

# Emergency department crowdedness level and its determinants at selected public hospitals in Addis Ababa, Ethiopia

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## Abstract

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**Background:** Emergency department overcrowding is a critical public health concern, negatively impacting patient care, safety, and hospital efficiency in Ethiopia and many other countries. It contributes to longer lengths of stay, increased mortality rates, staff burnout, and higher healthcare costs. **Objective:** This study aimed to assess the level of emergency department overcrowding in Tikur Anbessa Specialized Hospital and St. Paul's Specialized Hospital in Addis Ababa, Ethiopia, using the National Emergency Department Overcrowding Scale (NEDOCS)

**Methods:** A cross-sectional study was conducted from June 20 to 27, 2023, enrolling all patients presenting to the emergency departments during this period. Data were collected using a standardized checklist adapted from previous studies with adjustments. Hourly observations were recorded for seven days and analyzed using SPSS version 26.

**Results:** Over seven-day period, emergency department crowding was assessed every hour during the daytime, resulting in 84 sampling times. The median NEDOCS score, indicating crowding severity, was 476.5 (IQR: 363-595), with a mean score of 455.7 (SD  $\pm$ 74.2) and a range of 287 to 581. The primary factors contributing to overcrowding were prolonged patient lengths of stay and high patient flow. Nearly 60% (393 patients) stayed beyond 24 hours, with an average length of stay of 4 days (SD  $\pm$ 2.8), reaching up to 16 days in some cases. The most frequent reason for extended ED stays was bed scarcity (77.9%).

**Conclusion:** Emergency departments in the selected hospitals are experiencing critically high patient volumes, leading to dangerously long wait times. This overcrowding requires immediate, coordinated action to mitigate its impact on patient care delivery.

**Keywords:** Emergency department, Crowdedness level, National emergency department, Overcrowding scale, Ethiopian.

## Background

Emergency departments (EDs) across the globe grapple with overcrowding, a critical problem defined as demand exceeding the capacity to deliver timely, quality care (1). In Ethiopia, like many other countries, this public health crisis threatens patient safety, care quality, and even lives (2).

ED overcrowding cascades through the healthcare system, impacting patients, providers, and the community. Prolonged stays, wait times, and increased errors harm patients, while staff burnout and rising costs strain the system (3). Factors influencing this complex issue include patient volume, processing time, and discharge rates (4).

Rising numbers of accidental injuries and complications from non-communicable diseases fuel the need for emergency care. However, resource-limited healthcare systems in developing countries struggle to meet this demand, creating an imbalance between service provision and need (4, 5).

Delays in care due to overcrowding not only compromise service quality but also exacerbate medical problems. This multifactorial issue results in longer wait times, decreased patient satisfaction, and a domino effect across the entire hospital (6). When patient numbers overwhelm staffed beds and wait times breach reasonable limits, overcrowding sets in (7).

Addressing this complex challenge requires accurate measurement and evidence-based understanding of overcrowding's impact. Researchers have employed various measures to quantify its severity (2, 7).

Defining the extent of emergency department (ED) crowding can be challenging due to the lack of a standardized metric, often relying solely on clinician perception (9). To address this and better manage crowding across hospitals, various measurement scales have been developed, including the Emergency Department Work Index (EDWIN), the National ED Overcrowding Scale (NEDOCS), and the occupancy rate (10). Recently, NEDOCS has emerged as a particularly sensitive and specific method, receiving strong recommendations for its use (7, 8).

ED crowding remains a critical public health challenge in Ethiopia's healthcare system. While recognized as a serious nationwide issue, the actual level of crowding remains unclear. This study aims to utilize the NEDOCS method to assess the crowding level and its contributing factors in Ethiopian EDs within the chosen study area. By gaining a clearer understanding of this issue, healthcare managers can effectively allocate

resources and implement necessary adjustments. Ultimately, the findings aim to inform decision-makers about the prevalence of ED crowding and support the development of practical solutions to improve the quality of emergency services in Ethiopia.

## Materials and Methods

### Study setting, design, period, and population

This a hospital-based cross-sectional study conducted from June 20<sup>th</sup> to June 27<sup>th</sup>, 2022 at the Emergency Departments of Tikur Anbesa Specialized Hospital and St. Paul's Hospital Millennium Medical College in Addis Ababa, Ethiopia to assess the level of crowding in the emergency department (ED). Both hospitals are tertiary-level teaching facilities, serving as national referral centers and receiving over 50,000 emergency department visits annually. They offer advanced specialty services and academic training in emergency medicine, encompassing diverse consultants across numerous disciplines. Additionally, they boast a proportionally higher number of both emergency department and inpatient beds compared to other facilities. These factors, coupled with their high patient volume and reputation as leading tertiary hospitals, motivated the purposeful selection of these institutions for the study. Both hospitals offer a comprehensive range of general and advanced emergency services, solidifying their suitability for this investigation.

Data were collected from all patients presenting to the ED during the designated data collection period. The study did not involve any direct patient contact. To ensure patient anonymity, all identifying information was removed from the retrieved data. This approach was deemed exempt from informed consent requirements by the institutional review board.

### Operational definition

Validated NEDOCS is validated when the score is comparatively assessed for ED overcrowding using a subjective assessment of the clinical care provider (11).

### Measurements

Measurement method of overcrowding: To determine the level of overcrowding, the emergency department (ED) status was recorded hourly through direct observation for a seven-day period (June 20<sup>th</sup> to 27<sup>th</sup>) during the daytime. The National Emergency Department Overcrowding Scale (NEDOCS) indices were used, adapted slightly from prior studies (8, 10, 11,12).This adapted NEDOCS model assessed

crowding based on several key factors: Total number of treatment beds in the ED (A), Total number of hospital beds (B), Total number of patients in the ED (C), Total number of patients requiring respiratory care in the ED (D), Longest wait time for patients in the ED to be admitted to a hospital bed (E), Number of patients waiting for admission to the ED (F), Longest wait time for patients awaiting treatment (G). These factors were entered into the following formula to calculate a NEDOCS score:  $85.8(C/A) + 600(F/B) + 13.4*(D)+0.93*(E)+5.64*(G)-20^{**}$

Based on the resulting score, ED status was categorized as follows: 0-50: Normal, 50-101: Busy, 101-140: Overcrowded, 141-180: Severely overcrowded and >180: Disaster.

## Data collection

Data collection occurred over seven days, with observations conducted every hour between 8:00 AM and 7:00 PM, resulting in a total of 84 sampling times. We utilized structured checklists adapted from previous studies with modifications to suit our specific needs (2, 8). To ensure consistency and accuracy, two qualified BSc nurses were recruited for data collection. Additionally, an MSc nurse served as a supervisor throughout the process. All personnel received a one-day training session covering the study instruments and data collection procedures. To guarantee data integrity, completeness checks were performed daily.

## Data analysis

Prior to data entry, all collected data was thoroughly cleaned for completeness and consistency. Checklists were coded to simplify the data entry process. Using SPSS version 26, the coded data was entered and analyzed. Associations between independent and dependent variables were calculated, with p-values < 0.05 considered statistically significant for all independent variables. Findings were then presented in a combination of sentences, figures, tables, and charts for clear and comprehensive communication.

## Ethical considerations

Table 1: ED crowdedness level of hospitals using NEOCS at adult emergency department of selected public hospitals in Addis Ababa, Ethiopia.

Days of data collection	Total average no of patients per day			Patients more than 24 hrs.			NEOCS			ED crowded Level		
	TASH	SPHMMC	Total	TASH	SPHMMC	Total	TASH	SPHMMC	Total	TASH	SPHMMC	Total
Monday	72	31	103	37	29	66	559	406	483	Disaster	Disaster	Disaster
Tuesday	67	28	95	33	13	46	489	419	454	Disaster	Disaster	Disaster
Wednesday	66	30	96	35	25	60	519	487	503	Disaster	Disaster	Disaster
Thursday	65	27	92	36	20	56	507	473	490	Disaster	Disaster	Disaster
Friday	70	33	103	37	21	58	487	516	501	Disaster	Disaster	Disaster
Saturday	64	33	97	30	19	49	362	414	388	Disaster	Disaster	Disaster
Sunday	60	32	92	43	15	58	314	436	375	Disaster	Disaster	Disaster

Ethical clearance was obtained from departments of research ethics review committee of St. Paul's Hospital Millennium Medical College. Permission was obtained from each hospital management office prior to data collection.

## Results

### Emergency department flow and overcrowding level

During the study time a total of 84 sampling periods were recorded to scores indicative of overcrowding using NEDOCS. All measured values in the sampling period exceeded 180, indicating a "disaster level" according to established benchmarks. Furthermore, the median NEDOCS score stood at 476.5 (IQR: 363-595), with a mean score of 455.7 ( $\pm 74.2$  SD) and a range of 287 to 581 (Table 1). Mondays, Wednesday and Fridays exhibited significantly higher overcrowding levels compared to weekends as illustrated in Figure 1.

During this study period a total of 678 patients were involved in the study out of which 464(68.4 %) were from Tikur anbesa specialized hospital. The average LOS in emergency department was 4 days with maximum duration of stay of 16 days with a standard deviation of 2.8 days. Among the 678 patients studied, 57.96% (393 patients) experienced length of stay exceeding 24 hours. As stated in table 1 below the commonest cause, 77.9%, of prolonged length of stay was lack of available beds. A quarter (73.3%) of patients experiencing extended LOS had medical conditions (Table 2). Patient visits to emergency had different flow patterns with peak periods from 10:00 am to 12:00 pm and higher volumes on Mondays and Fridays (refer to Figure 2 for details).

Table 3: Diagnosis of patients stayed over 24 hours. in adult emergency department of selected hospitals Addis Ababa, Ethiopia 2022.

Diagnosis	Hospital		Total of patients >24 hours. N (%)
	TASH, N (%)	SPHMMC, N (%)	
Medical	183 (72.9)	105 (74.0)	288 (73.3)
Surgical	48 (19.1)	35 (24.0)	83 (21.1)
Trauma	20 (8.0)	2 (1.4)	22 (5.6)

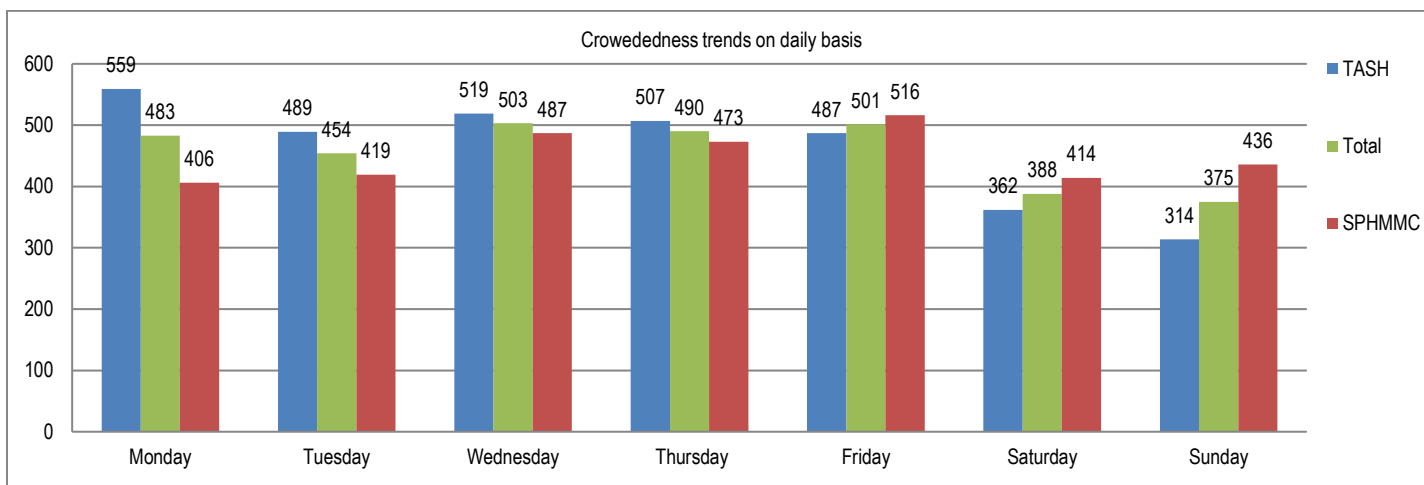


Figure 1: Average daily observed NEOCS frequency of ED crowdedness for patients visited at adult emergency department of selected governmental Hospitals in Addis Ababa, Ethiopia 2022.

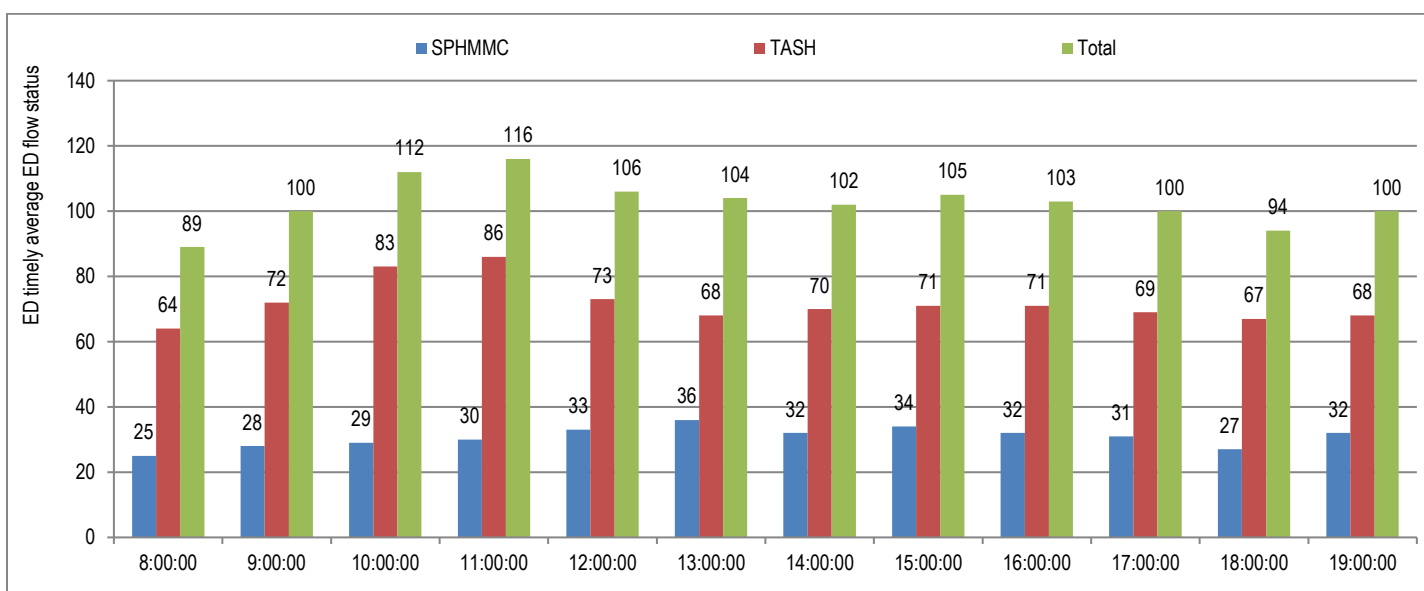


Figure 2: ED timely average ED flow status for patients visited at adult emergency department of selected governmental hospitals in Addis Ababa, Ethiopia 2022

## Factors associated with overcrowding

Higher patient flow volume and specific referral cases requiring specialized services (particularly hematologic and cardiac) contributed to overcrowding and influenced LOS. Our analysis identified two key factors contributing to overcrowding in the emergency department (ED): prolonged length of stay (LOS) and patient flow.

The NEDOCS score exhibited significant positive correlations with two key indicators of ED crowding: the average daily total number of patients (Spearman's  $\rho = 0.41$ ,  $p < .001$ ) and the average length of stay for patients exceeding 24 hours (Spearman's  $\rho = 0.897$ ,  $p < .001$ ). These findings suggest that both a high volume of patients and longer stays for admitted patients are significant contributors to ED overcrowding.

## Discussion

ED overcrowding poses a significant challenge to healthcare systems, leading to adverse outcomes such as extended patient stays, worsened conditions for critically ill patients, compromised quality of care, and reduced patient satisfaction (13). It signifies an imbalance between available resources and patient demands, ultimately hindering the quality of emergency medical services like similar studies conducted in USA (14).

This study employed the highly accurate and sensitive NEDOCS score to assess crowding levels in our hospitals. The results reveal a disastrous degree of overcrowding throughout the sampling period, exceeding levels observed in similar studies conducted elsewhere. This can be primarily attributed to prolonged patient stays within the ED and a higher patient flow compared to other settings. These factors directly influence the

NEDOCS calculation, and our analysis demonstrated a highly significant correlation (Spearman,  $p < 0.001$ ) between them. Notably, 58% of admitted patients experienced stays exceeding 24 hours, with some enduring delays of up to 16 days. Likewise, these findings align with previous research conducted in various contexts (7, 10, 13, 15) the primary reasons for these prolonged stays included limited bed availability, plans for direct discharge from the ED, delayed senior physician decisions and consultations, and extended wait times for diagnostic results.

This study was conducted at tertiary-level hospitals, which act as referral centers for various specialized services, attracting patients from across the country. This contributes to the higher patient flow observed. On average, 96 patients were seen daily, with a majority requiring emergency admission and lacking the option for prompt transfer or discharge. Referrals typically included patients with hematological, oncological, cardiac, or renal conditions requiring specialized care and often arriving with complications necessitating immediate admission. As these specialized services are primarily available at tertiary-level hospitals, transferring patients elsewhere is seldom feasible, leading to extended stays in the ED while awaiting an inpatient bed. Crowding and patient flow were observed to be higher on Mondays and Fridays, aligning with typical workweek patterns. Patients often choose to delay seeking care until weekdays due to factors like diagnostic and consultant accessibility, leading to them presenting on Mondays with exacerbated or complicated conditions, contributing to ED overcrowding. Similarly, patients undergoing regular outpatient follow-up on Fridays, anticipate deterioration over weekend and often end up admitted to the ED resulted in exacerbating ED crowding. This aligns with a study done in Dutch showing higher patient flow on Mondays and Fridays which is a key contributor to overcrowding (16).

This study identified several key contributing factors to ED overcrowding, including: Limited inpatient or hospital bed availability, Delayed patient admission, delayed patient discharge and Delayed investigations and consultations

These findings mirror observations from similar studies conducted internationally (4, 5, and 17). Implementing appropriate measures to address these factors holds significant potential for reducing ED overcrowding and improving patient care.

A key limitation of this study is that it only looked at tertiary hospitals, which might not reflect the crowding situation in other Ethiopian hospitals.

Further research across various hospital types is needed to see if similar crowding patterns exist throughout the healthcare system. Secondly, Seasonal variations, holidays, and other external factors can significantly impact crowding levels. Collecting data across multiple time points and over an extended timeframe would provide a more comprehensive understanding of ED crowding dynamics throughout the year.

## Conclusion

This study revealed a critically high level of crowding (disaster) in the emergency department (ED) at the investigated site. This overcrowding represents a priority issue demanding immediate attention within the hospital system. Our analysis identified two key contributing factors: prolonged patient length of stay and high patient flow. Notably, patients with medical cases exhibited longer stays compared to others. Several factors contributed to extended stay in the ED, including: Limited availability of inpatient beds, Delays in patient discharge from the ED to home, Prolonged waits for senior consultations and decision-making, Delays in receiving investigation results. Addressing these underlying causes effectively has the potential to significantly reduce congestion and improve patient care within the ED.

## Abbreviations

DRERC: departments of research ethics review committee; ED: Emergency Departments; EDWIN: Emergency Department Work Index; IQR: Interquartile range; NEOCS: National Emergency Overcrowding Score; SD: Standard deviation; SPSS: Statistical package for social science; TASH: Tikur Anbessa Specialized Hospital

## Declarations

### Ethics approval and consent to participate

Ethical clearance was obtained from departments of research ethics review committee (DRERC) of St. Paul's hospital Millennium College approved on 10/06/2022. Permission was obtained from each hospital management office prior to data collection. The study did not involve any patient contact, and all identifiers were removed from the information as it was obtained.

### Consent for publication

Not applicable



## Availability of data and materials

All the data supporting the study findings are within the manuscript. Additional detailed information and raw data are available from the corresponding author on reasonable request.

## Competing interests

We have no competing interest

## Funding

No funding was obtained for this study

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## Authors' contributions

MS and AW conceptualized the research problem, designed the study and conducted fieldwork. ZG data collection and data analyzed, and drafted the manuscript data, conceptualization, preparing the final manuscript, and revising the final manuscript. All authors of the manuscript have read and agreed to its content.

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