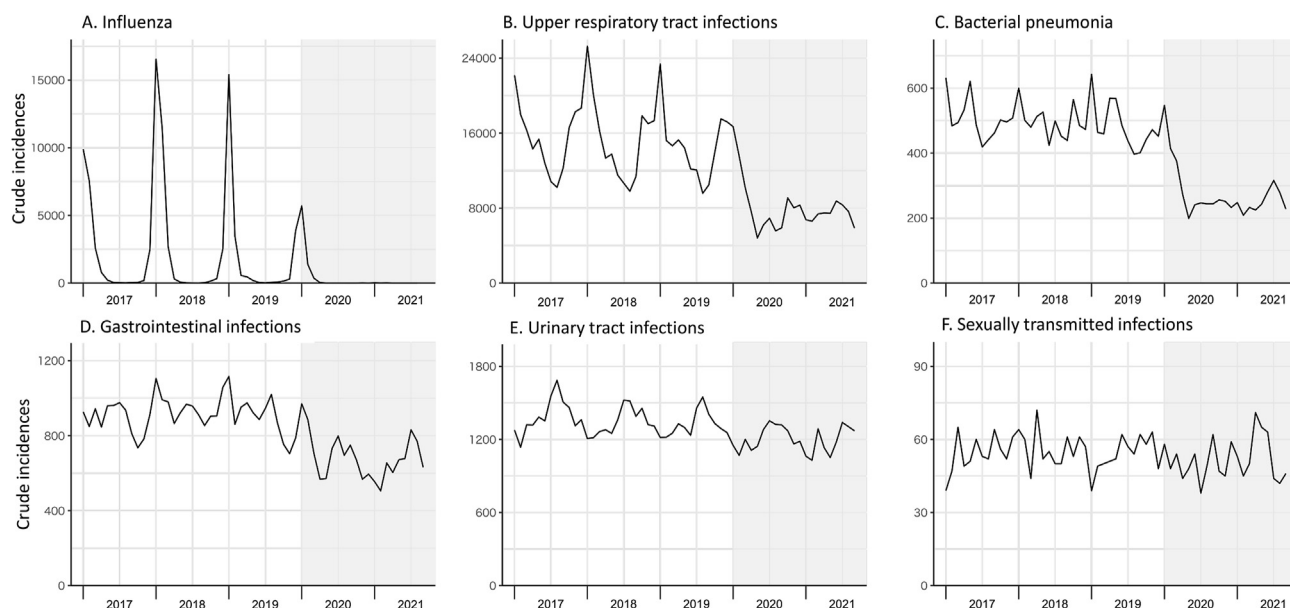


Fig. 1. Trends of monthly crude incidences for infectious diseases before the COVID-19 pandemic (from 2017 to 2019) and during the pandemic (from January 2020 to September 2021). (A) Influenza, (B) upper respiratory tract infections, (C) bacterial pneumonia, (D) gastrointestinal infections, (E) urinary tract infections and (F) sexually transmitted infections. The grey background represents the COVID-19 pandemic phase.

outpatient visits was 2,512 and 2,325 per 1,000 persons per month before and during the COVID-19 pandemic, respectively. The average healthcare costs were 38,299,000 and 37,365,000 Japanese yen (approximately 320,000 and 311,000 US dollars when converted to 120 yen to the dollar) per 1,000 persons per month before and during the COVID-19 pandemic periods, respectively.

The results of the adjusted IRRs of infectious diseases, number of outpatient visits and healthcare costs during the COVID-19 pandemic compared with the prepandemic period are presented in Table 1. A remarkable decrease (>94%) in influenza incidence was observed after April 2020. The incidence of URI and bacterial pneumonia also significantly decreased (by approximately 50%) from April 2020 to June 2021, although the adjusted IRRs slightly increased in July to September 2021. In contrast, the proportion of hospitalisations among all bacterial pneumonia episodes was significantly elevated from 25.1% before the COVID-19 pandemic to 29.3% during the pandemic (risk difference, 4.2% [95% confidence interval (CI), 2.6%–5.9%]; $P < 0.001$). The incidence of gastrointestinal infections and UTIs also decreased significantly (by approximately 30% and 10%, respectively) during the pandemic period. Meanwhile, the incidence of STIs did not decrease during the COVID-19 pandemic period, with a significant increase observed in April to June 2021 (adjusted IRR, 1.37 [95% CI, 1.18–1.60]). The trends in adjusted IRRs of STIs by gender for each quarter are shown in Supplementary Table S3. STIs incidence among women significantly increased in April to June 2021 (adjusted IRR, 1.41 [95% CI, 1.20–1.65]), which was not observed among men (adjusted IRR, 0.90 [95% CI, 0.47–1.72]).

The number of outpatient visits and healthcare costs also significantly decreased throughout the pandemic period; the adjusted IRRs of outpatient visits ranged from 0.86 to 0.93, and those of healthcare costs ranged from 0.91 to 0.97, respectively (Table 1).

Discussion

In this region-wide study using a patient-based claims database, a significant reduction in non-COVID-19 respiratory infections, acute gastroenteritis and UTIs was reported during the COVID-19

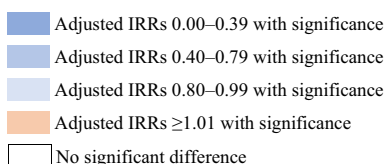
pandemic; however, an increase in STIs was observed. An indirect impact on the incidence of non-COVID-19 diseases has been reported in several countries. Kadambari et al. analysed trends in paediatric hospitalisations for 19 infectious diseases using data from all NHS hospitals in England.¹¹ The authors reported a 94%, 66%, 82% and 60% reduction in hospital admissions for influenza, URI, bronchiolitis and pneumonia, respectively. A 32% reduction in community-acquired pneumonia in people aged ≥ 65 years was observed in a region-wide study of individuals using the public healthcare system in Tuscany, Italy.⁷ In Japan, Nagano et al. and Yan et al. reported a 50% decrease in the number of hospitalised patients with community-acquired pneumonia during the COVID-19 pandemic.^{5,12} However, these previous studies were conducted using hospital databases and did not cover medical care provided in clinics, where most outpatients visit. The observed decreases in non-COVID-19 infectious diseases, including those seen in the present study, could be due to a reduction in the disease incidence or behavioural changes as part of stay-at-home mandates. This study observed a significantly greater reduction in non-COVID-19 respiratory infections, including influenza, URI and bacterial pneumonia, and gastrointestinal infections, compared with the number of outpatient visits. UTIs also decreased slightly, although the reduction rate was similar to that of outpatient visits. Therefore, the decline in the incidence of UTIs and the number of outpatient visits may have also impacted the rate of reported UTIs. The decline in the incidence of non-COVID-19 respiratory tract infections continued throughout the pandemic, including when the prevalence of COVID-19 cases was low and when the region was not in a declared state of emergency. Behavioural changes, including physical/social distancing, wearing masks and hygiene measurements, are likely to be the main reasons for this decline. In addition, the current claims-based study does not rule out the possibility that infectious diseases were underdiagnosed because people avoided visiting clinics or hospitals in association with stay-at-home recommendations.

The decrease in the incidences of gastrointestinal infections and UTIs, which showed a 10%–39% and 9%–13% reduction, respectively, in this study, were reported in several other studies.^{8,9} In Germany, during the pandemic period (from April 2020 to March 2021), the number of patients with gastrointestinal infections and UTIs

Table 1
Adjusted incidence rate ratios (IRRs) and 95% confidence intervals of infectious diseases, outpatient visits and healthcare costs during every quarter of the COVID-19 pandemic period compared 2017–2019 (prepandemic period).

Infectious diseases, outpatient visits, healthcare costs	2020				2021		
	Jan.–Mar.	Apr.–Jun.	Jul.–Sep.	Oct.–Dec.	Jan.–Mar.	Apr.–Jun.	Jul.–Sep.
Influenza	0.34 (0.33–0.35)	0.06 (0.04–0.08)	0.05 (0.02–0.13)	0.00 (0.00–0.01)	0.00 (0.00–0.00)	0.01 (0.00–0.02)	0.06 (0.03–0.15)
Upper respiratory tract infections	0.72 (0.72–0.73)	0.46 (0.46–0.47)	0.58 (0.57–0.59)	0.51 (0.50–0.52)	0.39 (0.39–0.40)	0.61 (0.60–0.62)	0.73 (0.72–0.74)
Bacterial pneumonia	0.84 (0.79–0.89)	0.44 (0.41–0.48)	0.54 (0.50–0.58)	0.49 (0.46–0.53)	0.43 (0.40–0.47)	0.49 (0.45–0.53)	0.64 (0.60–0.69)
Gastrointestinal infections	0.90 (0.86–0.94)	0.67 (0.64–0.71)	0.82 (0.78–0.86)	0.73 (0.70–0.77)	0.61 (0.58–0.64)	0.75 (0.71–0.78)	0.85 (0.81–0.89)
Urinary tract infections	0.91 (0.88–0.95)	0.89 (0.85–0.92)	0.87 (0.84–0.90)	0.88 (0.85–0.92)	0.92 (0.89–0.96)	0.87 (0.83–0.90)	0.88 (0.85–0.91)
Sexually transmitted infections	1.13 (0.95–1.34)	0.94 (0.79–1.12)	0.96 (0.81–1.14)	0.95 (0.80–1.14)	1.13 (0.95–1.34)	1.37 (1.18–1.60)	0.90 (0.76–1.08)
Outpatient visits	0.93 (0.93–0.93)	0.86 (0.86–0.86)	0.90 (0.90–0.90)	0.89 (0.89–0.89)	0.90 (0.89–0.90)	0.91 (0.91–0.91)	0.91 (0.91–0.91)
Healthcare costs	0.97 (0.97–0.97)	0.91 (0.91–0.91)	0.94 (0.94–0.94)	0.93 (0.93–0.93)	0.96 (0.96–0.96)	0.96 (0.96–0.96)	0.95 (0.95–0.95)

COVID-19, coronavirus disease 2019



decreased by 36% and 11%, respectively, compared with the prepandemic period (from April 2019 to March 2020).⁸ A study from Finland found that the incidence of cystitis among children was 11%–12% lower in 2020 than in 2017–2019.⁹ Interestingly, the reduction rate of UTIs was similar to that in the present study, although measures of social restrictions and the scale of COVID-19 epidemics varied in different countries. UTIs have been considered non-communicable diseases; therefore, improved hygiene measurements during the pandemic may have also contributed to the reduction in occurrence.⁹

In this study, the IRRs of STIs (syphilis, chlamydia and gonococcal infections combined with diagnostic tests) did not decrease in 2020 and increased significantly in April to June 2021. The indirect impact of COVID-19 on the incidence of STIs has also been reported in the United States. Kelly et al. reported a decrease in the number of reported cases of chlamydial diseases (31%), late syphilis (19%), early syphilis (15%) and gonorrhoea (13%) during January to June 2020 compared with January to June 2019 using California surveillance data.¹³ In this report, delays in diagnosis and treatment were a concern. It was stated that urgent interventions by healthcare providers and public health officers were needed to help mitigate the pandemic’s negative consequences on STI control. In the Japanese national surveillance system, the number of diagnoses of syphilis decreased in 2020 (3,046 cases) compared with 2019 (3,753 cases); however, it increased in 2021 (4,497 cases).¹⁴ There are several hypotheses about the potential factors associated with the increase in STIs during the COVID-19 pandemic. According to the US Center for Disease Control and Prevention,¹⁵ (1) more people may seek screening or care after lifting restrictions; (2) people with STIs may transmit the infection to others for longer periods because of the reduced access to health care; and (3) social restriction measures may have changed the sexual behaviour of individuals, including an increase in new sexual partners or networks.

The present study also showed a gender difference in the trend of incidence of STIs. However, there is concern that STIs may be underdiagnosed, particularly in men compared with women. It is suggested that chlamydial infection, which is the most common STI and often has little or no symptoms in men, is one of the pivotal

factors. Underdiagnosis or underreporting of chlamydia may be due to decreased screening during the pandemic.^{15,16} This may be a serious public health concern, and appropriate screening and medical consultations are strongly recommended. Health promotion strategies and warnings aimed at the public and healthcare providers are also needed.

This study evaluated the number of outpatient visits and healthcare costs. Throughout the pandemic period, the decline in healthcare costs was marginal (3%–9%) compared with the decline in outpatient visits (7%–14%). These results are consistent with a previous study that reported a 6.3% decrease in Japanese acute care hospital charges in April and May 2020 (the first wave of the pandemic).¹⁷ The present study revealed that the declines in outpatient visits and healthcare costs continued through to September 2021 (the end of the fifth wave). The reported number of non-infectious diseases, such as malignant tumours, decreased during the pandemic, and treatment for malignancies was delayed due to the depletion of medical resources in association with the COVID-19 pandemic.^{18,19} In the present study, an approximately 20% decrease in the number of surgeries for gastrointestinal cancers was observed during the COVID-19 pandemic when the state of emergency or quasi-emergency measures were implemented (data not shown).

Several studies have described the indirect impact of COVID-19 on healthcare utilisation.^{20,21} Recently, Perofsky et al. reported a substantial decline in hospitalisations and emergency department visits unrelated to COVID-19.²⁰ The authors were concerned about the delay in seeking care among high-risk patients and potential future increases in morbidity or mortality. STIs were the greatest concern in this study; screening, diagnosis and treatment need to be provided extensively to prevent further transmission, even if patients have mild or no symptoms or if people are under social restrictions from the public health perspective.

The strength of the present study is its large, population-based data set covering 800,000 residents. Various infectious diseases were evaluated simultaneously, focusing on the difference between non-COVID-19 infections and STIs; it was observed that the COVID-19 pandemic impacted different diseases to a varying extent.

The present study also has several limitations. First, the results may not be representative of the whole of Japan because the claims database used in this study was composed of claims from only one prefecture. Second, because an administrative claims database was used, the accuracy of the diagnosis was not validated. However, changes and trends were considered possible to evaluate because the recording of the diagnosis, testing and treatment behaviour of healthcare providers probably did not change. Third, only the incidence of disease was evaluated; therefore, data regarding disease severity or mortality were not included in the present analysis. Finally, although several cofactors may exist between the COVID-19 pandemic and the incidence of non-COVID-19 illnesses, this study could not assess the magnitude of the effect of each mediator, such as social restrictions, physical distancing and hygiene measures.

In conclusion, this patient-based claims database study revealed that the incidence of non-COVID-19 respiratory tract and gastrointestinal infections dramatically decreased during the COVID-19 pandemic. UTIs also decreased slightly, whereas STIs did not decrease, but rather increased, and large STI epidemics are of concern. Despite behavioural restrictions and changes due to the COVID-19 pandemic, there remains a need for appropriate and continued STI screening and promotion of care-seeking behaviours among at-risk individuals.

Author statements

Ethical approval

This study was conducted in accordance with the Declaration of Helsinki and was approved by the Ethics Committee of Jichi Medical University Hospital (approval number 21-198).

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Competing interests

None declared.

Authors' contributions

N.K., H.H., T.I. and S.H. designed the study. N.K., Y.H., K.G. and N.M. collected, organised and analysed the data and performed statistical analyses. N.K., H.H. and S.H. interpreted data. N.K. and S.H. drafted the article. All the authors critically revised the article for intellectual content. All authors have read and approved the final article.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.puhe.2022.10.018>.

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