

Primary Care Services for Diabetes and Hypertension During the COVID-19 Pandemic: A Five-year Panel Study from Northern Thailand

Daoroong Komwong^{1*}, Mereerat Manwong², Kulpimol Charoendee³,
Thawatchai Sattayasomboon¹

¹Sirindhorn College of Public Health, Phitsanulok, Faculty of Public Health and Allied Health Sciences, Praboromarajchanok Institute, Thailand, ²College of Medicine and Public Health, Ubon Ratchathani University, Ubon Ratchathani, Thailand, ³Department of Disease Control, Ministry of Public Health, Nonthaburi, Thailand. *Corresponding Author's Email: daoroong.k@scphpl.ac.th

Abstract

The COVID-19 pandemic disrupted healthcare systems globally, particularly affecting chronic disease management in low- and middle-income countries. While immediate impacts have been documented, long-term effects on primary care services for non-communicable diseases remain poorly understood. This study investigated the impact of the COVID-19 pandemic on primary care services for diabetes and hypertension in northern Thailand over a five-year period. A panel study was conducted from 2018 to 2022, covering 47 districts across five provinces in northern Thailand. Secondary data were obtained from the Ministry of Public Health databases and the National Health Security Office, including service coverage: Quality Care Bundle scores for diabetes (QCB-DM) and hypertension (QCB-HT), quality indicators: hospitalization rates for ambulatory care sensitive conditions for diabetes (ACSCs-DM) and hypertension (ACSCs-HT) and health outcomes: glycemic control (HbA1c < 7%). Generalized Estimating Equation (GEE) models were used to assess the relationship between COVID-19 case numbers and healthcare indicators. COVID-19 case numbers showed no statistically significant associations with QCB-DM and QCB-HT scores. ACSCs-HT decreased significantly ($p < 0.001$), whereas ACSCs-DM remained stable ($p = 0.360$). Glycemic control (HbA1c < 7%) significantly decreased during the pandemic period ($p = 0.005$). The findings suggest that adaptive healthcare strategies may help sustain continuity of chronic disease services during public health emergencies, although broader determinants of health should also be considered to optimize patient outcomes.

Keywords: Coverage, COVID-19, Diabetes Mellitus, Hypertension, Primary Care, Quality.

Introduction

Non-communicable diseases, including diabetes, hypertension, chronic respiratory diseases, cardiovascular diseases and cancers, are the leading contributors to global mortality, accounting for over 70% of deaths worldwide (1). Effective primary care plays a pivotal role in managing non-communicable diseases by providing preventive care, early diagnosis, treatment and continuous monitoring (2). The emergence of the COVID-19 pandemic disrupted healthcare systems worldwide, profoundly impacting the delivery of healthcare services, particularly for patients with non-communicable diseases. The urgent need to address the COVID-19 pandemic necessitated a reallocation of resources, including healthcare personnel, equipment and funding, diverging attention from routine healthcare services (1, 3). In Thailand, primary care services

play a central role in chronic disease management through an extensive district health system and community-based healthcare network (4). During the COVID-19 pandemic, healthcare facilities were required to simultaneously maintain routine non-communicable disease services while responding to rapidly increasing COVID-19 cases (5). This created substantial challenges in balancing emergency response and continuity of chronic disease care. This resource reallocation exerted significant strain on primary care systems managing non-communicable diseases. The imposition of lockdowns, social distancing measures and fear of contracting COVID-19 forced many non-communicable disease patients to delay or avoid routine check-ups, screenings and treatment appointments (2, 3, 6). Delays in care, medication adherence issues and reduced access

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to preventive screenings likely contributed to an increase in hospitalizations for complications related to non-communicable diseases (7-9). While many existing studies focus on the immediate disruptions during the pandemic's peak, previous research has primarily focused on high-income countries, leaving knowledge gaps regarding non-communicable disease patients' experiences in diverse healthcare settings (8). Moreover, comprehensive studies encompassing the pre-pandemic, during-pandemic and post-pandemic periods, particularly regarding specific challenges non-communicable disease patients face in primary care coverage and quality, remain limited. The lack of a holistic perspective on non-communicable disease care utilization patterns and health outcomes across all COVID-19 phases hinders the development of effective strategies for ensuring adequate non-communicable disease care during and after public health emergencies. Previous studies have reported substantial disruptions in healthcare utilization during the COVID-19 pandemic, including delayed outpatient visits, interruptions in routine monitoring, changes in healthcare-seeking behavior and reductions in outpatient attendance, routine follow-up visits and hospital admissions for chronic disease care across various healthcare systems and countries (10, 11). Such disruptions were observed among patients with chronic conditions, particularly those requiring continuous monitoring and long-term follow-up, including diabetes and hypertension. These interruptions may have affected continuity of care and contributed to challenges in maintaining chronic disease management during prolonged periods of healthcare system strain (5). In contrast, adaptive strategies such as telemedicine implementation, community-based care models and service reorganization were introduced in some settings and may have helped sustain continuity of chronic disease care despite considerable pressures on health services (12). These findings suggest that healthcare system context and adaptive capacity may substantially influence resilience and continuity of care during public health emergencies. Although these studies provided valuable insights, several limitations remain. Most previous investigations were conducted in high-income countries, used cross-sectional or short-term study designs and focused primarily on isolated

healthcare indicators rather than evaluating multiple dimensions of healthcare system performance simultaneously. Furthermore, comprehensive longitudinal studies examining healthcare system responses across pre-pandemic and pandemic periods remain limited, particularly in low- and middle-income countries where primary care systems rely heavily on community-based healthcare networks. Evidence from international organizations has also highlighted widespread disruptions in essential healthcare services during the COVID-19 pandemic, including interruptions in screening programs, routine follow-up visits, medication access and chronic disease management activities (5). Such disruptions were particularly pronounced in resource-constrained settings where healthcare systems frequently faced workforce shortages, service capacity constraints and competing healthcare priorities during the pandemic response. These challenges may have further complicated efforts to maintain continuity of chronic disease services and routine healthcare delivery. Consequently, understanding healthcare system resilience and continuity of chronic disease services during prolonged public health emergencies remains incomplete (13).

The present study addresses these limitations by using longitudinal panel data from Thailand's public healthcare system to simultaneously evaluate service coverage, quality indicators and health outcomes over a five-year period. By examining multiple dimensions of primary care performance across several phases of the COVID-19 pandemic within a community-based healthcare system, this study provides a broader perspective on healthcare system responses beyond immediate service disruptions or single healthcare indicators. The findings may contribute to a better understanding of healthcare system resilience and continuity of chronic disease care over time.

In Thailand, the primary care system plays a central role in healthcare delivery through an extensive community-based healthcare infrastructure (4). Understanding healthcare system responses during the COVID-19 pandemic may therefore provide important insights for future health system preparedness. Evaluating multiple dimensions of healthcare performance can provide insights into strengths and potential gaps in

service delivery and support the development of strategies to sustain continuity of chronic disease care during future public health emergencies.

Therefore, this study aimed to investigate the impact of the COVID-19 pandemic on primary care services for diabetes and hypertension within Thailand's public healthcare system. Specifically, the study examined the relationship between COVID-19 case numbers and primary care service coverage, quality indicators and health outcomes.

Methodology

Study Design, Setting and Participants

This study employed a 5-year panel design, spanning from 2018 to 2022, based on secondary data obtained from public healthcare facilities, including hospitals and primary care centers, across 47 districts in five northern provinces of Thailand: Phitsanulok, Sukhothai, Uttaradit, Tak and Phetchabun (approximate GPS coordinates 15.5°–17.8° N 98.5°–101.5° E). All public healthcare facilities were administered by the Ministry of Public Health. The study population consisted of patients with diabetes and hypertension who are receiving care within the public health system in the study area.

Data Sources and Collection

Data used in this study were obtained from multiple administrative databases maintained by the Ministry of Public Health (MOPH) and the National Health Security Office (NHSO), covering fiscal years 2018 to 2022 (October 1, 2017, to September 30, 2022). Aggregated district-level datasets were extracted and provided by the responsible agencies according to the objectives of the study.

Data related to primary care service coverage, including Quality Care Bundle indicators for diabetes and hypertension (QCB-DM and QCB-HT), quality indicators including ambulatory care sensitive conditions for diabetes and hypertension (ACSCs-DM and ACSCs-HT), hospitalization data and glycemic control outcomes (HbA1c <7%) were obtained from administrative claims and outpatient healthcare databases under the Universal Coverage Scheme managed by the National Health Security Office.

COVID-19 case data were obtained from the COVID-19 surveillance database maintained by the Department of Disease Control, Ministry of Public Health. Public healthcare facility information,

including healthcare facility type, district codes, diabetes prevalence, hypertension prevalence, population characteristics, and health workforce supply (health professionals, nurses, and public health officers), were obtained from administrative databases maintained by the Ministry of Public Health.

Variables and Measurements

The studied variables were defined and measured to comprehensively assess the coverage, quality and health outcomes of healthcare services. Primary care service coverage was assessed according to clinical practice guidelines, focusing on the annual monitoring of complications in diabetic and hypertensive patients, including evaluations of HbA1c levels, microalbuminuria, blood lipid levels and routine eye and foot exams. The effectiveness of care was quantified using the Quality Care Bundle, the average effectiveness scores for diabetes and hypertension management, both measured on a scale of 0 to 10, with 10 representing the highest level of effectiveness.

Primary care services quality was gauged through Ambulatory Care Sensitive Conditions for both diabetes and hypertension. Hospitalization rates for Ambulatory Care Sensitive Conditions serve as a well-established indicator for evaluating primary care effectiveness. Ambulatory Care Sensitive Conditions are medical conditions for which timely and suitable primary care intervention might prevent hospital admission, as identified by the Agency for Healthcare Research and Quality (14, 15). This metric was expressed as the rate of hospitalizations per 100,000 population, determined by the number of hospital discharges with primary diagnosis codes corresponding to diabetes and hypertension, excluding cases involving specific procedures (16).

Health outcomes in diabetes care were measured by the proportion of patients achieving target-level blood sugar control, defined as an HbA1c level of less than 7%. This multi-dimensional approach enabled a robust evaluation of the effectiveness of healthcare services in managing chronic conditions.

Statistical Methods

Descriptive statistics were used to summarize primary care coverage, service quality and diabetes health outcomes. Given the longitudinal nature of the 5-year panel data, a generalized estimating equation method was used to

determine the relationship between COVID-19 case numbers and the variables of coverage, quality and diabetes health outcomes. The continuous outcome resulted in the selection of the Gaussian family and identity link function, as well as the independent working correlation matrix.

The Quality Care Bundle scores for diabetes and hypertension models were adjusted for covariates including urban–rural classification (based on the referral capacity level of district hospitals, where districts containing referral hospitals, which are typically located in the main urban districts of each province, were classified as urban areas, whereas districts containing community and lower-level referral hospitals were classified as rural areas), proportion of female population, age-specific prevalence of diabetes and hypertension and health workforce variables, including nurses and public health officers. The Ambulatory Care Sensitive Conditions models for diabetes and hypertension were adjusted for Quality Care Bundle scores, urban–rural classification and proportion of female population. Health outcomes in diabetes care were adjusted for age-specific prevalence of diabetes, Quality Care Bundle scores for diabetes, urban–rural classification and proportion of female population. A p-value of less

than 0.05 was considered statistically significant. Data were analysed using Stata Statistical Software, Version 19.5 (StataCorp LLC, College Station, TX, USA).

Results and Discussion

QCB-DM scores ranged from 5.36 to 5.63, with the highest level observed before the major nationwide COVID-19 surge in 2020, followed by a gradual decline through 2022. A similar pattern was observed for QCB-HT scores, as depicted in Figure 1, indicating potential impacts on continuity of routine chronic disease services during later phases of the pandemic. QCB-DM and QCB-HT scores showed slight positive trends in relation to COVID-19 case numbers; however, these associations were not statistically significant in the adjusted analyses, as shown in Table 1. Despite the absence of statistically significant associations, QCB indicators did not show substantial deterioration during the pandemic period.

Figure 1 presents trends in Quality Care Bundle scores for diabetes (QCB-DM) and hypertension (QCB-HT) from 2018 to 2022. Both indicators remained relatively stable throughout the study period, with slight fluctuations observed during later phases of the COVID-19 pandemic.

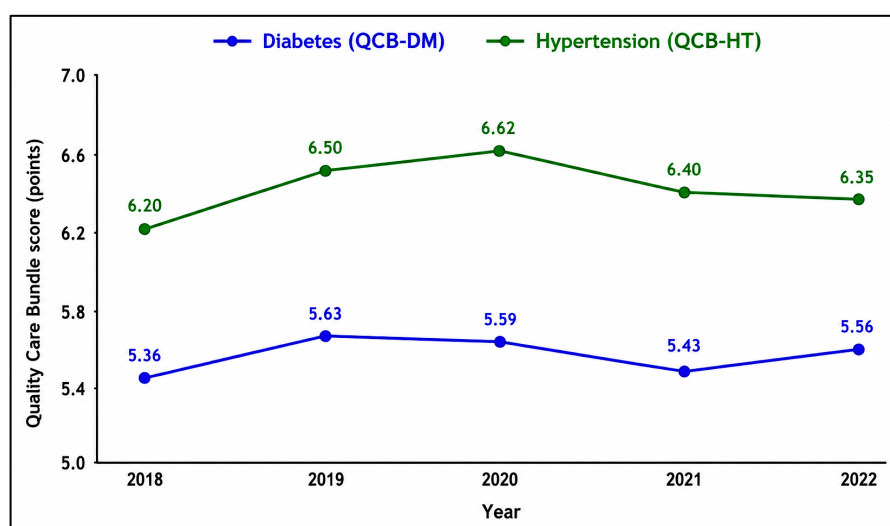


Figure 1: Trends in Quality Care Bundle Scores for Diabetes (QCB-DM) and Hypertension (QCB-HT) from 2018 to 2022 in Northern Thailand

Although the adjusted analyses did not demonstrate statistically significant associations between COVID-19 case numbers and QCB-DM or QCB-HT scores, primary care coverage indicators remained relatively stable throughout the pandemic period. This finding may reflect the resilience and adaptive capacity of Thailand's

primary care system in maintaining essential chronic disease services despite substantial healthcare system pressures. Several adaptive strategies, including restructuring of care delivery models, one-stop services and community-based support systems, may have contributed to

sustaining routine chronic disease management during the pandemic (17, 18).

Diabetes healthcare coverage indicators, including health worker visits, body mass index (BMI) checks, fasting blood sugar (FBS) evaluations and haemoglobin A1c (HbA1c) assessments, showed a significant decline during the pandemic period; however, service coverage recovered subsequently (19). This resilience of Thailand's primary care clinics may assist in maintaining the effectiveness of the overall care management process score for chronic disease care throughout the pandemic (1). The relative stability of Thailand's primary care system during the COVID-19 pandemic may be related to adaptive service delivery approaches, including one-stop services in primary care units, as described in a national health system response monitor report. This strategy allowed patients to receive necessary screenings and tests in a single visit, which may have contributed to maintaining continuity of chronic disease care during the pandemic period (18). Moreover, Thailand's village health volunteers (VHVs) may have supported continuity of chronic disease monitoring and follow-up during the pandemic period. Village health volunteers (VHVs) have been described as additional health facilitators and mediators for patients with chronic non-communicable diseases, including diabetes and hypertension (20). This community-based support

system may have helped maintain annual checkups and routine chronic disease monitoring during the pandemic.

ACSC-DM rates fluctuated between 328.57 and 349.47 per 100,000 individuals, while ACSC-HT rates ranged from 54.95 to 124.68 per 100,000 persons. Hospitalization rates for both conditions showed a declining trend during the pandemic period, particularly after 2020, despite increasing COVID-19 case numbers, as shown in Figure 2. The reduction in ACSCs-HT hospitalization rates may reflect changes in healthcare utilization and hospital admission patterns during the pandemic. In the adjusted analysis, COVID-19 cases were not significantly associated with ACSCs-DM (p -value = 0.360), whereas COVID-19 case numbers were negatively associated with ACSCs-HT (p -value < 0.001), as mentioned in Table 1.

Figure 2 presents trends in hospitalization rates for ambulatory care sensitive conditions related to diabetes (ACSCs-DM) and hypertension (ACSCs-HT) from 2018 to 2022. Hospitalization rates for both conditions generally declined during the pandemic period, particularly after 2020. The decline was more pronounced for hypertension-related conditions. This trend suggests possible changes in healthcare utilization and hospital admission practices during the COVID-19 pandemic period.

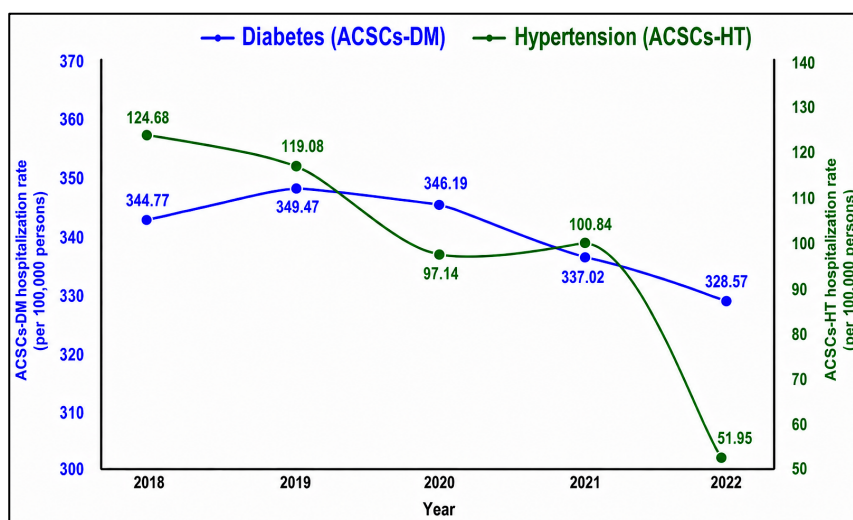


Figure 2: Trends in Hospitalization Rates for Ambulatory Care Sensitive Conditions for Diabetes (ACSCs-DM) and Hypertension (ACSCs-HT) from 2018 to 2022

The variations in hospitalization rates for diabetes (ACSCs-DM) and hypertension (ACSCs-HT) in relation to COVID-19 cases are noteworthy. The lack of significant correlation for diabetes-related

hospitalizations suggests the resilience of diabetes management programmes, likely due to several factors. Early identification of diabetes as a major risk factor for severe COVID-19 outcomes

prompted increased vigilance in primary care settings (21). Primary care providers implemented proactive strategies, including enhanced monitoring and early intervention for high-risk groups (18). The pandemic accelerated the adoption of risk stratification approaches for red (urgent), amber (priority) and green (routine) patient categories for effective routine outpatient service follow-up, recovering missed activity and ensuring intensive outpatient care for urgent and high-risk patients (22). This targeted approach may have averted complications that typically lead to ACSC-DM hospitalizations. Additionally, patients' reluctance to seek hospital care during the pandemic may also have altered healthcare-seeking behaviors and hospitalization patterns (19).

Simultaneously, hospital resources were extensively reallocated for COVID-19 treatment during the pandemic (23). This situation may have increased admission thresholds for diabetes-related complications, potentially stabilizing hospitalization rates while delaying care in some cases.

The negative correlation observed for hypertension hospitalizations presents an unexpected outcome that can be interpreted in several ways. Primarily, this finding points to a rapid adaptation of care delivery approaches. The decrease in ACSC-HT likely reflects an effective shift towards community-based and home-based care management, including telemedicine and remote monitoring for hypertension patients. These approaches not only maintained treatment quality but also contributed to reducing

unnecessary hospital visits (24). Furthermore, the decrease in ACSC-HT with the surge in COVID-19 cases suggests a more effective utilization of hospital resources, as approximately one-quarter of 122 countries reported reduced availability of inpatient services or hospital beds (23). A significant decrease in hospital admissions during the pandemic, particularly for ambulatory care-sensitive conditions such as hypertension, has been reported (10). Overall, healthcare systems may have become more selective during the pandemic period, prioritizing admission for severe and urgent conditions while reducing avoidable hospitalizations (24, 25). Regarding health outcomes, more than 81% of diabetic patients achieved glycemic control (HbA1c <7%) throughout the study period, as shown in Figure 3. However, increasing COVID-19 case numbers were associated with lower proportions of patients achieving glycemic control in the adjusted analysis. This declining trend may reflect disruptions in long-term diabetes management and continuity of care during the pandemic period, as discussed in Table 1.

Figure 3 presents trends in glycemic control among diabetic patients from 2018 to 2022. Glycemic control remained relatively stable throughout the study period, although gradual declines were observed during later phases of the COVID-19 pandemic. These findings may reflect potential disruptions in continuity of diabetes management during the pandemic period and challenges in maintaining long-term glycemic control during healthcare crises.

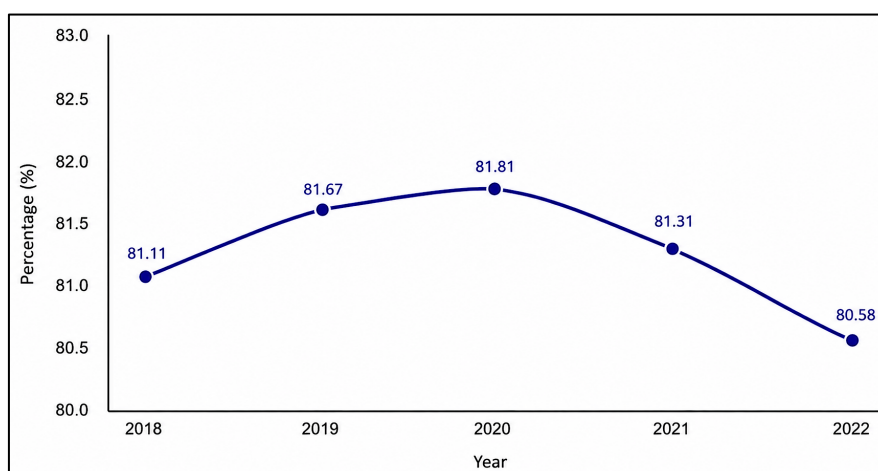


Figure 3: Percentage of Diabetic Patients Achieving Glycemic Control (HbA1c <7%) from 2018 to 2022

The negative correlation between achieving glycemic control and the COVID-19 circumstances is a cause for concern. Challenges in maintaining optimal diabetes management during the pandemic have been reported, including reduced physical activity, altered dietary habits and mental health issues that may contribute to deteriorating glycemic control (21).

Pandemic-related interruptions in medication supply chains and changes in healthcare accessibility may have also affected medication adherence (26). While some patients stockpiled medications, others struggled to get their usual prescriptions (27). However, the psychological

effects of the epidemic's stress, anxiety and despair could have physiological consequences for glycemic control (21). In addition, COVID-19 infection induces acute hyperglycemic crisis and exacerbates the prognosis of patients with poorly controlled DM (28).

Table 1 summarizes associations between COVID-19 case numbers and healthcare indicators using generalized estimating equation models. COVID-19 case numbers were not significantly associated with QCB-DM, QCB-HT, or ACSCs-DM indicators. However, significant associations were observed for ACSCs-HT and glycemic control outcomes.

Table 1: Impact of COVID-19 on Coverage and Quality of Primary Care Services and Health Outcomes in Diabetes Care

Variables	b _{Unadjusted}	b _{Adjusted}	95%CI of b _{Adjusted}	p-value
Coverage of Primary Care Service				
QCB-DM score				
Number of COVID-19	0.0000105	0.0000117 ^a	-0.0000065 – 0.0000298	0.209
QCB-HT score				
Number of COVID-19	0.0000214	0.0000261 ^b	0.0000190 – 0.0000712	0.257
Quality of Primary Care Services				
ACSCs-DM				
Number of COVID-19	-0.0021398	-0.0024390 ^c	-0.0076605 – 0.0027825	0.360
ACSCs-HT				
Number of COVID-19	-0.0068471	-0.0062242 ^d	-0.0093908 – (-0.0030576)	<0.001
Health Outcomes in Diabetes Care				
Number of COVID-19	-0.000977	-0.0002997 ^e	-0.0005070 – (-0.0000925)	0.005

Note: ^aAdjusted for diabetes prevalence, total health professional, total nurse and public health officers, urban–rural classification and proportion of female population; ^bAdjusted for hypertension prevalence, total health professional, total nurse and public health officers, urban–rural classification and proportion of female population; ^cAdjusted for QCB-DM score, urban–rural classification and proportion of female population; ^dAdjusted for QCB-HT score, urban–rural classification and proportion of female population; ^eAdjusted for diabetes prevalence, QCB-DM score, urban–rural classification and proportion of female population.

This study has several limitations related to outcome measurement and data availability. First, the analyses were based on aggregated district-level secondary data obtained from administrative databases, which did not contain individual-level socioeconomic, behavioral, or clinical information. Although the study population was limited to individuals covered under Thailand's Universal Coverage Scheme, residual contextual differences across districts may still exist. The lack of patient-level data also prevented examination of heterogeneous pandemic impacts across patient subgroups with varying disease severity or comorbidities. Second, healthcare utilization indicators during the COVID-19 pandemic should be interpreted with caution. ACSCs hospitalization rates may have been influenced not only by primary care quality, but also by changes in healthcare-seeking behavior, delayed care, hospital admission policies, bed availability and

resource reallocation during the pandemic period. Similarly, QCB scores primarily reflected care processes rather than patient-centered outcomes. Finally, several potentially important factors influencing chronic disease care could not be directly measured, including telemedicine adoption, lifestyle changes and psychological stress during the pandemic. In addition, the observational nature of the study does not permit causal inference regarding the relationship between COVID-19 case numbers and primary care performance indicators.

These findings have important implications for health policy and practice. Policymakers should institutionalize successful adaptive strategies observed during COVID-19, including one-stop NCD services, risk-stratified care protocols (red–amber–green categorization) and strengthened community health volunteer networks, as permanent components of primary care delivery

systems. Investment in digital health infrastructure, particularly telemedicine platforms and integrated electronic health records, is essential to maintain care continuity during future public health emergencies.

Future research should employ prospective data collection methods to capture comprehensive care processes and patient experiences during crises, conduct patient-level analyses to identify vulnerable subgroups most affected by care disruptions and further investigate the role of telemedicine and adaptive care delivery approaches in maintaining continuity of chronic disease care during public health emergencies (12). Future studies should also examine broader changes in healthcare utilization patterns and long-term impacts across healthcare systems (11).

Conclusion

This five-year panel study provides evidence regarding the impact of the COVID-19 pandemic on primary care services for diabetes and hypertension within Thailand's public healthcare system. Although statistically significant deterioration in Quality Care Bundle indicators was not observed, declines in glycemic control and changes in hospitalization patterns suggest that maintaining service continuity alone may not be sufficient to preserve optimal chronic disease outcomes during public health emergencies.

The findings highlight the importance of adaptive primary care strategies, including community-based service delivery, continuity of care approaches and health system flexibility, in supporting chronic disease management during healthcare crises. Thailand's experience may provide useful insights for strengthening resilience of primary care systems during future public health emergencies.

This study should be interpreted considering several limitations, including the use of aggregated administrative data, lack of individual-level socioeconomic and clinical information and the observational study design, which limits causal interpretation. Future studies using patient-level and longitudinal data are needed to better understand long-term impacts of public health emergencies on chronic disease management, healthcare utilization patterns, vulnerable patient subgroups and the role of telemedicine and

adaptive care models in sustaining continuity of care.

Abbreviations

ACSCs-DM: hospitalization rates for ambulatory care sensitive conditions for diabetes, ACSCs-HT: hospitalization rates for ambulatory care sensitive conditions for hypertension, QCB: Quality Care Bundle, QCB-DM: Quality Care Bundle scores for diabetes, QCB-HT: Quality Care Bundle scores for hypertension.

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Author Contributions

Daoroong Komwong: Conceptualization, Conducted the Study, Collected the Data, Analyzed the Data, Interpreted the Findings, Drafted the Manuscript, Mereerat Manwong: Conceptualization, Data Analysis, Interpreted the Data, Drafted the Manuscript, Kulpimol Charoendee: Data Collection, Thawatchai Sattayasomboon: Conceptualization, Conducted the Study, Drafted the Manuscript. All four authors critically reviewed the final manuscript.

Conflict of Interest

The authors declare no conflict of interest regarding the publication of this article.

Data Availability

The data supporting the findings of this study were obtained from administrative health databases of the Ministry of Public Health and the National Health Security Office, Thailand. Due to institutional and ethical regulations, the data are not publicly available but may be obtained from the corresponding author upon reasonable request and with approval from the respective authorities.

Declaration of Artificial Intelligence (AI) Assistance

AI-assisted technology was used to support manuscript preparation, including language editing and document formatting. The authors have critically reviewed all AI-assisted content and

assume full responsibility for the manuscript's accuracy and integrity.

Ethics Approval

This study was approved by the Institutional Review Board at Sirindhorn College of Public Health, Phitsanulok, Faculty of Public Health and Allied Health Sciences, Praboromarajchanok Institute in Thailand. The reference number is SCPHPL 3/2566/1.1.

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