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Impact of the COVID-19 pandemic on continuity of medical treatment for patients with chronic diseases in Japan: a retrospective cohort analysis

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Abstract

Background The COVID-19 pandemic has raised concerns about continuity of care for chronic diseases such as diabetes, hypertension, and dyslipidemia. Although studies have documented declines in healthcare utilization, few have assessed individual-level patterns of treatment interruption.

Methods We conducted a retrospective cohort analysis using administrative claims data (2018–2021) from a Prefecture, Japan. Eligible patients were diagnosed with and prescribed medications for diabetes mellitus, hypertension, or dyslipidemia in January of 2019 or 2020 and followed until December of each year. The primary outcome was the time-to- interruption of physician visits, defined as a gap of at least 60 days between follow-up visits. We used Cox proportional hazards regression, adjusted for age, sex, comorbidities, and prior healthcare utilization, to compare the risk of treatment interruption in 2020 (COVID-19 group) vs. 2019 (pre-pandemic group). Sensitivity analyses were performed with thresholds of 30 and 90 days. Logistic regression examined whether pandemic-related interruptions were associated with the likelihood of returning to treatment within one year.

Results A total of 410,911 patients met the inclusion criteria. Across all three chronic conditions, the hazard of interruption was significantly higher in 2020 than in 2019; adjusted HRs are 1.26 (95% CI = 1.17–1.36) for diabetes, 1.39 (95%CI = 1.31–1.47) for hypertension, and 1.24 (95%CI = 1.17–1.32) for dyslipidemia, respectively. No significant difference in resuming care was observed between the 2020 and 2019 interruptions (OR = 0.89; 95% CI = 0.81–1.09). Sensitivity analyses showed consistent findings, despite slight variations in hazard ratios for different gap thresholds.

Conclusions The COVID-19 pandemic was associated with an increased risk of treatment interruption in patients with chronic diseases, underscoring the need for targeted strategies to maintain care continuity during public health emergencies. While older patients and those with multimorbidity showed earlier interruptions, the overall patterns persisted across disease groups, emphasizing the importance of preemptive measures and patient outreach to prevent delayed or forgone care.

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Keywords COVID-19, Chronic disease management, Treatment interruption, Continuity of care, Administrative claims data

Background

The coronavirus disease 2019 (COVID-19) pandemic significantly disrupted healthcare systems worldwide, including Japan, where a state of emergency led to restrictions on non-essential activities and reduced medical services such as health check-ups, outpatient visits, and hospitalizations [1, 2]. These changes raised concerns about continuity of care, particularly for patients with chronic diseases such as diabetes, hypertension, and dyslipidemia [3–7].

Chronic disease management relies on regular monitoring to prevent complications [8–10]. For example, Japanese guidelines recommend bi-monthly visits for diabetes management [11], while treatment adherence is crucial for hypertension and dyslipidemia to prevent cardiovascular events and avoid unnecessary hospitalizations [12, 13]. In addition, the Japanese government has promoted better management of diabetes, hypertension, and dyslipidemia through the incentive system of continuous follow-up visits for chronic disease patients to ensure continuous care and promote monitoring of patient condition [14]. Japanese local governments are legally required to strategize medical plans to provide adequate care for chronic diseases, such as diabetes mellitus, within the framework of the healthcare delivery system [15]. Studies have reported overall declines in healthcare utilization during COVID-19 [16–21], but few have examined individual patient behaviors. Treatment interruptions can result from various factors, including patient concerns about infection risk, limited healthcare access, and systemic healthcare adjustments [22–24]. However, existing research largely focuses on healthcare demand rather than the specific patterns of treatment discontinuation.

This study analyzes administrative claims data to assess the impact of COVID-19 on treatment continuity for chronic disease patients in Japan. It aims to clarify how the pandemic influenced medical visits, particularly in terms of interruption of physician visits and subsequent healthcare-seeking behavior. Findings will provide insights for future healthcare planning to maintain chronic disease care during public health crises.

Methods

Study design and data source

In this retrospective cohort study, we analyzed the administrative database of health insurance claims between 2018 and 2021 in Mie Prefecture, Japan, as well as in our previous study [25, 26]. The database includes data on self-employed individuals, retirees, and individuals aged 75 years or older. The claims database stores unique identifiers, beneficiary characteristics(sex and birth date), and treatment history information (diagnosis, medical procedures, prescriptions, and medical fees). Diagnostic information is recorded using the International Statistical Classification of Diseases and Related Health Problems, 10 th Revision (ICD-10) and more detailed codes of the Japanese disease names. Medical procedures are recorded using Japanese medical practice codes. Prescription histories are recorded using the 2016 version of the World Health Organization (WHO) anatomical therapeutic chemical (ATC) classification and their corresponding Japanese drug codes. We obtained patient data regarding sex, age, diagnosis, and time of each physician visit.

This study was performed in accordance with the Declaration of Helsinki. Our study was approved by the Institutional Review Board of Institute for Health Economics and Policy (approval number: R4-010). The requirement for informed consent was waived by the Institutional Review Board because of the anonymized nature of our data in accordance with the Ethical Guidelines for Medical and Health Research Involving Human Subjects published by the Ministry of Health, Labor, and Welfare of Japan.

Patient selection

We identified patients who were diagnosed with and received treatment prescriptions for hypertension, diabetes mellitus, and dyslipidemia between January 2019 and December 2020, which a previous study used to validate a published algorithm [27]. Diagnoses was identified using the recorded ICD-10 codes (I10–I15, E11–E14, and E78). Prescription history was identified using the following recorded WHO-ATC codes for January each year: C08 (calcium channel blockers) and/or C09 (agents acting on the renin-angiotensin system), A10 (drugs used in diabetes mellitus), and C10 (lipid-modifying agents). We collected patient claims data until December of the same year. We targeted patients with claims data recorded in January and follow-up data until December of each year. We excluded patients with a history of admission, change in insurance, or death before the end of the observation period. Additionally, patients with only one physician visit during the observation period were excluded as their outcomes could not be assessed.

Outcome and variables

We used the first visit of each patient in January as the index date and collected diagnostic information as baseline characteristics, including diseases for which previous studies reported common co-occurring diseases among older adults [28] and the pandemic had a high impact on reducing physician visits: COVID-19, low back pain, mental illness, dialysis, stroke, heart failure (HF), acute myocardial infarction (AMI), and cancer [16, 29]. To understand the proximity between patients and medical institutions, the medical facilities used by each patient in the previous year were recorded.

Our primary outcome was the interruption of physician visits, defined as the absence of revisits within 60 days of previous visits. This threshold was based on Japanese clinical practice guidelines, which recommend follow-up every one to two months for chronic disease management [11]. Japanese public health insurance has established a reimbursement system for outpatient management of diabetes, hypertension, and dyslipidemia based on continuous visits for at least two months [14]. There are no absolute criteria to determine discontinuation of treatment, but we adopt 60 days for this reason from the point of view of policy aspects and medical guidelines. It is important to note that our study defines treatment interruption as a lack of follow-up medical visits rather than direct medication adherence. Notably, our primary outcome reflects healthcare utilization patterns, including follow-up visits, are important indicators of chronic disease management quality because they indicate physician oversight, treatment adjustments, and patient engagement with healthcare services.

Time to treatment interruption was defined as the duration from a patient's first visit of the year (index: January) to the first occurrence of treatment interruption, which was determined as the first instance where no follow-up visit was recorded within 60 days. Patients who maintained regular visits throughout the study period were censored at the end of follow-up (December 31). Additionally, patients who were lost to follow-up due to death or insurance changes were censored at their last recorded visit. To further clarify this process, we have included a diagram illustrating different patient visit patterns and interruption scenarios, highlighting how time-to-event was determined under varying circumstances (Supplementary Fig. 1).

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Statistical analysis

To confirm changes in the volume of medical care provided in the target area, the number of outpatient visits for each disease state was tabulated by year and month. This aggregation does not identify individual patients but rather confirms changes in the total demand for medical care.

To assess the impact of the pandemic on the external environment, we divided the patients into two cohorts for each physician visit: before and during COVID-19. The first COVID-19 case in Japan was confirmed on January 14, 2020 [30]. We assigned patients' visits recorded in 2020 to the population affected by the COVID-19 epidemic (i.e., the exposed group) and compared them with the population which had visited in 2019 (control group). We summarized the characteristics of the eligible patients by year. Then, we compared the patient characteristics (disease condition and use of medical facilities in the previous year) and outcomes. Continuous variables are presented as means and standard deviations (SD) or medians and interquartile ranges (IQRs), as appropriate. Categorical variables are presented as frequencies and percentages.

We estimated the crude cumulative incidence of interruptions for one year using the Kaplan–Meier estimator [31]. We also compared the interruption rates between the groups by using a log-rank test. Adjusted hazard ratios (HRs) for COVID-19 were estimated using the Cox regression after adjusting for potential confounders, including age, sex, prescription for treatment of other targeted diseases, and disease conditions that could affect physician visits: COVID-19, low-back pain, mental illness, dialysis, stroke, HF, AMI, and cancer (stomach, colon, hepatic, lung, breast, bile duct, pancreas, prostate, and cervical). Additionally, we added the number of patients with COVID-19 per population of the municipality of residence as an adjusted variable as time-series data to adjust the effects of external factors that change over time [32]. The assumption of proportional hazards was graphically verified using Schoenfeld residual plots [31]. To evaluate whether specific subgroups were more vulnerable to the impact of treatment interruptions, HRs were calculated by dividing participants into the older (> 65 years old), non-older multimorbidity (No. of disease conditions ≥ 3), and non-multimorbidity groups. This subgroup analysis aimed to identify high-risk populations that may require targeted policy interventions to maintain treatment continuity during future public health crises.

Even if there were many interrupted visits during the COVID-19 pandemic, if patients were monitored by resuming visits, the severity of the illness might not be affected. The probability that a patient would return for follow-up visits might have depended on the visit interruption that occurred during the COVID-19 pandemic. To examine whether treatment interruption during the COVID-19 period was associated with a likelihood of returning to treatment, we performed a logistic regression analysis. The dependent variable was return to treatment within 12 months after interruption (1 = returned, 0 = did not return). The key independent variable was whether the interruption occurred during the COVID-19 period (2020) or in the pre-pandemic period (2019). We adjusted for potential confounders, including age, sex, comorbidities, and healthcare utilization in the last year.

For the sensitivity analysis, an evaluation was conducted in which the criteria for treatment interruption varied from 60 to 30 and 90 days. The impact of this change in criteria on the conclusions of the analysis was examined to confirm the robustness of the results.

All analyses were conducted using R software (version 4.3.1; R Foundation for Statistical Computing, Vienna, Austria). A significance level of 5% was used for all analyses.

Results

Figure 1 shows the flowchart of patient selection. Between January 2020 and January 2021, a total of 410,911 patients diagnosed with hypertension, diabetes mellitus, or dyslipidemia were identified. Specifically, 40,965 patients with hypertension, 22,503 with diabetes mellitus, and 23,615 with dyslipidemia were identified based on both the prescription records and diagnoses for each disease. After applying the exclusion criteria, the patients were categorized into two groups: during COVID-19 (2020 group) and pre-COVID-19 (2019 group). For hypertension, 18,187 and 17,208 patients were included in the 2019 and 2020 groups, respectively. The number of patients with diabetes mellitus was 11,970 and 11, 398 in 2019 and 2020, respectively. Finally, for dyslipidemia, there were 15,006 and 13,719 in the2019 and 2020 groups, respectively.

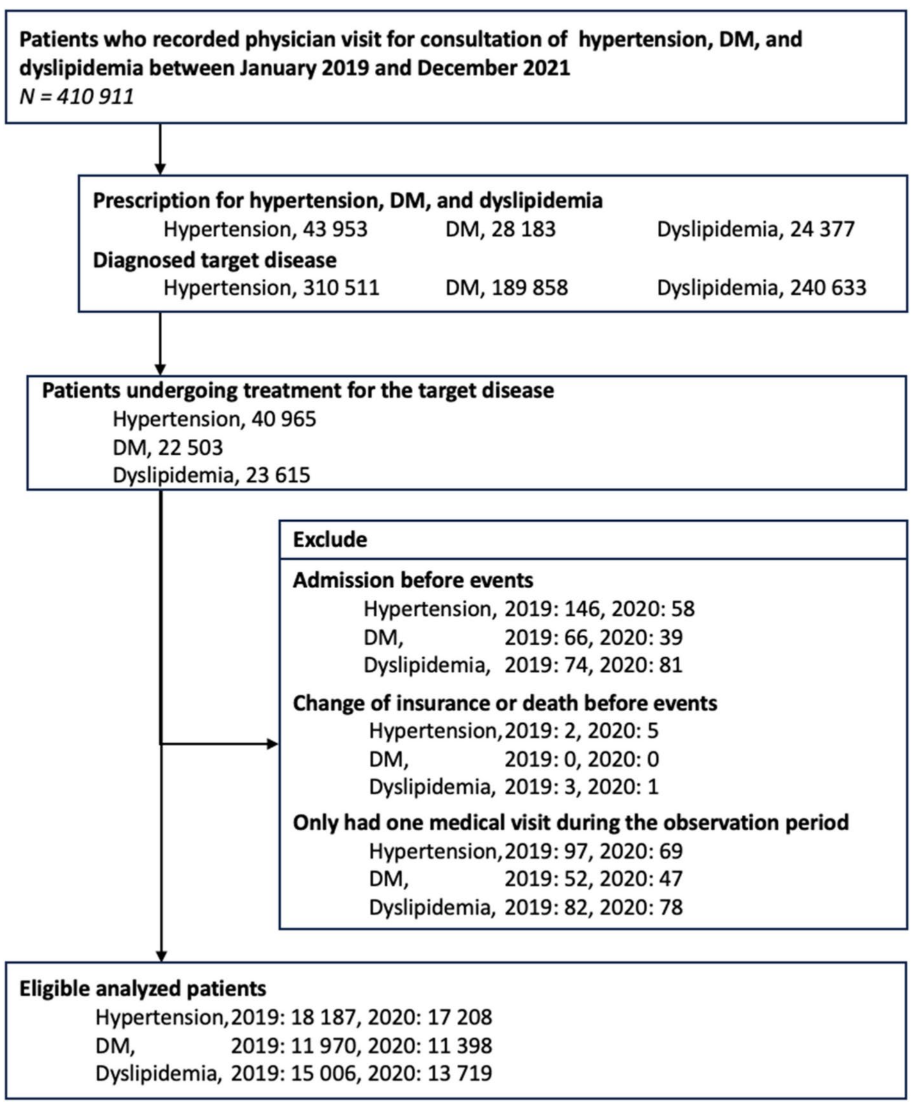

Fig. 1 Patient selection flow diagram

Table 1 Baseline characteristics of study population

Targeted Disease	*Diabetes Mellitus*		*Hypertension*		*Dyslipidemia*	
Variable	*2019, N = 11,970*	*2020, N = 11,398*	*2019, N = 18,187*	*2020, N = 17,208*	*2019, N = 15,006*	*2020, N = 13,719*
Sex, Female (%)	5,560 (46%)	5,269 (46%)	11,020 (61%)	10,357 (60%)	10,032 (67%)	9,170 (67%)
Age	75 (69, 81)	75 (70, 81)	78 (72, 84)	79 (72, 85)	76 (70, 81)	76 (70, 82)
Number of visits per patient	19 (13, 32)	18 (13, 30)	18 (13, 30)	17 (12, 28)	17 (12, 27)	16 (12, 26)
Low-back pain	2,349 (20%)	2,370 (21%)	13,895 (76%)	13,058 (76%)	3,477 (23%)	3,350 (24%)
Mental illness	926 (7.7%)	913 (8.0%)	1,531 (8.4%)	1,384 (8.0%)	1,244 (8.3%)	1,175 (8.6%)
Dialysis	337 (2.8%)	264 (2.3%)	260 (1.4%)	204 (1.2%)	106 (0.7%)	86 (0.6%)
Stroke	198 (1.7%)	199 (1.7%)	361 (2.0%)	339 (2.0%)	215 (1.4%)	192 (1.4%)
Heart failure	157 (1.3%)	183 (1.6%)	595 (3.3%)	532 (3.1%)	177 (1.2%)	159 (1.2%)
AMI	24 (0.2%)	22 (0.2%)	44 (0.2%)	37 (0.2%)	31 (0.2%)	27 (0.2%)
All cancer	1,047 (8.7%)	1,086 (9.5%)	1,422 (7.8%)	1,421 (8.3%)	896 (6.0%)	854 (6.2%)

N: Number of patients in each group, Continuous variables are presented as means and standard deviations (SD), Categorical variables are presented as frequencies and percentages

Table 2 Hazard ratios for each disease by age group and comorbid status

Group	*N*	*No. of events (%)*	*HR (95% CI)*
Diabetes Mellitus			
All patients	23,357	2,697(11.5)	1.26(1.17–1.36)
Older group (≧ 65 years- old)	20,330	2251(11.1)	1.27(1.17–1.38)
Adults (≦ 65 years-old,and > 17 years-old)	2,545	381(15.0)	1.17(0.96–1.43)
Multimorbidity group (No. of disease condition ≧ 3)	2,385	270(11.3)	1.15(0.91–1.47)
Non-multimorbidity group (No. of disease < 3)	20,972	2,427(11.6)	1.27(1.17–1.38)
Hypertension			
All patients	35,368	5,061(14.3)	1.39(1.31–1.47)
Older group (≧ 65 years- old)	32,739	4,568(14.0)	1.39(1.32–1.48)
Adults (≦ 65 years-old,and > 17 years-old)	2,171	414(19.1)	1.32(1.08–1.60)
Multimorbidity group (No. of disease condition ≧ 3)	8,048	1,185(14.7)	1.23(0.91–1.50)
Non-multimorbidity group (No.of disease < 3)	27,320	3,876(14.2)	1.40(1.32–1.49)
Dyslipidemia			
All patients	28,670	4,307(15.0)	1.24(1.17–1.32)
Older group(≧ 65 years- old)	25,572	3,710(14.5)	1.27(1.19–1.35)
Adults (≦ 65 years-old,and > 17 years-old)	2,552	500(19.6)	1.06(0.89–1.26)
Multimorbidity group (No. of disease condition ≧ 3)	2,102	301(14.3)	1.05(0.83–1.31)
Non-multimorbidity group (No. of disease < 3)	26,568	4,006(15.1)	1.26(1.18–1.34)

Table 2 presents the results of a Cox proportional hazards regression model, evaluating the time until treatment interruption across different patient groups. Treatment interruption was defined as the absence of physician visits for 60 consecutive days. Hazard ratios (HRs) and 95% confidence intervals (CIs) compare the risk of treatment interruption in 2020 relative to 2019 (reference group). HR higher than 1 indicates an increased risk of treatment interruption in 2020 compared to 2019. The model was adjusted for age, sex, comorbidities, and previous healthcare utilization patterns

Table 1 shows the baseline characteristics of the eligible patients. No patient with COVID-19 was identified. Ultimately, 410,911 individuals were included in the analysis. For patients with hypertension, there was no change in disease condition; however, the frequency of physician visits decreased. Notably, the number of patients who discontinued visits increased despite the overall decrease in the patient population and number of visits (Table 2).

Figure 2 shows the frequency of patient visits by year and month, between 2018 and 2020. The total number of patient visits steadily decreased: 10,014,594 in 2018, 9,946,944 in 2019 (with a Y-on-Y ratio of 0.993), and 9,576,649 in 2020 (with a Y-on-Y ratio of 0.962). The decline in patient visits varied by disease, with dyslipidemia, diabetes, and hypertension (Y-on-Y ratios of 0.863, 0.903, and 0.934, respectively) ranking in the descending order from 2019 to 2020.

Figure 3 shows the cumulative incidence curves for treatment interruptions in diabetes mellitus, hypertension, and dyslipidemia. In diabetes mellitus, over an average follow-up of 284.1 ±80.4 days, there were 2,697 events. For hypertension, during an average follow-up of 274.3 ±85.6 days, there were 2,519 events. In dyslipidemia, over an average follow-up of 277.6 ±79.0 days, there were 4,307 events. For each disease, the crude cumulative incidence of events was higher in the 2020 group than that in the 2019 group.

The adjusted hazard ratios (HRs) for diabetes mellitus were 1.26 (95% CI, 1.17–1.36) in the overall population,

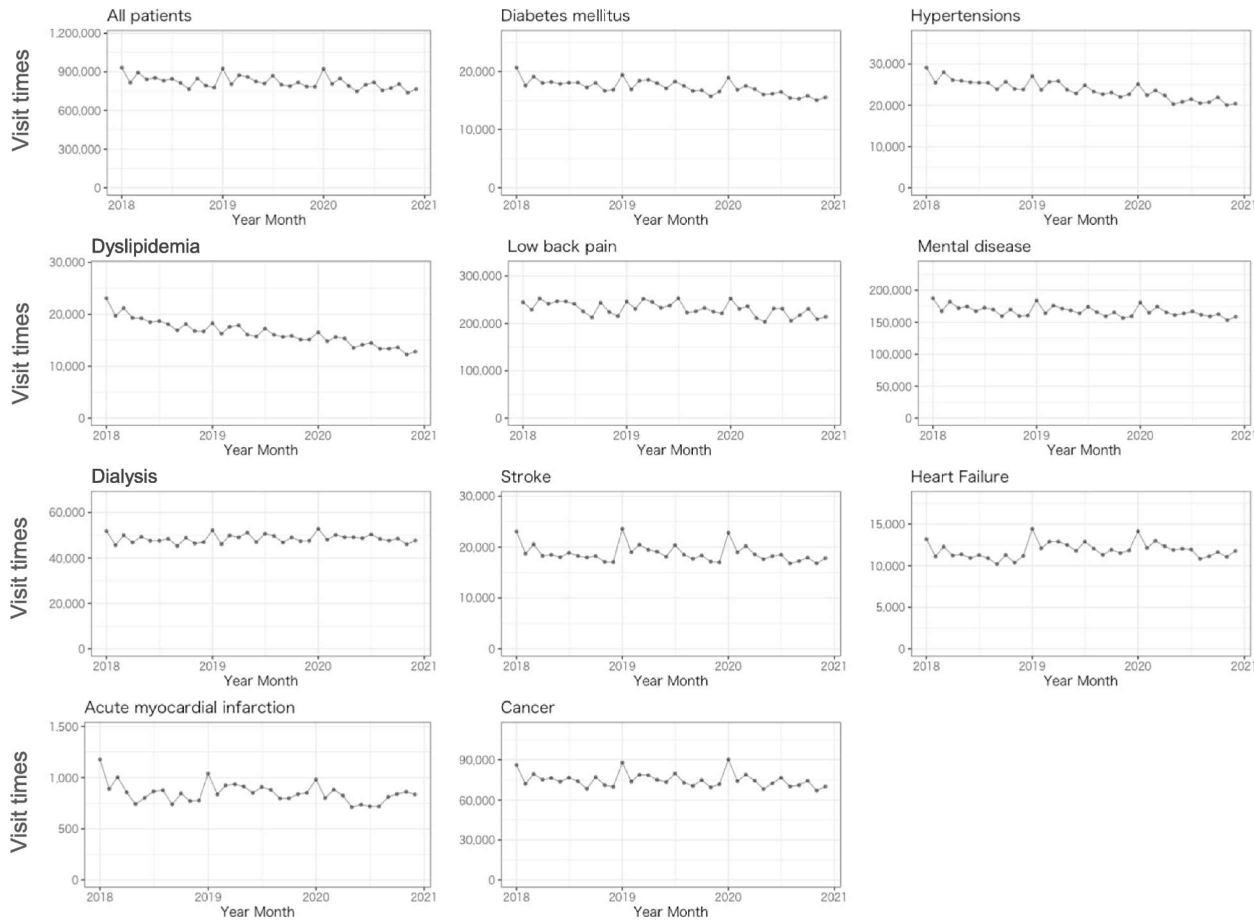

Fig. 2 Frequency of patient visits by year and month from 2018 to 2020

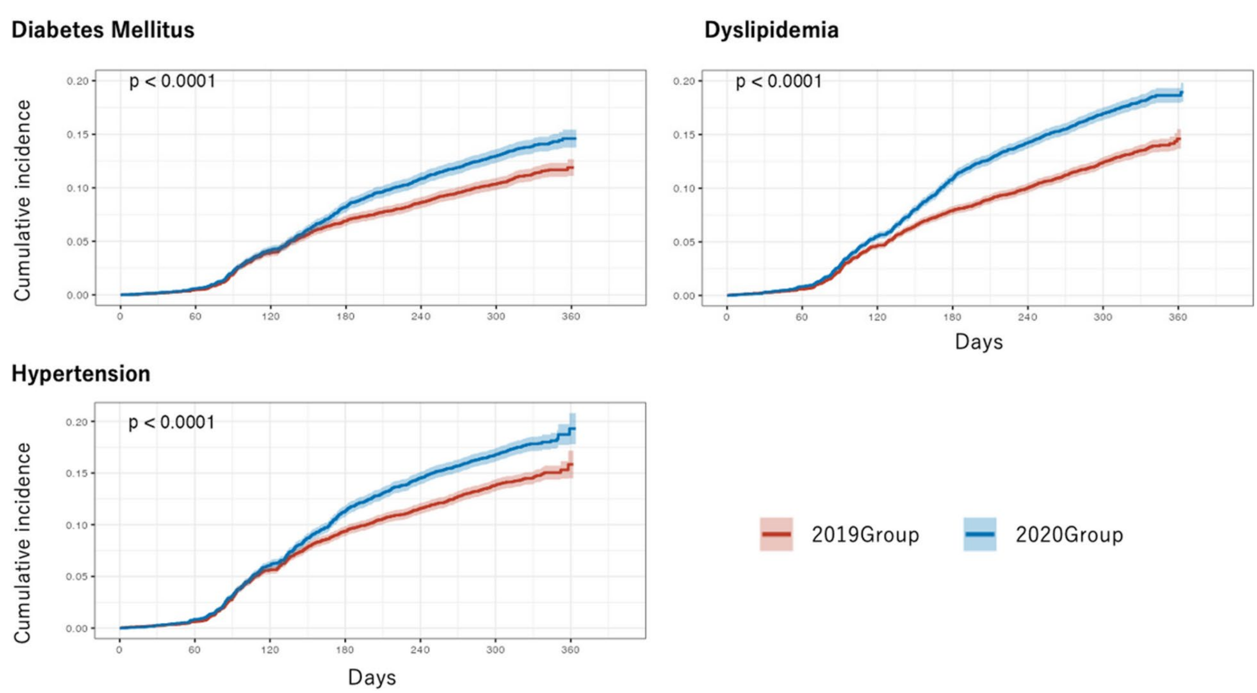

Fig. 3 Cumulative incidence curves for treatment interruption

1.27 (1.17–1.38) among older adults, and 1.15 (0.91–1.47) in the multimorbidity group. Similarly, for hypertension, the HRs were 1.39 (1.31–1.47), 1.39 (1.32–1.48), and 1.23 (0.91–1.50), respectively, and for dyslipidemia, they were 1.24 (1.17–1.32), 1.27 (1.19–1.35), and 1.05 (0.83–1.31), respectively. Among these three conditions, hypertension showed the highest HRs, followed by diabetes and then dyslipidemia. In contrast, no significant HR was found for any of the conditions in the multimorbidity subgroup.

Sensitivity analyses showed consistent trends with the primary analysis, suggesting potential variations in the robustness of the findings (Supplementary Tables 1 and 2).

The logistic regression model showed no statistically significant association between experiencing treatment interruption during the COVID-19 period and the probability of returning to treatment within 12 months (OR = 0.89, 95% CI = 0.81–1.09, p = 0.67). This suggests that treatment interruptions during the pandemic were not associated with a reduced likelihood of resuming medical care compared to pre-pandemic interruptions.

Discussion

This study revealed that patients with chronic diseases during the COVID-19 pandemic faced an increased rate of interruption treatment. Using claims data, we found that changes in the external environment due to COVID-19 led to a reduction in both the total number of visits and the time until medical interruption.

As shown in Fig. 2, the impact on patient behavior by COVID-19 varied across diseases. Outpatient visits for diabetes, hypertension, and dyslipidemia declined sharply, while essential and emergency care, such as dialysis and acute myocardial infarction, remained stable. Mental health visits rebounded quickly, likely due to increased psychological distress, and cancer care showed minimal fluctuations. This transition variety by disease highlights the need to adjust for disease type as a covariate, as failing to do so could bias interpretations of treatment interruptions.

Our analysis, which adjusted for patient visit history in the previous year, as well as patient disease conditions and characteristics, confirmed that the trend of reduced total visits and shorter time until medical interruption persisted.

In the case of diabetes as an example, an HR of 1.26 suggests a 26% higher rate of treatment interruption during the pandemic compared to pre-pandemic conditions, underscoring the pandemic's impact on care continuity. And based on HR estimates, treatment interruption rates were higher for hypertension, diabetes, and dyslipidemia, in that order. This indicates that discontinuation rates varied among chronic conditions, with a 15% difference between hypertension and dyslipidemia.

Similar findings have been reported both nationally and internationally, with studies from Japan highlighting substantial disruptions in endocrine and metabolic disease care and U.S. and Asian countries research demonstrating reduced healthcare utilization and worsening diabetes control [33, 34]. A previous study performed in Japan shows no significant change in the probability of treatment interruption [35]. Although the background of this previous study is similar to our present study in that the area was affected by a low number of cases of COVID-19, it differs in several points: the previous study's subject was limited to those in the 40 s to 60 s, and hypertensive patients receiving treatment with antihypertensive drugs. We also obtained data on medical care for the elderly aged 70 and over, and this is a strength of this study in that it is possible to evaluate the patient group that requires management for continued medical care. We should also note that this study differs in that it assessed the incidence rate leading up to treatment interruption using time-to-event analysis and evaluated the fact that the time to interruption was accelerated.

Overall, our study strengthens the understanding of how treatment disruptions occurred using a time-to-event approach. These findings emphasize the need for targeted interventions to maintain healthcare continuity and suggest that future research should further explore the long-term consequences of treatment interruptions on patient outcomes.

If treatment interruptions during the COVID-19 period were merely temporary delays caused by the infection situation in the target area and governmental messages, and treatment was later resumed, medical management could also be reinstated. However, as demonstrated in this study, the timing of treatment interruptions during the COVID-19 period was not associated with treatment resumption in the following year. Therefore, it is essential to implement appropriate measures and enhance patient communication to support those who experienced treatment interruptions during the COVID-19 pandemic in returning to medical care.

Our analysis showed that older patients and those with comorbid conditions had their medical care interrupted earlier than others. This trend was not observed in the other patient groups, and it was clear that how patients responded to the external environment depended on their background, such as age and other health conditions. Patients with multiple disease conditions may have been told by their physicians to continue regular visits because of the risk of deteriorate, but this point was not significant in this study. Notably, the older patients, who were more prone to deteriorate as well, discontinued their visits. They may have voluntarily chosen to discontinue their visits due to the risk of COVID-19 infection, despite the need for continued treatment. Given the results of our analysis, which suggest that these patients may not return for follow-up visits, it would be beneficial to make efforts to encourage older patients to resume regular check-ups. Based on the results of the analysis, this may contribute to targeting, particularly when delivering continuous medical care.

National and local health administrations and medical institutions must recognize that infectious disease epidemics are risk factors for interrupted medical visits. As this study showed, disrupted patients during a pandemic will not return to medical care, making it impossible to manage them to prevent serious illnesses.

Although the Japanese government has included infectious disease control measures in its healthcare plans, there is currently no specific mention of follow-ups for patients with NCDs. Even during infectious disease outbreaks, the monitoring and consultation of patients with NCDs should be continued as much as possible to prevent serious diseases. Since our results revealed that in the absence of any intervention, patients discontinued their medical visits, governments should prepare a plan of action, such as the use of consultation methods that consider infection status and risk (e.g., online consultations, telephone consultations, and remote monitoring technology), but these medical provision scheme have not been widespread in Japan [25]. The development of these systems could be an effort to make the pandemic experience a learning experience for future generations.

This study did not analyze mortality as an outcome, as our primary focus was on continuity of healthcare access rather than direct clinical outcomes. As shown in the number of deaths in our study population (Fig. 1) was relatively small, a finding consistent with previous reports of negative excess mortality attributable to COVID-19 in Japan [36]. Anaysis association clinical outcome and discontinuity would require longer observation interval. Future research integrating hospital records and mortality registries could further explore the relationship between healthcare access disruptions and patient survival.

Our findings suggest that the COVID-19 pandemic was associated with an increased risk of treatment interruption among chronic disease patients. Although the use of individual-level claims data allowed for a detailed, individualized analysis tracked treatment behavior and provided granular insights, the study has several limitations. First, it analyzed medical examinations in an area where the number of infected individuals was very small. The results of this analysis may vary in areas where the number of infected individuals is increasing. Therefore, the results should be interpreted as the result of changes in consultation behavior due to qualitative changes in the environment, such as messages from the government, even though the number of infected persons was not high. Second, data on the severity of each disease and test results to ascertain the severity of the disease were not included because insurance claims data were used. Third, Japan has a universal healthcare system that guarantees free access to health care services. Therefore, the results may differ between countries with different levels of institutional accessibility. However, it is worth noting that similar results have been reported in countries with different access [33, 34]. Fourth, some patients may be included in both the 2019 and 2020 cohorts, and within-subject correlation was not explicitly accounted for. Additionally, patients with multiple chronic diseases were included, but no specific paired analysis was conducted. Future research could consider paired analyses or hierarchical modeling to refine the estimation of treatment interruption patterns at the individual level. Finally, treatment interruption in this study was defined by the absence of follow-up visits rather than the discontinuation of medication intake. While this approach captures healthcare access continuity, it does not account for patients who continue medication without revisiting their physicians. As visit-based analysis does not fully reflect medication adherence, future studies incorporating prescription and medication history data would provide a more comprehensive understanding of the pandemic's impact on healthcare access and adherence. Furthermore, the interpretation should consider the potential for underestimation of treatment interruptions. This possibility arises from limitations inherent in the observational setting, such as the exclusion of patients with only a single visit to enable the calculation of visit intervals.

In summary, our study highlights the significant impact of the COVID-19 pandemic on patient behavior and healthcare-seeking patterns, especially among those managing chronic conditions. This emphasizes the importance of strategies to reduce treatment interruptions and improve healthcare access during public health crises, because such interruptions can have serious consequences for patient outcomes. Further research and interventions are required to address the complex challenges posed by pandemics and their implications for chronic disease management.

Abbreviations

AMI	Acute myocardial infarction
ATC	Anatomical therapeutic chemical
CI	Confidence Interval
COVID-19	Coronavirus disease 2019
HF	Heart failure
HRs	Hazard ratios
NCD	Non-Communicable Diseases
SD	Standard deviations
WHO	World Health Organization

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12913-025-12798-3.

Supplementary Material 1.

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Authors' contributions

TI analyzed and interpreted study data; AK, JS, JH, HY MK and KG provided technical assistance in extracting and transforming data into usable data sets for analysis, all data processing design and resource management were performed by MK and KG; YT and TN provided conceptualization of the study and interpretation of the results from their professional perspectives, and NM provided data collection and overall supervision. TI wrote the main manuscript, figures, and tables. All authors read and approved the final version of the manuscript.

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Data availability

No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate

Our study was approved by the Ethics Committee of Institute for Health Economics and Policy (approval number: R4-010). The requirement for informed consent was waived because of the anonymized nature of the data in the database.

Consent for publication

Not applicable.

Competing interests

TN reports grants or contracts: I&H Co., Ltd.; Cocokarafine Group Co., Ltd.; KonicaMinolta, Inc.; NTT DATA; consulting fees: Ohtsuka Pharmaceutical Co.; Takeda Pharmaceutical Co.; Johnson & Johnson K.K.; AstraZeneca plc; Nippon Zoki Pharmaceutical Co., Ltd.; payment or honoraria for lectures, presentations, speakers bureaus, manuscript writing or educational events: Pfizer Japan Inc.; MSD K.K.; Chugai Pharamaceutical Co.; Takeda Pharmaceutical Co.; Janssen Pharmaceutical K.K.; Boehringer Ingelheim International GmbH.; Eli Lilly Japan K.K.; Maruho Co., Ltd.; Mitsubishi Tanabe Pharma Co.; Novartis Pharma K.K.; Allergan Japan K.K.; Novo Nordisk Pharma Ltd.; TOA EIYO Ltd.; AbbVie Inc.; ONO PHARMACEUTICAL CO., LTD.;GSK plc; Alexion Pharmaceuticals, Inc.; Cannon Medical Systems Co.; Kowa Company, Limited; Araya; Merck Co.; Amicus Therapeutics, Inc.; stock options: BonBon inc.; donation: CancerScan; JMDC Inc. YT is employed through a joint research fund between Kyoto University and HealthTech Laboratory Inc.

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