Survival Analysis Of COVID-19 Patients with Type 2 Diabetes: Lesson From Pandemic

Analisis Ketahanan Hidup Pasien COVID-19 dengan Diabetes Tipe 2: Pelajaran dari Pandemi

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ABSTRACT
Type 2 diabetes mellitus (T2DM) is a common chronic comorbidity that exacerbates the clinical course of COVID-19, leading to higher complication rates and mortality. Patients with T2DM experience impaired immunity, persistent inflammation, and metabolic dysfunction, making them more vulnerable to severe viral infections. Despite extensive global research, evidence from Indonesia remains scarce, highlighting the need for local data to guide public health strategies. This study aimed to analyze the survival of COVID-19 patients with T2DM and identify factors associated with mortality in Padang City. A retrospective cohort study using surveillance data from the Padang City Health Office between March 2020 and March 2021 included 209 randomly selected patients. Survival analysis was conducted using Kaplan–Meier methods, and Cox regression models identified mortality predictors. The study found that 6.7% of patients died, with an incidence rate of 0.0058. T2DM patients had nearly four times the risk of death compared to non-diabetic individuals (HR = 3.9; 95% CI: 1.2–14.2). Other predictors included older age, male sex, multiple comorbidities, symptomatic status, and hospitalization. These findings emphasize the need to prioritize T2DM patients in vaccination, early detection, and integrated diabetes management to strengthen health system resilience.

Keywords : Diabetes Mellitus, COVID-19, Survival, Mortality, Risk Factors, And Public Health

ABSTRAK
Diabetes melitus tipe 2 (DMT2) adalah komorbiditas kronis yang umum yang memperburuk perjalanan klinis COVID-19, mengakibatkan tingkat komplikasi dan kematian yang lebih tinggi. Pasien dengan DMT2 memiliki gangguan kekebalan, peradangan persisten, dan disfungsi metabolik, yang membuat mereka lebih rentan terhadap infeksi virus parah. Meskipun telah dilakukan penelitian global yang ekstensif, bukti dari Indonesia masih sedikit, menyoroti kebutuhan data lokal untuk memandu strategi kesehatan masyarakat. Studi ini bertujuan untuk menganalisis kelangsungan hidup pasien COVID-19 dengan DMT2 dan mengidentifikasi faktor-faktor yang berhubungan dengan kematian di Kota Padang. Studi kohort retrospektif menggunakan data surveilans dari Dinas Kesehatan Kota Padang antara Maret 2020 dan Maret 2021 melibatkan 209 pasien yang dipilih secara acak. Analisis kelangsungan hidup dilakukan menggunakan metode Kaplan–Meier, dan model regresi Cox mengidentifikasi prediktor kematian. Studi tersebut menemukan bahwa 6,7% pasien meninggal, dengan tingkat kejadian 0,0058. Pasien DMT2 memiliki risiko kematian hampir empat kali lipat dibandingkan individu non-diabetes (HR = 3,9; CI 95%: 1,2–14,2). Prediktor lainnya termasuk usia lebih tua, jenis kelamin laki-laki, komorbiditas ganda, status gejala, dan status rawat inap. Temuan ini menggarisbawahi pentingnya memprioritaskan pasien DMT2 untuk vaksinasi, deteksi dini, dan manajemen diabetes terpadu untuk meningkatkan ketahanan sistem kesehatan.

Kata Kunci : Diabetes Mellitus, COVID-19, Survival, Kematian, Faktor Risiko, dan Kesehatan Masyarakat

INTRODUCTION

The COVID-19 pandemic constitutes a major global health crisis, resulting in extensive epidemiological, social, and economic impacts. The first case was reported in Wuhan, China, in December 2019, characterized as pneumonia of unknown origin (Ministry of Health of the Republic of Indonesia, 2020a). The infection was subsequently attributed to a novel coronavirus, designated Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2), which had not previously infected humans. The virus rapidly disseminated across various countries and regions, resulting in a significant increase in cases and considerable pressure on healthcare systems in numerous nations. On March 11, 2020, the World Health Organization (WHO) officially classified COVID-19 as a global pandemic (Huang et al., 2020; Ministry of Health of the Republic of Indonesia, 2020b).

As of December 31, 2021, COVID-19 has resulted in over 286 million cases worldwide, with fatalities surpassing 5.4 million and a case fatality rate (CFR) of 1.9%. The pandemic in Indonesia has significantly affected the country, resulting in 4.2 million confirmed cases and over 144,000 deaths, yielding a CFR of 3.38%, which is higher than the global average (WHO, 2021a). West Sumatra province has experienced considerable impact, particularly in Padang City, which has reported the highest number of cases in the region, totaling 42,242 confirmed cases, 554 deaths, and a case fatality rate of 1.32% (COVID-19 Handling Task Force, 2021; West Sumatra Provincial Health Office, 2021).

In the midst of pandemic control efforts, great attention is paid to high-risk groups, especially those with comorbid diseases. Diabetes Mellitus (DM) is one of the comorbidities most reliably linked to heightened severity and death from COVID-19. Diabetes mellitus is a chronic metabolic disorder marked by dysregulation of blood glucose levels, significantly affecting the immune system. Individuals with diabetes mellitus exhibit diminished immune system functionality, vascular endothelial abnormalities, and persistent inflammatory states, which may exacerbate the clinical progression of SARS-CoV-2 infection (Muniyappa & Gubbi, 2020; Wahdana et al., 2020).

Reports indicate that the pandemic has led to an increase in diabetes mellitus cases, attributed to lifestyle changes, restricted healthcare access, and heightened psychosocial stress (Rajpal et al., 2020). Prior research indicates that diabetes mellitus notably elevates the risk of severe complications, intensive care requirements, and mortality among individuals diagnosed with COVID-19. A meta-analysis conducted by Zheng et al. (2020) indicated that COVID-19 patients with diabetes mellitus (DM) face a mortality risk that is up to three times higher than that of patients without DM (Zheng et al., 2020). Meanwhile also found a significant association between DM and decreased survival, with a p-value of 0.039 and a 2.8-fold higher risk of death (Zhang et al., 2020).

In Padang City, the number of COVID-19 cases and deaths was higher than anywhere else in West Sumatra. Yet no one has closely studied how diabetes shaped the survival of patients here. This gap matters. Global studies give us a picture, but local outcomes can look very different. Age distribution, the mix of other chronic diseases, and the limits of local hospitals all play a role. By turning the spotlight on Padang, this study tries to fill that gap and offer evidence that can be used directly in daily clinical work and in public health decisions.

One important feature of this study is the period in which it was carried out. The data cover March 2020 to March 2021, which was the very beginning of the pandemic in Indonesia. At that point, vaccination had not yet started and new variants such as Delta or Omicron had not appeared. This means the findings capture a "clean" picture of how diabetes alone affected COVID-19 survival. In other words, the results reflect outcomes without the added influence of vaccines or variant-specific changes. Filling this gap provides much-needed local evidence while also offering insights that help the global community understand the role of diabetes in the early stages of an emerging infectious disease.

This study aims to examine the survival of COVID-19 patients with and without diabetes mellitus in Padang City and

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to identify demographic, clinical, and comorbidity-related factors associated with mortality. In addition, the study seeks to generate recommendations for health policy interventions, including the prioritization of high-risk groups, strengthening of early detection and monitoring, and the integration of diabetes care into local pandemic preparedness strategies.

The main focus is to assess how much greater the risk of death is in COVID-19 patients with diabetes mellitus compared to those without diabetes mellitus, as well as the extent to which other variables such as age, gender, number of comorbidities, symptoms, and hospitalization status affect these outcomes. As the pandemic transitions to a post-pandemic phase, this study is also an important reflection to understand how chronic comorbidities such as DM exacerbate the impact of acute infections, as well as how health systems should respond more purposefully during future health crises. The findings are expected to advance scientific understanding while also providing evidence-based guidance for the formulation of risk mitigation policies and the protection of vulnerable populations in future public health emergencies.

METHODS

We conducted a retrospective cohort study using secondary surveillance data from the Padang City Health Office covering 15,533 confirmed COVID-19 cases between March 2020 and March 2021. This period was chosen because it reflected the early pandemic phase, before vaccination began and major variants emerged. From this population, 209 patients were selected through simple random sampling, restricted to cases with complete information on diabetes status, comorbidities, symptoms, hospitalization, and survival outcomes. Cases with discrepancies or missing data were excluded.

The dataset included demographic variables (age, gender), diabetes status (type 1 and type 2), comorbidities, symptoms, hospitalization, and survival status. Comorbidities were categorized as none, one, or two or more. Symptom status was classified as asymptomatic or symptomatic, while hospitalization status was based on medical recommendation and clinical severity. Survival time was calculated as the number of days from COVID-19 diagnosis to death or the end of follow-up. While the surveillance system provided comprehensive coverage, the accuracy depended on timely and complete reporting, and underreporting of comorbidities or symptoms may have occurred.

Data analysis included univariate description, Kaplan-Meier survival estimates, and log-rank tests. Variables with $p < 0.25$ in bivariate analysis were entered into a Cox proportional hazards regression model, with proportional hazard assumptions tested prior to interpretation.

The research obtained ethical clearance from the Ethics Committee of the Faculty of Public Health at Andalas University (No. 4/UN16.12/KEP-FKM/2022).

RESULTS

From 209 COVID-19 patients studied and table 1, 93.3% survived until the end of the observation period, while 6.7% died, with an incidence rate of 0.0058, indicating about 5–6 early deaths per 1,000 cases.

Table 1. Status COVID-19 Patient Survival

Survival Status	Frequency	%	*Incidence Rate*
Censored	195	93.3	-
Event	14	6.7	-
Total	**209**	**100**	**0.0058**

Table 2 shows that high-risk groups included patients with diabetes mellitus (5.7%), aged >60 years (23.4%), males (41.1%), those with one or more comorbidities (12.4%), symptomatic patients (44.5%), and those hospitalized (34.9%). Kaplan-Meier and log-rank analyses demonstrated significant associations between all independent variables, DM status, age, gender, comorbidities, symptoms, and hospitalization and patient survival ($p < 0.05$).

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Table 2. Frequency Distribution of Characteristics of COVID-19 Patients in Padang City and Bivariat Analysis

Variables	Frequency	%	*p-value*	*p-log rank*	Mean
Diabetes Mellitus Status COVID-19 patients			0,002	0,000	
Non-DM	197	94.3			32,333
DM	12	5.7			16,675
Total	**209**	**100**			
Age			0,012	0,007	
≤ 60 years	160	76.6			32,274
> 60 years	49	23.4			20,861
Total	**209**	**100**			
Sex			0,021	0,014	
Female	123	58.9			33,551
Male	86	41.1			21,454
Total	**209**	**100**			
Number of Comorbidities			0,000	0,000	
Without Comorbidities	183	87.6			34,663
1 Comorbidities	21	10.0			17,891
≥2 Comorbidities	5	2.4			11,067
Total	**209**	**100**			
Symptom			0,024	0,016	
No symptoms	116	55.5			32,787
With symptoms	93	44.5			17,079
Total	**209**	**100**			
Hospitalization Status			0,020	0,014	
No	136	65.1			33,449
Yes	73	34.9			23,019
Total	**209**	**100**			

The Effect of Diabetes Mellitus on Survival

COVID-19 patients with DM have an average survival time of 16 days, much shorter than patients without DM who have an average of 32 days. The statistical test results showed a significant relationship between DM and survival (p-value = 0.002). The log-rank test indicated a statistically significant difference in survival between the two groups (p = 0.000). Cox regression bivariate analysis indicated that patients with diabetes mellitus (DM) exhibited a 5.7-fold increased risk of mortality compared to non-DM patients (HR = 5.726; 95% CI: 1.894-17.314). Upon adjusting for age, gender, comorbidities, and hospitalization status, diabetes mellitus (DM) was found to be significantly associated with a 3.9-fold increased risk (HR = 3.902; 95% CI: 1.166-14.172; p = 0.039).

Relationship between Age and Survival

Patients aged > 60 years had a mean survival time of 20 days, shorter than the age group ≤ 60 years which reached 32 days. The log-rank test showed a significant difference (p = 0.007). Bivariate analysis using Cox regression showed that patients aged > 60 years had a 3.85 times higher risk of death than patients aged ≤ 60 years (HR = 3.854; 95% CI: 1.349-11.011). After controlling for DM, gender, number of comorbidities, and hospitalization status in multivariate analysis, this association remained significant with an adjusted HR of 3.820 (95% CI: 1.065-13.704; p = 0.040).

Relationship between Gender and Survival

Male patients had an average survival time of 21 days, which was shorter than female patients who had an average of 33 days. Statistical test results showed a significant relationship between gender and survival (p-value = 0.021). The log-rank test results indicate a significant difference in survival between the two groups (p = 0.014). Bivariate Cox regression analysis shows that male patients have a 3.6 times higher risk of death compared to female patients (HR = 3.631; 95% CI: 1.217–10.828). After controlling for age, DM,

number of comorbidities, and hospitalization status, gender was no longer statistically significant (HR = 3.609; 95% CI: 0.929–14.020; p = 0.064).

Relationship Between Number of Comorbidities and Survival

Patients with ≥2 comorbidities had an average survival time of 11 days, shorter than patients with one comorbidity (18 days) or no comorbidities (34 days). Statistical analysis revealed a significant association between the number of comorbidities and survival (p-value = 0.000). The log-rank test results showed a significant difference in survival time between groups (p = 0.000). Bivariate Cox regression analysis indicated that patients with ≥2 comorbidities had a 6.2-fold higher risk of death compared to patients without comorbidities (HR = 6.191; 95% CI: 3.114–12.311). After adjusting for age, sex, DM, and hospitalization status, the number of comorbidities remained significant with a 4.9-fold higher risk (HR = 4.944; 95% CI: 2.101–11.636; p = 0.000).

Relationship between Symptom Status and Survival

Patients exhibiting symptoms had an average survival time of 17 days, which is shorter than the 33 days observed in asymptomatic patients. Statistical analysis indicated a significant correlation between symptom status and survival (p-value = 0.024). Log-rank test results showed a significant difference in survival between the two groups (p = 0.016). Bivariate Cox regression analysis showed that symptomatic patients had a 3.9 times higher risk of death compared to asymptomatic patients (HR = 3.947; 95% CI: 1.194–13.049). This variable was not included in the final model because it did not meet the criteria as an independent factor in multivariate analysis.

Relationship between Hospitalization Status and Survival

Patients who were hospitalized had an average survival time of 23 days, which was lower than patients who were not hospitalized, who had an average survival time of 33 days. Statistical test results showed a significant relationship between hospitalization status and survival (p-value = 0.020). The log-rank test results showed a significant difference in survival between the two groups (p = 0.014). Bivariate Cox regression analysis indicated that hospitalized patients had a 3.6 times higher risk of death compared to non-hospitalized patients (HR = 3.570; 95% CI: 1.217–10.474). After adjusting for age, sex, DM, and number of comorbidities, inpatient status remained significant with a 4.7-fold higher risk (HR = 4.653; 95% CI: 1.242–17.439; p = 0.023).

Kaplan Meier Curves

Based on Figure 1, the Kaplan–Meier curves show that the groups of patients with diabetes mellitus, advanced age, male gender, ≥2 comorbidities, symptomatic infection, and hospitalization experienced a sharper decline in survival probability over time. This indicates that these groups had a faster reduction in the probability of survival compared to their counterparts, reflecting a higher risk of death.

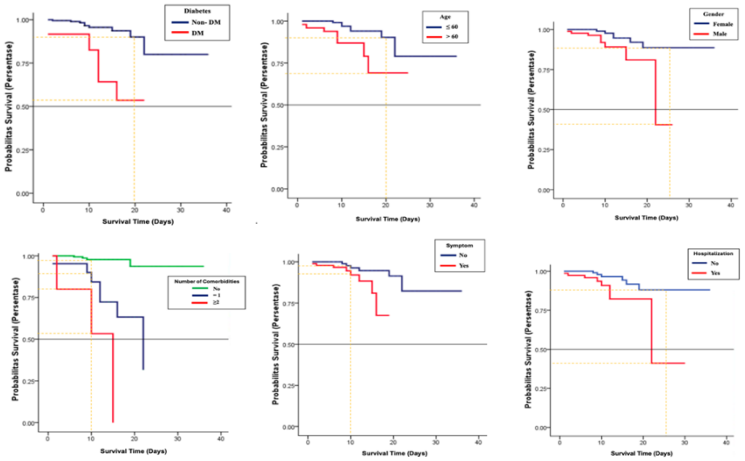

Figure 1. Kaplan-Meier Curve of COVID-19 Patients Based on Research Variables

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Multivariate Analysis

In Table 3 shows that COVID-19 patients with DM have a 3.9 times higher risk of death than those without DM (HR 3.9, 95% CI 1.866–14.172) after adjusting for age, gender, number of comorbidities, and hospitalization status. The symptom status variable is not a confounder and should therefore be excluded from the model.

Table 3. Hazard Ratio Using the Cox Proportional Hazards Method

Variables	Bivariate			Multivariat		
	HR	CI 95%	*P-value*	HR	CI 95%	*P-value*
Diabetes Mellitus Status COVID-19 patients	5,726	1,894 – 17,314	0,000	3,902	1,166 – 14,172	0,039
Non-DM						
DM						
Age*	3,854	1,349 – 11,011	0,007	3,820	1,065 – 13,704	0,040
≤ 60 years						
> 60 years						
Sex*	3,631	1,217 – 10,828	0,014	3,609	0,929 – 14,020	0,064
Woman						
Man						
Number of Comorbidities	6,191	3,114 – 12,311	0,000	4,944	2,101 – 11,636	0,000
Without Comorbidities						
1 Comorbidities						
≥2 Comorbidities						
Symptom	3,947	1,194 – 13,049	0,016	-	-	-
No symptoms						
With symptoms						
Hospitalization Status	3,570	1,217 – 10,474	0,014	4,653	1,242 – 17,439	0,023
No						
Yes						

**Confounder*

DISCUSSION

The findings of this study align with previous research. Lestari and Ichsan (2021) reported a strong association between diabetes and poor COVID-19 survival ($p < 0.001$), while Wu et al. (2020) found that diabetic patients had nearly threefold higher mortality risk (Lestari & Ichsan, 2021; Wu et al., 2020). Chronic hyperglycemia weakens immunity, triggers inflammation, and disrupts insulin regulation (Pari et al., 2023). High glucose levels also impair immune cell function, reducing viral clearance efficiency (Hodgson et al., 2015). When this impaired defense combines with the chronic inflammatory state typical of diabetes, the immune response to SARS-CoV-2 can become excessive, potentially leading to cytokine storm events associated with severe illness (Lim et al., 2020). Long-term vascular damage increases risks of respiratory failure and multi-organ injury (Goshua et al., 2020).

The relationship between age and survival in this study also aligns with the findings of Warsi Maryati et al. (2022), who identified a significant association ($p < 0.001$) showing that patients aged over 60 years had lower survival probabilities than younger individuals (Maryati et al., 2022). This is attributable to physiological decline with aging, reduced organ function, and diminished immune responses, which heighten vulnerability to severe infection, pneumonia, and death (Masriadi, 2017).

A similar pattern emerged regarding gender. Margareth Dwiyanti (2021) found a significant association between gender and COVID-19 survival (p = 0.011), with male patients exhibiting a 2.3-fold higher mortality risk compared with females (Dwiyanti Simatupang & Made Arcana, 2021). Biologically, females possess stronger innate and adaptive immunity, influenced by estrogen's enhancement of immune cell function, whereas males are more likely to engage in behaviors such as smoking, increasing susceptibility to severe infection (Pradhan & Olsson, 2020).

The association between comorbidities and survival was likewise observed. Jun Mi et al. (2020) reported that patients with two or more comorbidities had lower survival and an 8.8-fold higher mortality risk than those with one or none (p = 0.0012) (Mi et al., 2020). Multiple chronic conditions create greater physiological strain, aggravating infection outcomes (Porzionato et al., 2020).

Furthermore, several studies demonstrated that symptom status significantly correlates with survival. Yan et al. (2020) and Drew (2021) found strong associations (p = 0.002 and p = 0.036) (Drew & Adisasmita, 2021; Yan et al., 2020). while Bonanad et al. (2020) observed shorter survival in symptomatic patients. Symptoms reflect viral replication and immune activation, and excessive inflammatory responses may escalate to cytokine storms, causing organ injury and increased mortality (Bonanad et al., 2020).

Hospitalization was significantly linked to survival outcomes. Paulo Jorge Nogueira et al. (2020) found a strong association (p = 0.001), while Ong et al. (2023) and Sousa et al. (2020) reported lower survival and a threefold higher mortality risk among hospitalized patients, reflecting severe cases such as pneumonia or ARDS (Ong et al., 2023; Sousa et al., 2020).

Key Lessons for Future Health Emergencies

The COVID-19 pandemic has provided valuable insights for future public health emergency strategies, especially concerning chronic diseases such as diabetes mellitus (DM). The findings of this study highlight the need to prioritize DM patients in vaccination and early screening, strengthen hospital preparedness, and integrate diabetes care into community-based primary healthcare. These results demonstrate how evidence can be transformed into actionable policies to protect vulnerable populations during future crises.

Targeted Surveillance for High-Risk Groups

DM significantly reduced survival time among COVID-19 patients, indicating it as a high-risk condition requiring close monitoring. Zhou et al. (2024), in a meta-analysis of over 60 million individuals, found COVID-19 increased the risk of new-onset DM (HR = 1.46; 95% CI: 1.38–1.55) (Zhou et al., 2024).

Naveed et al. (2023) reported a 17% rise in new DM diagnoses post-COVID-19 and over threefold higher risk among ICU patients (HR = 3.29). Strengthening comorbidity-based surveillance with real-time monitoring is crucial for identifying both acute and post-COVID diabetes. Integrating NCD variables, particularly DM, into national health information systems will enhance preparedness (Naveed et al., 2023).

Prioritization in Vaccination and Emergency Planning

The WHO (2021b) identifies DM as a major comorbidity linked to severe complications and mortality, while the CDC (2021) recommends prioritizing individuals with chronic diseases in pandemic response. This study reinforces that proactive and segmented healthcare is vital for protecting high-risk patients (CDC, 2021; WHO, 2021b).

Strengthening Community-Based Chronic Disease Management

Given the reduced survival of DM patients, community-centered care is essential. Ansbro et al. (2024) found that countries maintaining chronic disease services during the pandemic applied adaptable strategies such as home delivery of medication, teleconsultations, and community monitoring (Ansbro et al., 2024).

Coyle et al. (2024) noted that self-education, virtual support, and community health workers preserved glycemic stability (Coyle et al., 2023). Yu et al. (2023) highlighted the role of digital platforms in

sustaining metabolic control. Integrating DM care into local preparedness systems ensures uninterrupted services during crises (Yu et al., 2023).

Cross-Sectoral and Multidisciplinary Coordination

The higher mortality among DM patients indicates systemic weaknesses requiring multisectoral action. WHO (2023) emphasizes "Health in All Policies," integrating health across technology, education, and social protection sectors (WHO, 2023).

Simeon et al. (2024) showed that collaboration among governments, civil organizations, and social services sustained care for chronic patients. Such coordination supports early detection, drug access, and service continuity (Simeon et al., 2024).

Health Promotion and NCD Prevention

Low survival among DM patients underlines the need for promotive and preventive measures. Wang et al. (2025) demonstrated that lifestyle interventions digital or face-to-face reduced type 2 diabetes incidence by up to 46%. (Wang et al., 2025).

Sutthiworapon et al. (2024) showed that digital infographics improved knowledge, adherence, and glycemic control. Strengthening prevention, education, and lifestyle programs can reduce chronic disease burden and increase resilience (Sutthiworapon et al., 2024; WHO, 2021a).

Limitation

This study used retrospective surveillance data, risking reporting bias and missing information. Variables such as body mass index, glycemic control, socioeconomic status, and vaccination were unavailable. As observational data, causality cannot be confirmed. Future longitudinal studies with clinical and behavioral variables are needed. Despite these constraints, this study provides critical insight into how diabetes shaped COVID-19 survival during Indonesia's early pandemic phase.

CONCLUSIONS

The results of this study show that diabetes mellitus (DM) is closely linked with poorer survival in patients infected with COVID-19. Those with DM survived for a shorter period on average and faced nearly four times the risk of death (HR = 3.9) compared to patients without DM. This difference remained even after taking into account other factors such as age, sex, number of comorbidities, and whether the patient was hospitalized. These patterns suggest that DM does not simply accompany COVID-19 as a background condition but actively worsens the outcome of infection.

RECOMMENDATION

The study also offers lessons that are relevant beyond the immediate findings. In practice, the results highlight several areas that health systems should strengthen: identifying diabetes early among patients with infectious diseases, ensuring that people with chronic conditions receive timely treatment, and keeping essential services available even during health emergencies. It is equally important to improve the accuracy of surveillance data so that comorbidities are captured more reliably, and to equip primary care facilities to maintain continuity of care when crises occur. Taken together, the findings provide not only empirical evidence but also practical direction for policymakers. By addressing the vulnerabilities of people with chronic illnesses such as diabetes, health systems can be better prepared for future outbreaks and other public health emergencies.

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