Submitted: 09 January, 2025 Accepted: 21 March, 2025 Published: 08 October, 2025 DOI:10.22514/sv.2025.143

Open Access
Signa Vitae

ORIGINAL RESEARCH

Impact of increased emergency department ultrasound utilization on patient visit patterns

Chia-Ching Chen[1,†], Chi-Hao Chen[2,†], Chun-An Chou[3], Shao-Jen Weng[2,*], Yao-Te Tsai[4,*]

[1]Department of Emergency, Chang Bing Show Chwan Memorial Hospital, 505 Changhua, Taiwan
[2]Department of Industrial Engineering and Enterprise Information, Tunghai University, 407 Taichung, Taiwan
[3]Walmart Global Tech, Bentonville, AR 72716, USA
[4]Department of Information Management, National Kaohsiung University of Science and Technology, 824 Kaohsiung, Taiwan

***Correspondence**
sjweng@thu.edu.tw
(Shao-Jen Weng);
yaottsai@nkust.edu.tw
(Yao-Te Tsai)

† These authors contributed equally.

Abstract

Background: Ultrasonography is an important radiation-free diagnostic tool in emergency medicine, offering rapid bedside assessment. However, the relationship between increased ultrasound utilization and emergency department (ED) visit patterns has not yet been completely elucidated. **Methods**: This quasi-experimental study compared two regional hospitals (2021–2023) implementing different ultrasound strategies to analyze the relationship between ultrasound utilization rates and ED visit patterns, controlling for hospital characteristics and temporal trends using negative binomial regression. **Results**: The utilization rate of ultrasound technology at Chang Bing Show Chwan Memorial Hospital increased from 19.98% to 54.13% during the study period. Although the increased utilization of ultrasound was generally associated with a decrease in ED visits ($\beta = -2.3342$, $p < 0.001$), the significant interaction term "Time After: Hospital 1" ($\beta = 0.0332$, $p < 0.001$) suggested that the intervention hospital had an increase in ED visits more consistently than the control hospital. Interestingly, Chang Bing Show Chwan Memorial Hospital maintained this positive trend despite a decrease in the regional demographics. **Conclusions**: While higher ultrasound utilization was generally associated with fewer ED visits, the intervention hospital maintained more consistent ED visit patterns over time. This complex relationship suggests that the impact of increased ultrasound capability on ED utilization patterns may involve multiple factors beyond simple cause-and-effect relationships. Further research using more rigorous study designs is needed to establish potential causal relationships between ultrasound usage and ED visit patterns.

Keywords

Emergency medicine; Ultrasound; Healthcare quality; Emergency department visits

1. Introduction

Emergency departments (ED) encompass many medical specialties and care for a wide variety of patients of all ages in a complex environment [1]. With increasing emergency patient volumes and complex diagnostic needs, point-of-care ultrasound has proven to be a critical tool for addressing many exceptional challenges in emergency medicine [2, 3]. Understanding the consequences of increased ultrasound use in ED operations is critical for enhancing the quality of emergency care and patient outcomes.

Ultrasound technology offers several distinct advantages in emergencies as its point-of-care availability allows instant diagnosis and rapid clinical decision-making. The versatility of this technology allows for a wide range of applications, including cardiac and abdominal assessments and guided interventions [4]. Studies have demonstrated that the application of ultrasound can significantly reduce diagnostic times and improve the accuracy of treatment plans [5–7]. Its economic feasibility and the capacity to be repeated also make it highly suitable for continuous patient monitoring and re-assessment in emergency settings [8–10].

Although the recognized benefits of ultrasound in emergency care are well documented, research examining its impact on ED utilization patterns remains limited. Some studies have verified improvements in specific clinical outcomes and patient satisfaction but there is a gap in the understanding of how increased ultrasound utilization influences overall ED visit patterns. Current research has primarily focused on specific clinical applications or technical aspects of ultrasound use rather than its broader impact on ED utilization trends. The relationship between enhanced diagnostic capabilities and patient choice in emergency departments remains largely unexplored, therefore this study aimed to address this knowledge gap by examining how increased ultrasound utilization influences ED visit patterns and patient choice behavior in a regional hospital setting.

The relationship between enhanced diagnostic capabilities

and ED utilization patterns is complex and multifaceted so it was hypothesized that ultrasound availability, especially by performing more ultrasound examinations, may change the way patients use emergency services. Rapid access to ultrasound tests may improve how patients move through the system and make better utilization of equipment, while real-time tests may boost patient trust in the EDs. Healthcare workers with improved tools can provide better patient care, increasing the overall quality of emergency treatment, and thereby influencing how patients choose where to visit.

This study contributes to emergency medicine literature in three significant ways. First, it provides a structured framework for evaluating the relationship between ultrasound utilization and ED visit patterns, offering a systematic approach to assessing technological interventions in emergency settings. Second, it analyzes longitudinal data on the association between increasing ultrasound adoption rates (from 19.98% to 54.13%) and changes in ED utilization over a three-year period. Third, it offers insights into how enhanced diagnostic capabilities might influence patient flow in regional hospital settings, which could inform resource-allocation decisions in similar healthcare environments.

2. Materials and methods

This quasi-experimental study examined the impact of a planned intervention to increase ultrasound utilization in an emergency department compared to a control hospital.

2.1 Hospital status

The emergency departments of two neighboring hospitals in the medical group served as case studies: Chang Bing Show Chwan Memorial Hospital and Show Chwan Memorial Hospital. Compared to 2021, the number of acute general beds for Show Chwan Memorial Hospital and Chang Bing Show Chwan Memorial Hospital remained the same, with 675 beds and 500 beds, respectively. There was a slight variation in the number of specialist doctors but no significant change in the hardware for either hospital. However, significant developments have occurred over the past three years, particularly at the Show Chwan Memorial Hospital, which has access to more resources and has approximately 35% more hospital bed resources allowing it to serve a more significant number of emergency patients. This resource difference was accounted for in the statistical analysis by including hospital fixed effects in the regression model.

The ED at the Chang Bing Show Chwan Memorial Hospital began to increase its ultrasound execution rate in September 2021 to improve the quality of emergency services, with the average ultrasound execution rate increasing from 19.98% in the previous ten months to 38.02% by October 2021. After effectively training emergency medical staff and ensuring adequate emergency manpower to undertake more patients, the average ultrasound execution rate further increased to more than 54.13% from January to December 2023, thereby achieving the goal of high efficiency. Fig. 1 comparing the monthly ultrasound performance rates for emergency patients between the Chang Bing Show Chwan Memorial Hospital and Show Chwan Memorial Hospital shows the difference in ultrasound execution.

Three years after implementing measures to improve the ultrasound execution rate, the emergency service quality was quantified using emergency-related data to evaluate the association between ultrasound utilization and emergency care metrics. Although ED visits represent only one aspect of performance, this metric was selected because patients have considerable freedom to choose their healthcare providers in Taiwan, thus visit patterns reflect patient preferences to some extent. Visit volumes directly impact resource utilization and capacity planning, critical operational concerns for EDs. Moreover, changes in visit patterns following technological interventions may suggest shifts in referral patterns or patient care-seeking behaviors. Nevertheless, it is acknowledged that this metric alone cannot capture the full spectrum of ED performance which would ideally include measures of clinical outcomes, patient experience and operational efficiency.

2.2 Data collection

Administrative data including monthly ED visit statistics were collected from the hospitals from January 2021 to December 2023, with all patients who visited and registered at the ED included in the first stage. Patients diagnosed with COVID-19 were excluded from the study to reduce the sudden influx of a large number of patients which could distort the data and only present the normal emergency patient population. The ultrasound execution rate was calculated as the number of ED patients who underwent ultrasound examinations divided by the total number of monthly ED visits. Ultrasound examinations included all point-of-care ultrasounds performed in the ED regardless of anatomical site or purpose. Since only historical secondary statistical data such as the number of visits and usage rates were analyzed and the study did not involve human subjects, an Institutional Review Board (IRB) review was not required.

Additional data on regional population trends were collected from local government records for the period 2021–2023 to assess demographic changes in the service areas of both hospitals. Information on healthcare facility distribution in Changhua County was also gathered to monitor potential changes in the healthcare landscape that might affect ED utilization patterns.

2.3 Statistical analysis

Several analytical approaches were implemented to control for potential confounding factors that might influence ED visit patterns. First, the population trends in the service areas of both hospitals were examined to understand the demographic changes that might affect ED utilization. The resource difference between the two hospitals (Chang Bing Show Chwan Memorial Hospital has approximately 35% fewer beds than Show Chwan Memorial Hospital) was controlled for by including hospital fixed effects in the regression model. This approach allowed us to analyze the association between ultrasound utilization rates and visit numbers while accounting for baseline differences between hospitals.

Negative binomial regression was used to model the rela-

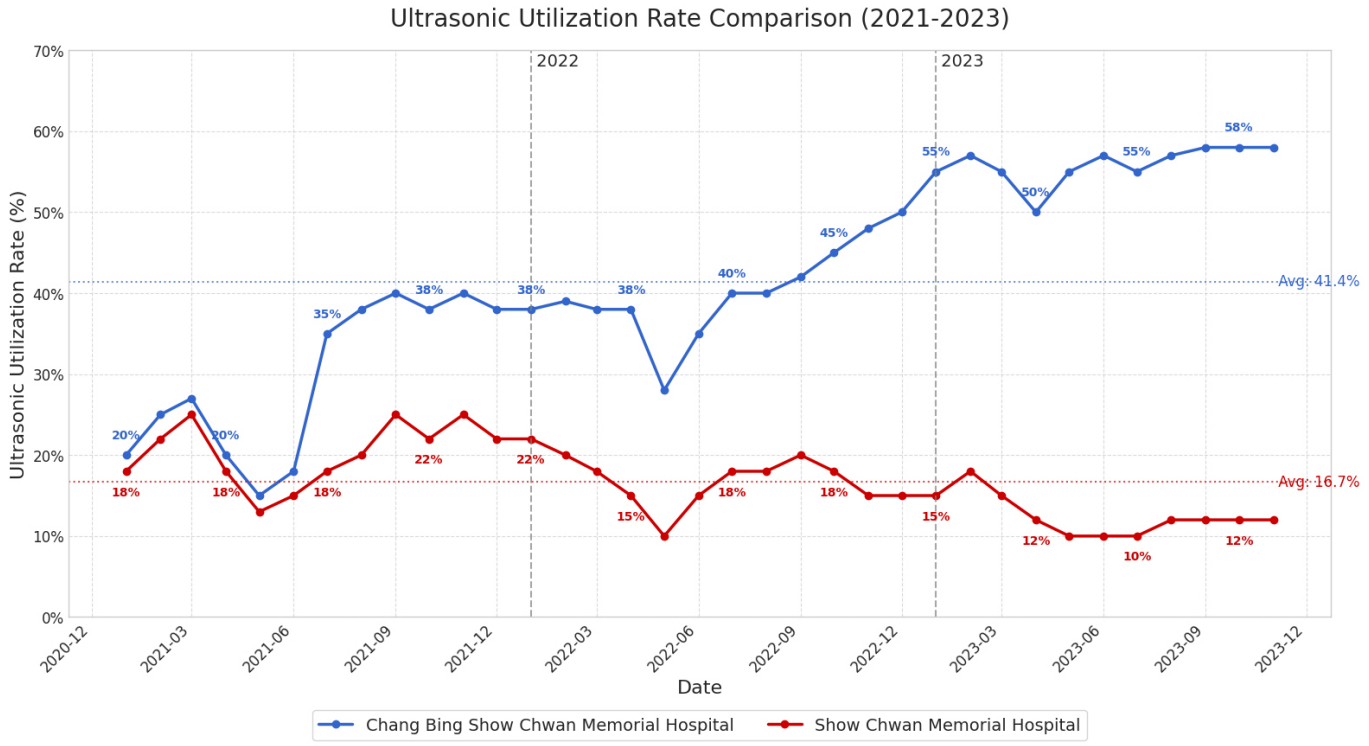

FIGURE 1. Three-year trends in emergency department ultrasound utilization: percentage of patient visits receiving ultrasound examinations at two memorial hospitals (2021–2023). Avg: Average.

tionship between the ultrasound utilization rates and ED visits. This model is appropriate for overdispersed count data in which many factors influence the number of visits. The model disentangles the major effects and interactions driving visit frequencies, thereby offering insights into temporal dynamics and institutional variations as follows:

Let Y_i denote the number of ED visits for the ith observation: The expected number of visits, μ_i, is modeled as:

$$\begin{aligned} Visits_i = & \\ & \beta_0 + \beta_1 Time_i + \beta_2 Intervention_i + \beta_3 Time\_after_i \\ & + \beta_4 Hospital_i + \beta_5 US\_rate_i \\ & + \beta_6 (Hospital \times Intervention)_i \\ & + \beta_7 (Hospital \times Time\_after)_i + \epsilon_i \end{aligned} \quad (1)$$

Where:

$Visit_i$ is the visit count for observation i,

$Time_i$ is the temporal variable that monitors the effect of time,

$Intervention_i$ is a binary variable which indicates whether an intervention was instituted,

$Time\_after_i$ is to measure time (month) elapsed after the intervention,

$Hospital_i$ indicates hospital-specific effects (Show Chwan Memorial Hospital = 0; Chang Bing Show Chwan Memorial Hospital = 1),

US_rate_i is the rate of ultrasound usage rate,

$(Hospital \times Intervention)_i$ and $(Hospital \times Time\_after)_i$ are interaction terms to capture differential effects by hospital,

ϵ_i is the error term.

The regression model included time variables to control for general temporal trends that might similarly affect both hospitals. The interaction terms (Hospital × Intervention and Hospital × Time_after) were specifically designed to capture differential effects by hospital, helping isolate the relationship between ultrasound utilization and ED visit patterns. All analyses were performed using R software (version 4.1.0), with the significance level set at $p < 0.05$.

3. Results

3.1 Emergency room visit analysis

The analysis revealed distinct ED visit patterns in both hospitals over the three-year study period (Fig. 2). While both hospitals experienced an overall increase in ED visits despite a decrease in the regional population, our primary focus was to examine the association between these visit patterns and ultrasound utilization rates, which increased dramatically at Chang Bing Show Chwan Memorial Hospital (from 19.98% to 54.13%) but remained relatively stable at Show Chwan Memorial Hospital. Importantly, these trends occurred despite population decreases in the surrounding areas, suggesting that factors beyond population changes influence ED utilization patterns. This observation prompted our investigation into whether changes in emergency care quality, specifically increased ultrasound utilization, were associated with these visit patterns.

Fig. 3 provides a more precise illustration of the difference in the number of annual emergency department visits between Chang Bing Show Chwan Memorial Hospital and Show Chwan Memorial Hospital. By the end of 2021, the

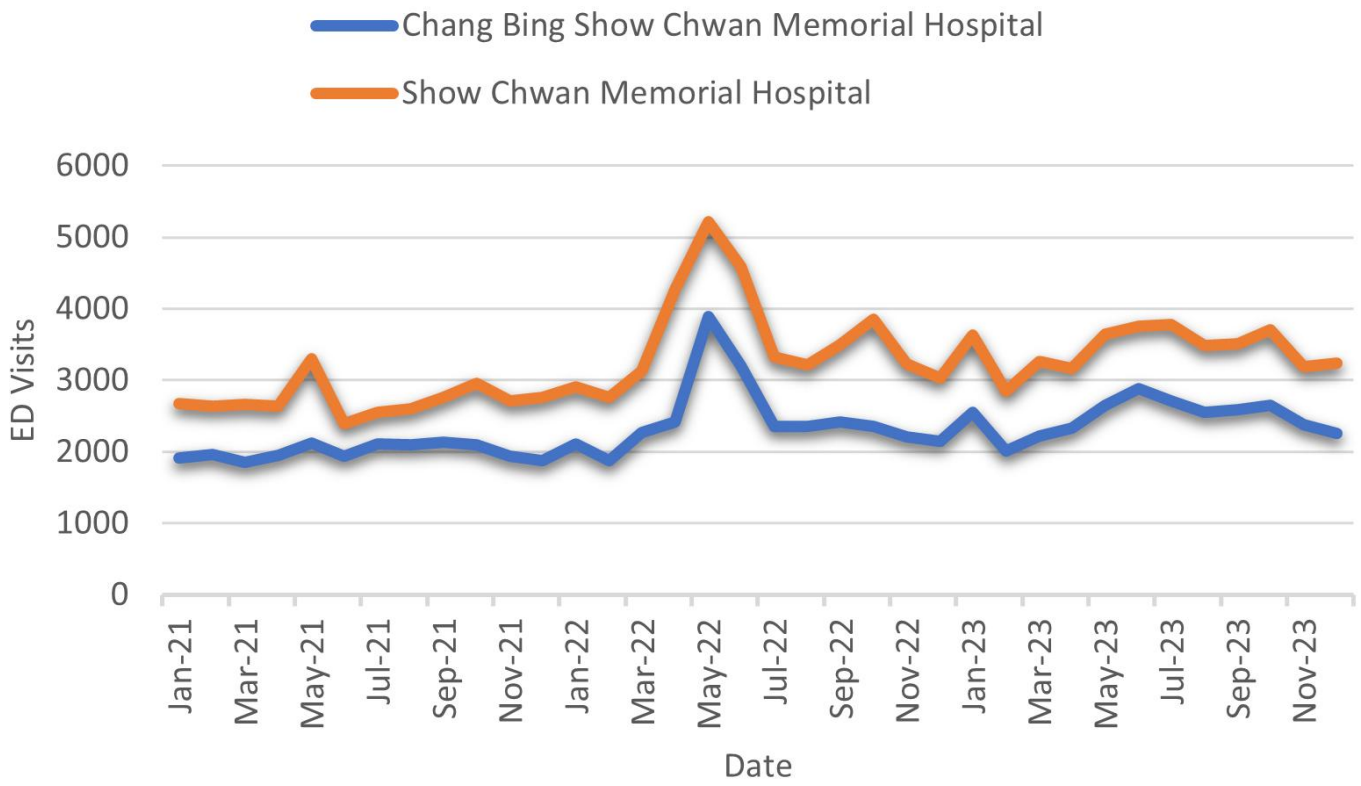

FIGURE 2. Three-year comparison of monthly emergency department visits between two memorial hospitals (2021–2023). ED: Emergency Department.

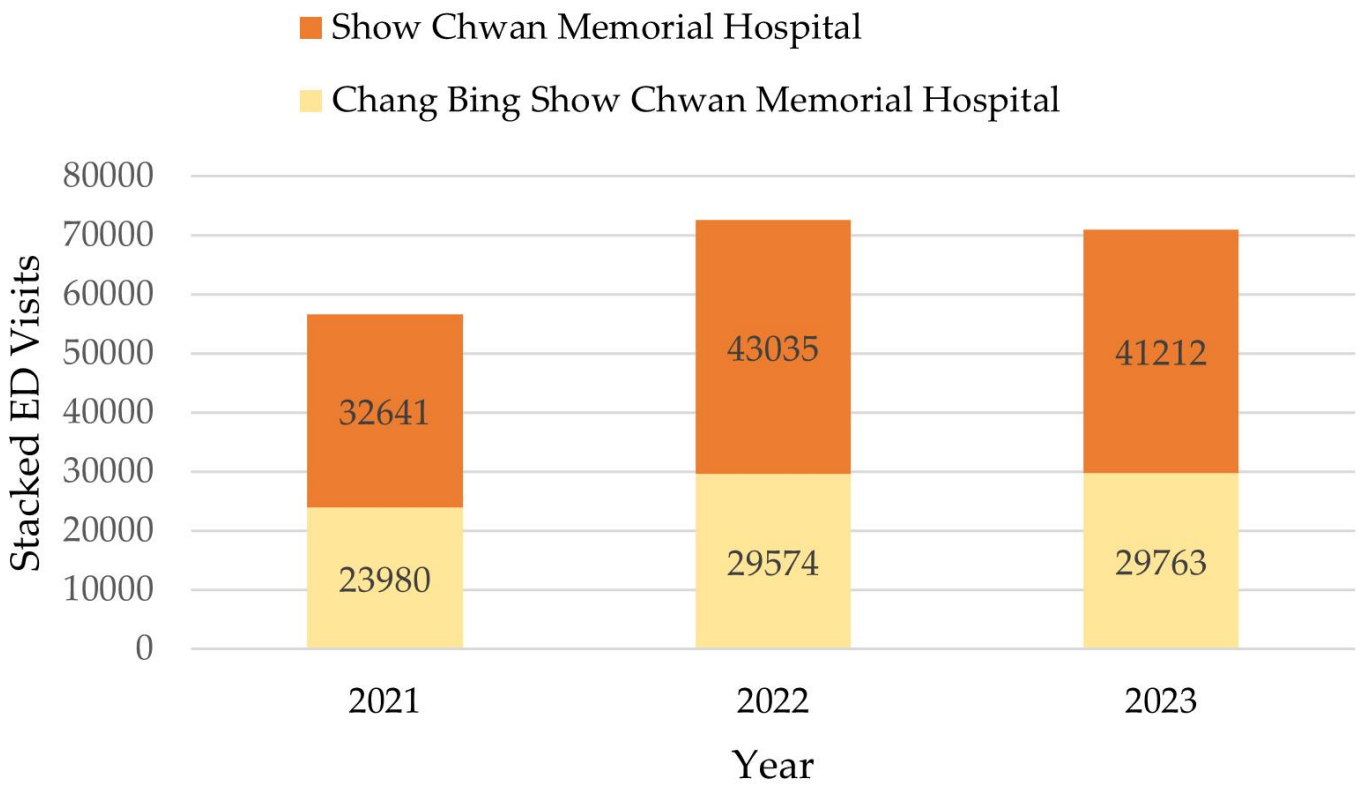

FIGURE 3. Stacked ED visits: two hospitals, 2021–2023. ED: Emergency Department.

two hospitals were represented by relatively small numbers of ED visits to their emergency departments. In contrast, in 2022, because of the effect of the pandemic that started in 2020, the number of department visits for Show Chwan Memorial Hospital increased significantly by 10,394 visits, and for Chang Bing Show Chwan Memorial Hospital by 5594 visits. During the pandemic, the proportion of emergency department visits at the Show Chwan Memorial Hospital increased by 1.62%. After the pandemic, in 2023, the proportion of emergency department visits at Show Chwan Memorial Hospital decreased by 1.2%, with 1823 fewer visits than the previous year. Meanwhile, the number of emergency department visits at Chang Bing Show Chwan Memorial Hospital has continued to increase annually, with an increase of 5783 visits from 2021 to 2023. After the pandemic, there were 189 more patients in 2023 than those in 2022.

Figs. 2,3 show that in 2022, due to the COVID-19 pandemic, many emergency patients flooded the emergency departments of both Show Chwan Memorial Hospital and Chang Bing Show Chwan Memorial Hospital. However, after the pandemic in 2023, the number of emergency department visits at Show Chwan Memorial Hospital decreased, whereas the number of emergency visits at Chang Bing Show Chwan Memorial Hospital remained relatively stable or even increased slightly. This calls for an analysis to determine whether the rise in emergency department visits at Chang Bing Show Chwan Memorial Hospital is related to improvements in the quality of emergency medical care.

3.2 Regional analysis of townships and cities

Fig. 4 shows the quarterly population increase or decrease for each township in Changhua County. It can be observed that most townships experienced negative growth. From January 2022 to December 2023, Changhua County's population decreased by 15,620, a 1.3 percent decrease from the total population in January 2022.

As shown in Fig. 5, the Show Chwan Memorial Hospital primarily receives emergency patients from Changhua City, Lukang Town, Hemei Town, Xiushui Township and Huatan Township. The total population of these areas will decrease by 6035 people between the end of 2022 and 2023, accounting for 2.37% of the total population of these five towns and townships. Chang Bing Show Chwan Memorial Hospital mainly provides services for emergency patients from Lugang Town, Hemei Town, Xianxi Township, Shengang Town and Fuxing Township. Population growth in Shengang Township is the only exception to population decline in these areas. Between 2022 and 2023, the total population of all five areas had decreased by 2943 (1.08% of the total population). Therefore, changes in population in towns and cities have not significantly impacted the changes in visitation to the emergency department.

3.3 Analysis of the number of medical institutions in Changhua County

In 2023, there are a total of 30 hospitals operating in Changhua County. From 2021 to 2023, the number of hospitals in Changhua City is expected to decrease by one. However, as this hospital mainly serves psychiatric patients, its closure does not affect the emergency departments at the Show Chwan Memorial Hospital or Chang Bing Show Chwan Memorial Hospital. By 2021, there are 1064 medical institutions in Changhua County, 1059 in 2022, and 1063 in 2023. Thus, it is clear that the number of hospitals or medical institutions did not cause much variation in the number of visits to the emergency room in Changhua County.

3.4 Controlling for confounding factors

Our analysis verified that the controls implemented in our statistical model effectively addressed the potential confounding factors identified in the methodology section. The detailed examination of population data confirmed our initial assessment that population changes could not explain the observed ED visit patterns. Despite population decreases in both hospital service areas (as detailed in sections 3.2 and 3.3), ED visits increased at Chang Bing Show Chwan Memorial Hospital, further supporting our focus on ultrasound utilization as a potential explanatory factor.

The analysis of healthcare facility distribution similarly confirmed minimal changes during the study period, with the closure of one psychiatric hospital having no impact on emergency services at either study hospital. This verification process strengthens our confidence that the fixed effects included in our regression model adequately controlled for the 35% difference in hospital bed resources, which was the most significant structural difference between the two facilities.

The regression results presented in section 3.5 should therefore be interpreted with the understanding that these potential confounders have been adequately addressed through our statistical approach, allowing for more reliable inferences about the relationship between ultrasound utilization and ED visit patterns.

3.5 Impact of ultrasound utilization on ED visits

The analysis revealed several significant associations between ultrasound utilization and ED visit patterns. Overall, periods with higher ultrasound utilization rates corresponded with periods of fewer ED visits after controlling for hospital differences and time trends. Additionally, the two hospitals exhibited different temporal patterns in ED utilization following the intervention period, with Chang Bing Show Chwan Memorial Hospital showing a more consistent upward trend in visits despite its smaller size.

The negative binomial regression analysis revealed several significant associations between ultrasound utilization and ED visits (Table 1), showing a significant baseline difference between hospitals, with Chang Bing Show Chwan Memorial Hospital having fewer ED visits overall than Show Chwan Memorial Hospital ($\beta = -0.2677$, standard error (SE) = 0.0502, $z = -5.329$, $p < 0.001$). This reflects the expected difference given the 35% fewer beds at the Chang Bing Show Chwan Memorial Hospital.

The ultrasound rate variable showed a significant negative association with ED visits ($\beta = -2.3342$, SE = 0.2887, $z =$

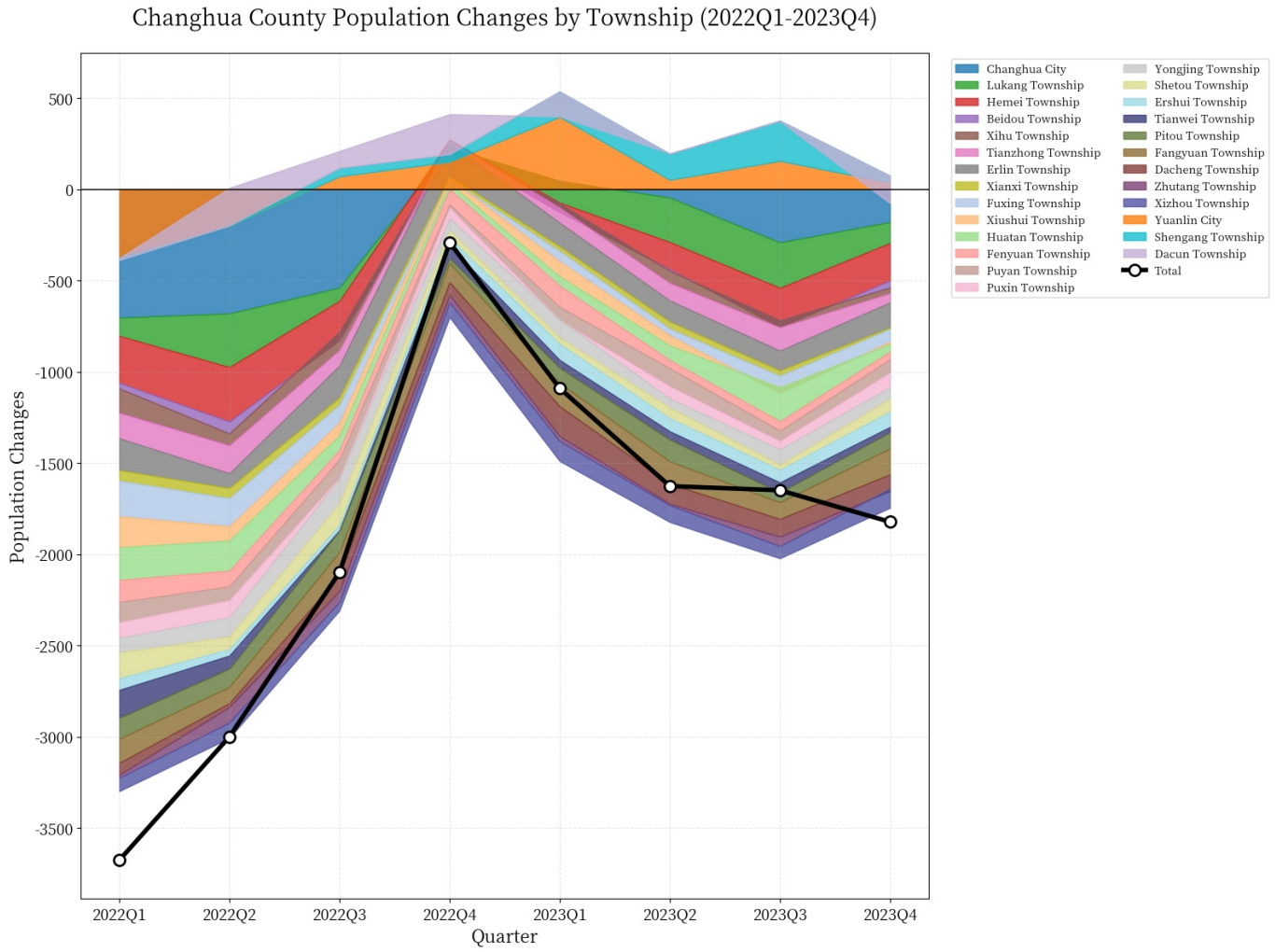

FIGURE 4. Changhua county: quarterly township population shifts (2022–2023).

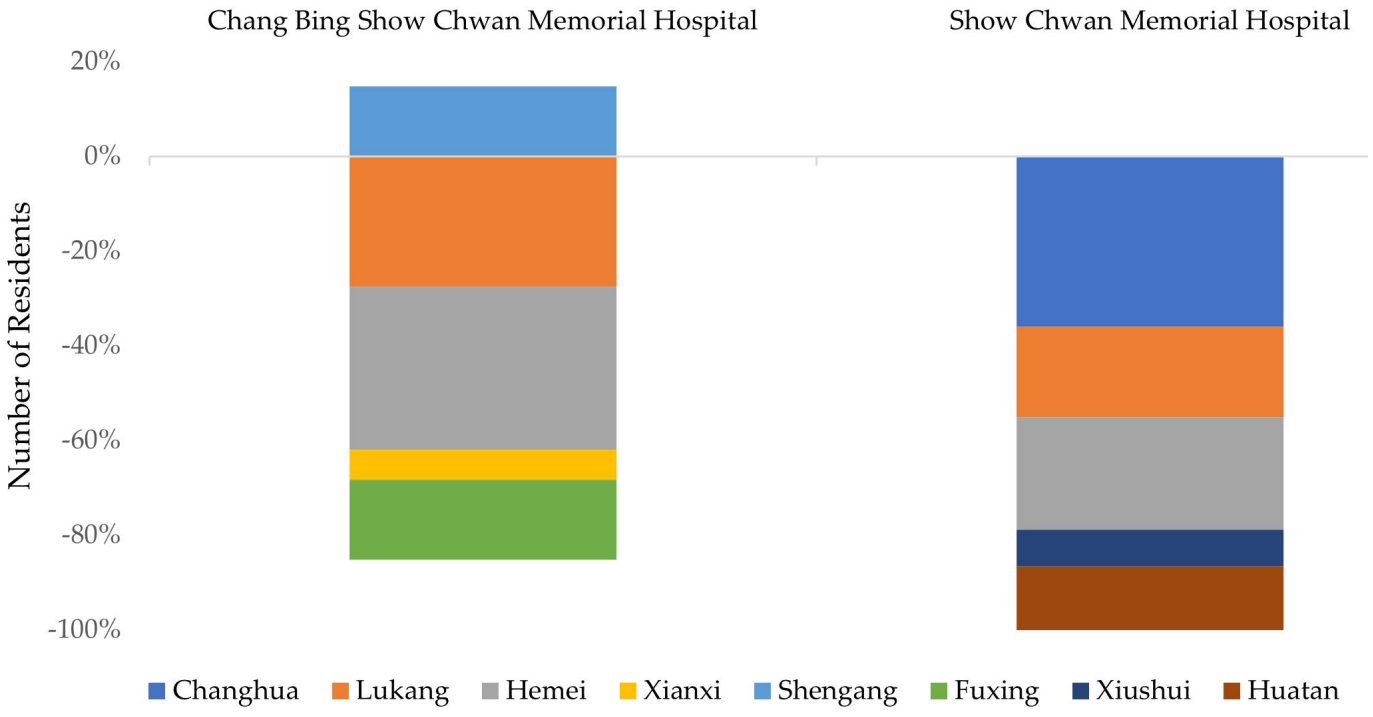

FIGURE 5. Population shifts: towns near two hospitals, 2022–2023.

TABLE 1. Negative binomial regression model parameter estimates.

Coefficient	Estimate	Upper/Lower Bound	SE	*z* value	Pr (>z)
(Intercept)	8.3626	[8.2107, 8.5155]	0.0793	105.342	<0.001***
Time	−0.0079	[−0.0294, 0.0137]	0.0110	−0.717	0.474
Intervention	0.2737	[0.1300, 0.4164]	0.0723	3.785	<0.001***
Time After	0.0025	[−0.0193, 0.0244]	0.0111	0.229	0.819
Hospital 1	−0.2677	[−0.3664, −0.1690]	0.0502	−5.329	<0.001***
Ultrasound Rate	−2.3342	[−2.8850, −1.7868]	0.2887	−8.085	<0.001***
Intervention: Hospital 1	0.1352	[−0.0160, 0.2863]	0.0771	1.754	0.079
Time After: Hospital 1	0.0332	[0.0235, 0.0430]	0.0051	6.542	<0.001***

*Sig.: ***$p < 0.001$. SE: Standard error; Pr: Probability.*

−8.085, $p < 0.001$), indicating that periods with higher ultrasound utilization rates corresponded with periods of fewer ED visits. This complexity could represent a wide range of hidden influences, including changes in the approach to managing patients corresponding to the increased use of ultrasound, shifts in the patients' demographic makeup, or other unexplained factors.

The link between the time after the change and each hospital (Time After: Hospital 1) showed a clear positive link (β = 0.0332, SE = 0.0051, z = 6.542, $p < 0.001$), marking a small 3.32% shift per time unit, which means approximately 16–20 more ED visits each month at Chang Bing Show Chwan Memorial Hospital compared to the earlier trend. In simple terms, this shift accounts for approximately 2–3% of the normal monthly ED visits (around 600 to 800 visits per month at Chang Bing Show Chwan Memorial Hospital). While overall ultrasound utilization showed a negative association with ED visits (β = −2.3342, SE = 0.2887, z = −8.085, $p < 0.001$), this positive interaction term revealed an important pattern, suggesting that although there might be an initial adjustment period, the intervention hospital demonstrated more consistent ED visit patterns over time. This is particularly noteworthy given the declining regional demographic numbers, indicating that increased ultrasound capability might have enhanced the hospital's ability to maintain stable patient volumes.

The number of visits to both hospitals changed differently following the intervention. Chang Bing Show Chwan Memorial Hospital had a slow yet steady rise in visits over three years with a total of 5783 visits from 2021 to 2023, whereas Show Chwan Memorial Hospital showed a less steady pattern (for example, the high of 10,394 visits in 2022 was followed by a drop of 1823 visits in 2023). The small coefficient (0.0332) suggests that while there was a lasting difference over time, there was only a minor effect on how the ED works. This means that differences between hospitals created separate shifts in time, but these shifts remained small in day-to-day operations. The change relates to more emergency room visits (β = 0.2737, SE = 0.0723, z = 3.785, $p < 0.001$) but the overall effect was not significant (β = 0.1352, SE = 0.0771, z = 1.754, p = 0.079), indicating that even though the time of change matched fluctuations in emergency room visit patterns, the direct impact did not vary much across hospitals.

4. Discussion

This study examined the association between ultrasound utilization and ED visit patterns in two hospitals over a three-year period, revealing several important patterns that warrant careful interpretation within the context of emergency medicine practice. Negative binomial regression analysis revealed a significant negative association between ultrasound utilization rates and ED visits, but this association requires careful interpretation. While higher ultrasound utilization corresponded to fewer ED visits, this relationship represents complex underlying dynamics rather than a simple cause-and-effect relationship. For example, temporal changes may be due to different clinical workflows and patient-management strategies. However, we observed that both hospitals had similar clinical workflows and patient management strategies. Changes in ED visits may also be due to variations in case mix and acuity or resource allocation patterns during periods of different ED volumes. Another potential explanation is that lower ED volumes might enable higher ultrasound utilization rates. The significant positive coefficient for the Time After: Hospital 1 interaction indicated distinct temporal patterns between the two hospitals with Chang Bing Show Chwan Memorial Hospital maintaining more consistent ED visit patterns despite its smaller size, though the modest coefficient (3.32% per time unit) suggests this effect was limited in practical terms.

Our findings contribute to the growing body of evidence regarding ED diagnostic capabilities. Previous studies have documented various aspects of ultrasound implementation, for example, Whitson and Mayo found that point-of-care ultrasound in the ED led to better diagnosis [11], Zanobetti *et al.* [12] reported that using multi-organ ultrasound resulted in changes in patient care, and Olgers *et al.* [13] stressed that doctors in urgent care must learn ultrasound in a standard way. Moreover, our results add to earlier work by examining how ultrasound usage and ED visits change over time. Even though the local population fell, ED visits to Chang Bing Show Chwan Memorial Hospital increased along with better ultrasound capacity, although many causes may have played a role. The present study extends this literature by examining the relationship between ultrasound utilization and ED visit patterns over an extended period of time, although our observational design precludes causal inference.

This study had several key limitations, its observational nature prevented causal inference between ultrasound use and

ED visit patterns. Although some factors were managed, the analysis did not account for factors such as local healthcare policy changes, disease trends and staffing patterns. Moreover, comparing only two hospitals may not apply well to other situations.

In conclusion, while our study suggests a relationship between diagnostic tool availability and ED utilization patterns, establishing causality would require additional investigation using more rigorous study designs. The relationship between diagnostic capabilities and ED operations remains an important area for future research.

5. Conclusions

In conclusion, our observational study documented changes in ultrasound utilization rates (from 19.98% to 54.13%) and ED visit patterns between the two hospitals. Negative binomial regression analysis demonstrated a significant association between these variables ($\beta = -2.3342$, $p < 0.001$). Our data showed concurrent temporal trends in ultrasound utilization and ED visits, with distinct patterns observed between the two study sites. The limitations of our observational design prevent the establishment of causal relationships between these variables.

Based on these findings, future research should benefit from prospective cohort studies with matched controls or time-series analyses across multiple institutions. Such studies would address the current limitations in understanding the relationship between diagnostic resource utilization and emergency department operations.

AVAILABILITY OF DATA AND MATERIALS

The datasets used and analyzed during the current study are available from the corresponding author upon reasonable request.

AUTHOR CONTRIBUTIONS

CCC and CAC—designed the research study. CHC and CAC—performed the research. CCC and CHC—analyzed the data. data curation, CCC, SJW and YTT—wrote the manuscript. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Not applicable. As this study did not involve any direct interaction with human subjects or use of personal data, ethics approval was deemed unnecessary according to national regulations.

ACKNOWLEDGMENT

Not applicable.

FUNDING

This research was funded by Chang Bing Show Chwan Memorial Hospital, grant number: BRD-112045.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

REFERENCES

[1] Gjesteby LA, Pare JR, Brattain LJ. Ultrasound for the emergency department and prehospital care. Engineering and Medicine in Extreme Environments. 2022; 48: 209–234.

[2] Gross TK, Lane NE, Timm NL; Committee on Pediatric Emergency Medicine. Crowding in the emergency department: challenges and recommendations for the care of children. Pediatrics. 2023; 151: e2022060971.

[3] Alaswad M, Abady EMA, Darawish SM, Barabrah AM, Okesanya OJ, Zehra SA, *et al.* Point-of-care ultrasound in pediatric emergency care in low-resource settings: a literature review of applications, successes, and future directions. Current Treatment Options in Pediatrics. 2025; 11: 1–13.

[4] Calderon Martinez E, Diarte E, Othon Martinez D, Rodriguez Reyes L, Aguirre Cano DA, Cantu Navarro C, *et al*. Point-of-care ultrasound for the diagnosis of frequent cardiovascular diseases: a review. Cureus. 2023; 36: e51032.

[5] Lee MS, Sweetnam-Holmes D, Soffer GP, Harel-Sterling M. Updates on the clinical integration of point-of-care ultrasound in pediatric emergency medicine. Current Opinion in Pediatrics. 2024; 36: 256–265.

[6] Russell FM, Supples M, Tamhankar O, Liao M, Finnegan P. Prehospital lung ultrasound in acute heart failure: impact on diagnosis and treatment. Academic Emergency Medicine. 2024; 31: 42–48.

[7] Karacabey S, Sanrı E. Use of ultrasound for diagnosis of clavicle fractures in the emergency department. Signa Vitae. 2021; 17: 139–142.

[8] Arvig MD, Lassen AT, Gæde PH, Gärtner SW, Falster C, Skov IR, *et al*. Impact of serial cardiopulmonary point-of-care ultrasound exams in patients with acute dyspnoea: a randomised, controlled trial. Emergency Medicine Journal. 2023; 40: 700–707.

[9] Boccatonda A, D'Ardes D, Tallarico V, Vicari S, Bartoli E, Vidili G, *et al.* Gastrointestinal ultrasound in emergency setting. Journal of Clinical Medicine. 2023; 12: 799.

[10] Lentz B, Fong T, Rhyne R, Risko N. A systematic review of the cost-effectiveness of ultrasound in emergency care settings. The Ultrasound Journal. 2021; 13: 16.

[11] Whitson MR, Mayo PH. Ultrasonography in the emergency department. Critical Care. 2016; 20: 227.

[12] Zanobetti M, Scorpiniti M, Gigli C, Nazerian P, Vanni S, Innocenti F, *et al*. Point-of-care ultrasonography for evaluation of acute dyspnea in the ED. Chest. 2017; 151: 1295–1301.

[13] Olgers TJ, Azizi N, Blans MJ, Bosch FH, Gans ROB, Ter Maaten JC. Point-of-care ultrasound (PoCUS) for the internist in acute medicine: a uniform curriculum. The Netherlands Journal of Medicine. 2019; 77: 168–176.

How to cite this article: Chia-Ching Chen, Chi-Hao Chen, Chun-An Chou, Shao-Jen Weng, Yao-Te Tsai. Impact of increased emergency department ultrasound utilization on patient visit patterns: a quasi-experimental study of two regional hospitals. Signa Vitae. 2025; 21(10): 53-60. doi: 10.22514/sv.2025.143.