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Flow pattern of Emergency Department visits during Ramadan: A single-center experience for 3 years in Muslim-Majority Country

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ABSTRACT

Objective: Emergency department (ED) facilities across the globe consider the delivery of high-quality, timely patient care is their main concern. Mistakes and malpractices could occur in poorly planned and unorganized ED facilities. Countries with Muslim majorities experience major shifts in ED patterns and social habits during the month of Ramadan. Our aim is to analyze the changes in flow patterns during three different periods and exploit ED triage and characteristics data, as well as the streaming of the time and date of all visits. *Methods:* A three-year retrospective study was conducted after retrieving and analyzing the emergency department health information system records at a tertiary care center that is publicly operated, funded, and owned, and that serves the entire community. Following the application of the inclusion and exclusion criteria, a thorough review of the study included a total of 33,142 patients. *Results:* A total of 11,106 visits were included throughout the month of Ramadan in the three-year interval. A deep decrease was noted during the periods of 6:59 PM and 7:59 PM, which represented a period of Iftar (breakfast) during Ramadan, with an average of 81 and 77 visits, followed by a significant increase in the period from 8:59 PM. *Conclusion:* Ramadan is characterized by a variety of practices and societal norms. It has a profound Influence on the healthcare system, particularly evident in the increased utilization of ED visits. Redistributing resources and human power is highly recommended to adapt to such changes.

Keywords: Emergency medicine, Ramadan, Trauma, Fasting

1. INTRODUCTION

The delivery of high-quality, timely patient care in emergency department (ED) facilities is considered a main concern to hospitals across the globe. Several areas could fall into mistakes and malpractices if the ED facility is not

well-managed and planned. Poor patient flow and departmental crowding are frequently caused by a mismatch between patient demand and the ED's capacity to provide care. In countries with Muslim majorities, the ED flow pattern could experience major shifts and changes, especially during the month of Ramadan, if compared to the other months. Evidence findings proved an increase in the frequency of hospital visits by various medical complications during the month of Ramadan (Elbarsha et al., 2018). Nonetheless, Ramadan is one of the 12-lunar months in the Islamic Hijri calendar, lasting 29-30 days. It is a holy month for Muslims where they convey unique social and nutritional practices. The difference in social practices is most notable when Muslims start to fast from sunrise to sunset leading to a change in their day and night cycles.

Fasting throughout Ramadan impacts individuals' activity, sleeping patterns, and hormone circadian rhythms (Lessan and Ali, 2019). As a result, adverse effects and significant changes in everyday physical habits and activities, including cognitive performance, have been reported among Muslims throughout Ramadan (BaHammam et al., 2010; Langford et al., 1994). Certain medical conditions also experience a surge during Ramadan, and this includes road traffic accidents which oppose a major health hazard in Saudi Arabia, particularly during Ramadan (Shanks et al., 1994) and during certain times of the day when drivers could tend to present with aggressive driving attitudes during the sunset and sunrise periods.

Hence, in this research, we aim to explore evidence-based strategies to manage ED facilities by analyzing a tertiary care canter's flow pattern during the month of Ramadan on a 3-year interval to improve patient flow, reduce crowding in ED, and improve the economic and clinical decision-making process by predicting the flow pattern during the month of Ramadan. It is important to enrich local literature by shedding light on the changes in flow patterns before- during- and after-COVID19 era. We attempt to reach those goals by exploiting ED triage data and streaming the time and date of all visits. Limited published literature assesses and observes the pattern of ED visits during Ramadan and correlates them with other demographic variables.

2. MATERIALS AND METHODS

Study design and sampling

Following the Strengthening the reporting of observational studies in epidemiology (STROBE) checklist for retrospective cohort studies. A three-year retrospective study was conducted in June 2022 after retrieving and analyzing the Emergency Department health information system records of a publicly operated tertiary care center, funded and owned, that serves the entire community with a bed capacity of 750 beds and up to 900 beds in an emergency situation. Furthermore, it receives an average of 60,000 visits annually. We included all patients who visited the ED during Ramadan, as well as the month prior and the month after, and for whom the time and date of the visit were readily available. Visits from the years 2019 to 2022 were included. Data was acquired using Microsoft Excel v16.0 sheet. After applying the inclusion and exclusion criteria, a total of 33,142 patients were included in the study.

Study duration

Ramadan is one of the Hijri calendar months, which depends on lunar observation; in such a way, the month of Ramadan was during the following periods:

May 6 - June 3 (2019)

April 24 - May 23 (2020)

April 13 - May 12 (2021)

Statistical analysis

The following variables were extracted: gender, age, nationality, triage level, ED section, time, and admission date. IBM SPSS Statistics for Windows (Version 21.0; IBM Corp., Armonk, NY, USA) was used for statistical analysis. For descriptive statistics, continuous variables were summarized using means and associated standard deviations (SD), while the categorical variables were presented using numbers and percentages (%). Multiple linear regression to explore any potential significant changes in the number of ED visits between Ramadan and other months during the daytime and nighttime. The reference variable for the regression was the month of Ramadan. The afternoon parameter is set to zero because it is redundant. $P < 0.05$ was considered statistically significant.

Ethical approval

Ethical approval for the study protocol and data usage was granted on April 20, 2022, by the Unit of Biomedical Research Ethics of King Abdulaziz University Hospital with reference number (209-22). All revealing data were masked, and patients' privacy was ensured throughout the conduct of the study.

3. RESULTS

In total, 33,142 patients visited ED within the study period. Of this total, visits by females were more prevalent, with 18,282 (55.2%) visits, while male visits were 14,860 (44.8%). Throughout the study duration, most patients were seen between the ages of 19 and 39; this age group represented 14,672 (44.3%) visits. Predominance visits by national patients (68.9%). Patients with Priority 3 – Urgent were the highest in number compared to other priorities. Furthermore, patients were divided into groups according to their ED section; adult patients represented the majority with 23,228 (70.1%) visits, followed by pediatrics with 5,003 (15.1%) visits.

Statistical significance was also observed in the ED. As can be shown in Table 1, statistical analysis revealed substantial differences in the frequency of ED visits by gender, different age group, nationality, triage level, and ED section over these three lunar months. As shown in Figure 1, a total of 4479 visits were recorded during Shaaban of 2019, the highest for Shaaban across the three years. A total of 10,809 visits were recorded during the month of Shabaan in three successive years (2019, 2020, 2021).

Table 1 Demographic and clinical profile of patients visiting ED in the three lunar months from 2019/1440H to 2021/1442H (n=33,142).

Variable	SHAABAN (n= 10,809)	RAMADAN (n=11,106)	SHAWAL (n=11,227)	Total
Gender N (%)				
Male	4,860 (45)	5,068 (45.6)	4,932 (43.9)	14,860 (44.8)
Female	5,949 (55)	6,038 (54.4)	6,295 (56.1)	18,282 (55.2)
Age groups (years) N (%)				
0 – 18	2,181 (20.2)	2,163 (19.5)	2,206 (19.6)	6,550 (19.8)
19 – 39	4,809 (44.5)	4,905 (44.2)	4,958 (44.2)	14,672 (44.3)
40 – 59	2,287 (21.2)	2,552 (23.0)	2,442 (21.8)	7,281 (22)
60+	1,532 (14.2)	1,486 (13.4)	1,621 (14.4)	4,639 (14)
Nationality N (%)				
Saudis	7,659 (70.9)	7,290 (65.6)	7,878 (70.2)	22,827 (68.9)
Non-Saudis	3,150 (29.1)	3,816 (34.4)	3,349 (29.8)	10,315 (31.1)
Triage level N (%)				
Priority 1 - Resuscitation	164 (1.5)	169 (1.5)	171 (1.5)	504 (1.5)
Priority 2 - Emergent	1,479 (13.7)	1,523 (13.7)	1,602 (14.3)	4,604 (13.9)
Priority 3 - Urgent	5,180 (47.9)	4,803 (43.2)	5,017 (44.7)	15,000 (45.3)
Priority 4 - Less Urgent	3,729 (34.5)	4,365 (39.3)	4,286 (38.2)	12,380 (37.4)
Priority 5 - Non-Urgent	257 (2.4)	246 (2.2)	151 (1.3)	654 (2)
ED section N (%)				
Adult	7,469 (70.0)	7,909 (71.3)	7,941 (70.7)	23,319 (70.4)
Pediatrics	1,691 (15.6)	1,603 (14.4)	1,709 (15.2)	5,003 (15.1)
Ob/Gyn	1,649 (15.3)	1,594 (14.4)	1,577 (14)	4,820 (14.5)

As for the month of Ramadan, the highest frequency of visits was observed during Ramadan in the year 2019, with a total of 3993 visits. A total of 11,106 visits were recorded throughout the same month in a three-year interval. As for the month of Shawal, during the year 2019, a total of 3927 visits were recorded, the highest in the month compared to the same month in different years. A total of 11,227 visits were recorded during the month of Shawal in the three years interval. The month of Shawal presented with the highest frequency of visits in three years compared to Shaaban and Ramadan. The highest volume of patients for a single year was recorded during the year 2019, with a total of 12,399 visits. Significance was observed among the three different months and years (p=0.000).

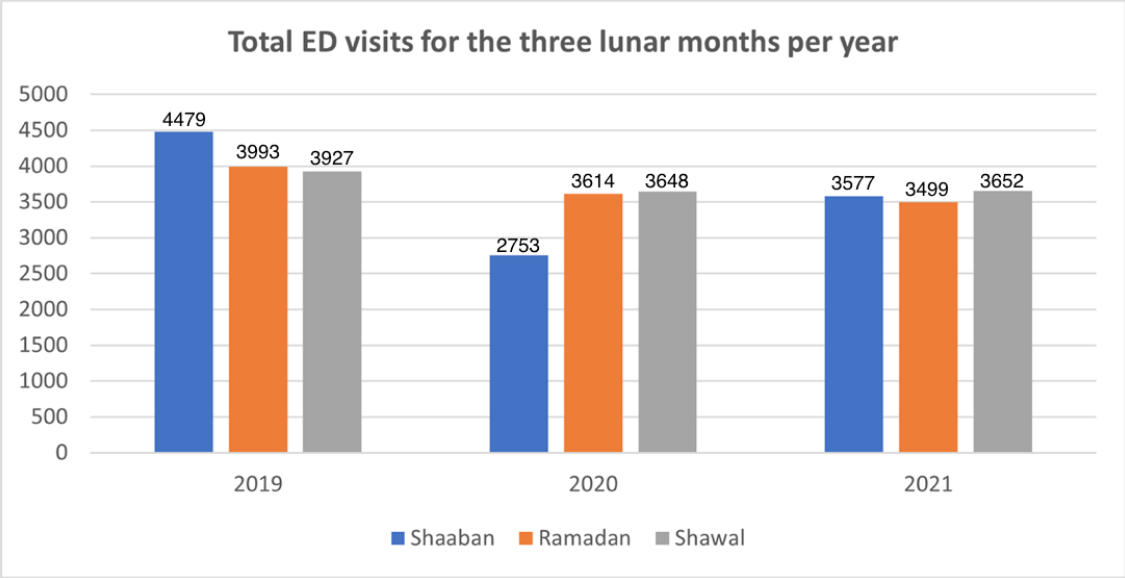

Figure 1 The total of ED visits

Upon reporting the average daily visits (ADVs), the month of Shaaban for the year 2019 presented with the highest ADVs (149.30 ± 16.206) across all months and years. The number declined in 2020 to reach the lowest ADVs across all months and years (91.77 ± 10.411). In 2021, Shaaban had an ADVs of 119.23 ± 18.480 visits. As for Ramadan, the year 2019 presented the second highest ADVs (137.69 ± 17.084) and the highest among the month of Ramadan compared to the three years interval. An average of 120.47 ± 21.177 visits were recorded for 2020 and 116.63 ± 16.234 visits for 2021. The month of Shawal had relatively more steady ADVs, with 130.90 ± 21.541 ADVs during 2019, 125.79 ± 30.071 ADVs during 2020, and 125.93 ± 16.654 ADVs during 2021. Moreover, the month of Shawal presented the highest ADVs compared to Shaaban and Ramadan. Other data, including month, year, and the grand total of average visits presented in detail in (Table 2).

Table 2 Average daily visits for the 3 lunar months in all 3 years

Average daily ED visits				
Year	Shaaban	Ramadan	Shawal	Year Total
2019	149.30 ± 16.206	137.69 ± 17.084	130.90 ± 21.541	139.31 ± 19.782
2020	91.77 ± 10.411	120.47 ± 21.177	125.79 ± 30.071	112.53 ± 26.413
2021	119.23 ± 18.480	116.63 ± 16.234	125.93 ± 16.654	120.54 ± 17.407
Month total	120.10 ± 28.115	124.79 ± 20.283	126.51 ± 22.703	
Grand total	124.13 ± 24.228			

The flow with an average visit per hour was assessed using the retrieved data, as illustrated in (Figure 2, 3). Certain periods of the day resembled central significance to the study's aims. This includes early ante meridiem hours (12-12:59 AM) and the mid-morning period (5-5:59 AM) due to the overlap of Ramadan's Sahur and sunrise at which Muslims start their fasting. As well as the first hour of the post meridiem period (12-12:59 PM), the two periods prior to and during breaking the fast (Iftar), which conjugate with sunset (6-6:59 PM and 7-7:59 PM, respectively), and finally the final period of the day (11-11:59 PM). Ramadan of 2019 recorded an average of 218 visits during the first ante meridiem hour (12-12:59 AM) with a relatively inconsistent pattern during the morning hours. Average visits were 211 during the period of 5-5:59 AM.

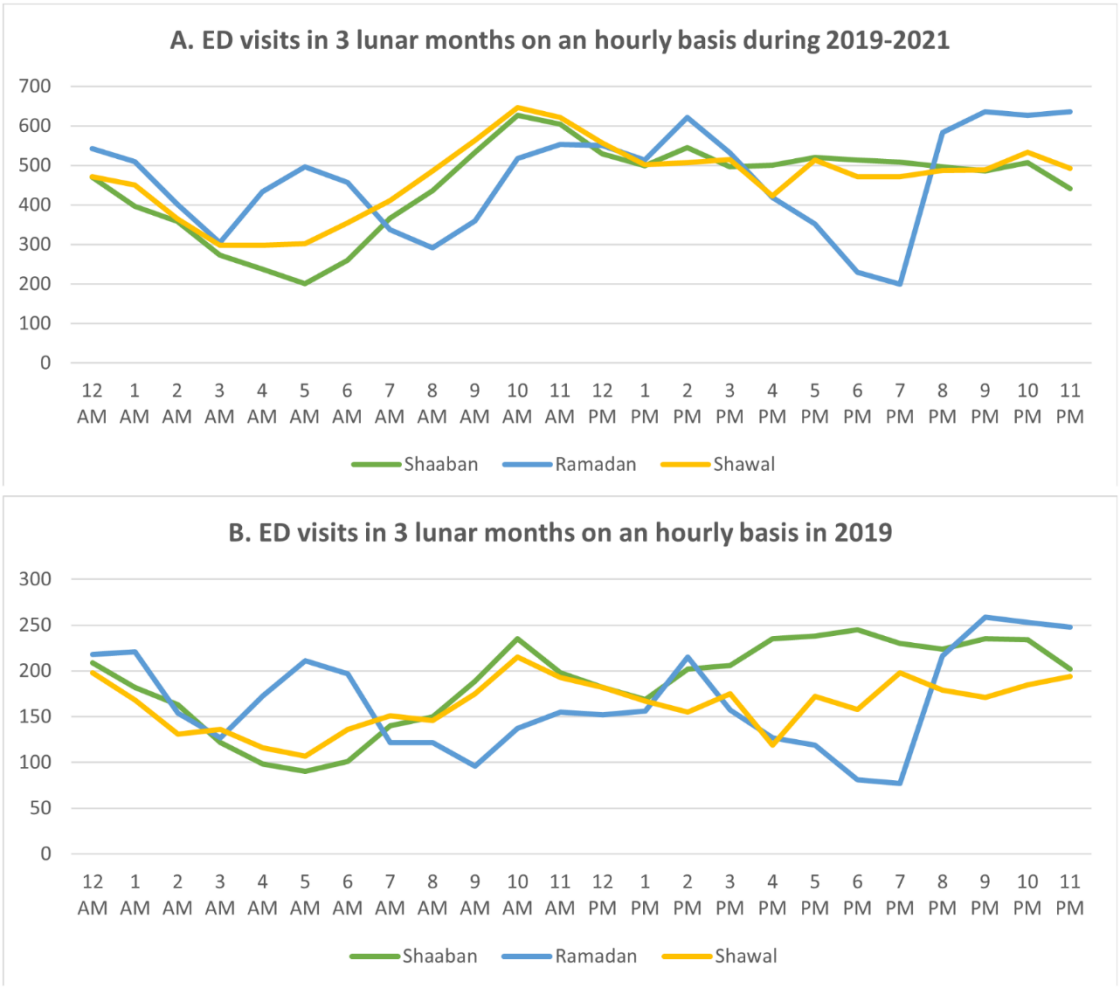

Figure 2 ED visits in 3 lunar months

As for the post-meridiem period, the average visits started in Ramadan at 12-12:59 PM with an average of 152 visits. An average of 81 and 77 visits during the period of 6-6:59 PM and 7-7:59 PM, respectively. Average visits rebound was observed during the period of 8-8:59 PM with an average of 216 visits. As for Ramadan of 2020, average visits were 161, 138, 77, 49, and 155 for the periods of 12-12:59 AM, 5-5:59 AM, 12-12:59 PM, 6-6:59 PM, 7-7:59 PM, and 11-11:59 PM respectively. During Ramadan of 2021, an average of 163 visits were recorded during the period of 12-12:59 AM and 147 during the period of 5-5:59 AM. Furthermore, an average of 138 visits was recorded during the period of 12-12:59 PM, 72 and 72 visits during the periods of 6-6:59 PM and 7-7:59 PM, respectively, and 233 during the period of 11-11:59 PM. The multivariate linear regression analysis identified multiple significant changes in the number of ED visits during the daytime and nighttime between Ramadan and other months; further details are presented in (Table 3, 4).

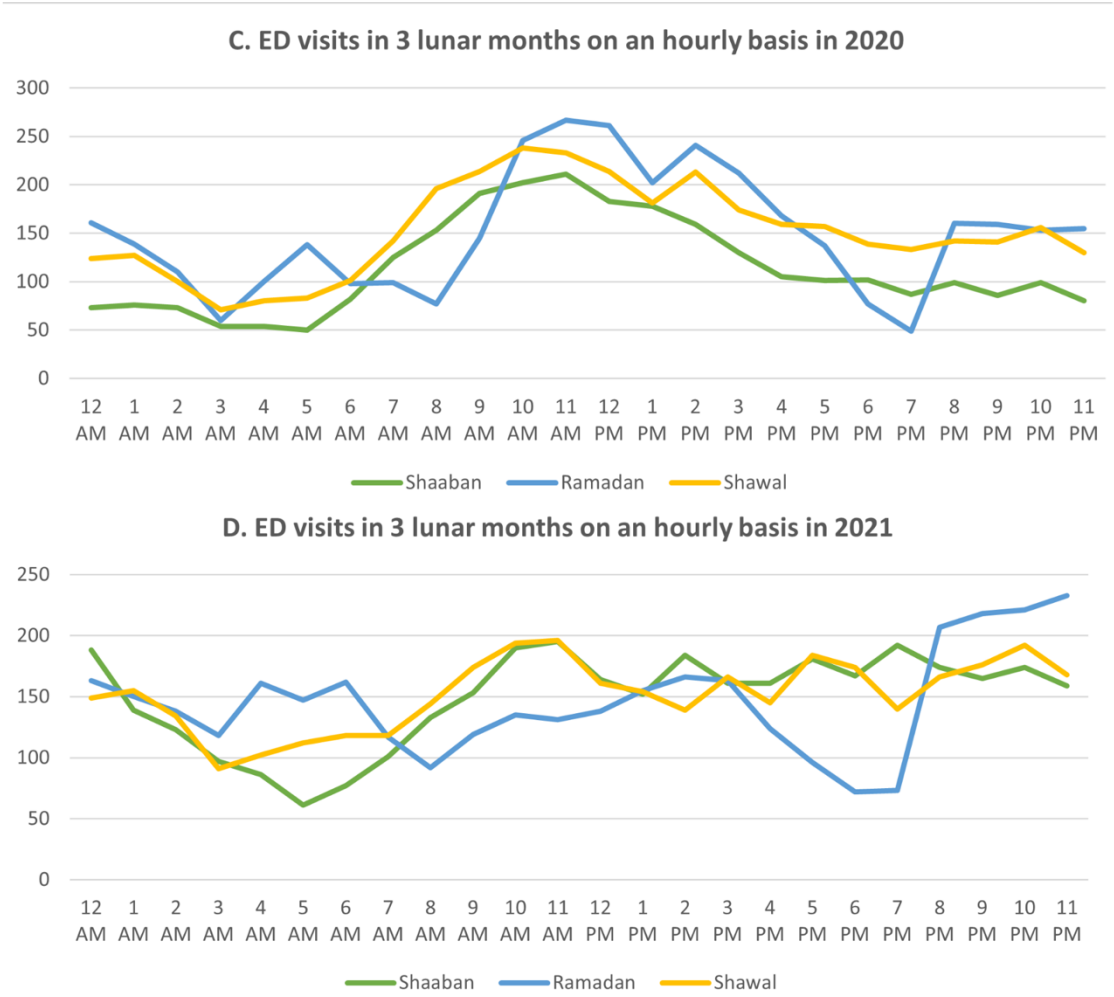

Figure 3 ED visits in 3 lunar months

Table 3 Multiple linear regression to explore any potential significant changes in the number of ED visits during the daytime between Ramadan and other months.

		Std. Error	Sig.	Exp(B)	95% Confidence Interval	
					Lower Bound	Lower Bound
Shaaban		.063	.024	-	-	-
	Morning (AM)					
	01:00 AM	.092	.240	.898	.750	1.075
	02:00 AM	.096	.760	1.030	.853	1.243
	03:00 AM	.104	.762	1.032	.841	1.267
	04:00 AM	.102	.000	.632	.517	.773
	05:00 AM	.105	.000	.467	.381	.574
	06:00 AM	.100	.000	.656	.539	.798
	07:00 AM	.098	.024	1.249	1.030	1.514
	08:00 AM	.099	.000	1.728	1.424	2.096
	09:00 AM	.093	.000	1.707	1.423	2.048
	10:00 AM	.087	.000	1.396	1.178	1.654
	11:00 AM	.086	.007	1.260	1.064	1.491
	12:00 PM (Afternoon)					
Shawal		.063	.026	-	-	-

	01:00 AM	.090	.866	1.015	.851	1.212
	02:00 AM	.096	.647	1.045	.866	1.261
	03:00 AM	.103	.255	1.124	.919	1.376
	04:00 AM	.098	.016	.790	.652	.958
	05:00 AM	.096	.000	.701	.580	.846
	06:00 AM	.095	.236	.894	.742	1.076
	07:00 AM	.097	.001	1.399	1.158	1.691
	08:00 AM	.097	.000	1.922	1.588	2.326
	09:00 AM	.092	.000	1.800	1.502	2.157
	10:00 AM	.086	.000	1.437	1.214	1.702
	11:00 AM	.086	.003	1.294	1.094	1.532
	12:00 PM (Afternoon)					

*The reference category is Ramadan.

†This parameter is set to zero because it is redundant.

Table 4 Multiple linear regression to explore any potential significant changes in the number of ED visits during the nighttime between Ramadan and other months.

Month		Std. Error	Sig.	Exp(B)	95% Confidence Interval	
					Lower Bound	Lower Bound
Shaaban		.061	.503	-	-	-
	Night (PM)					
	01:00 PM	.088	.881	1.013	.853	1.203
	02:00 PM	.085	.280	.913	.773	1.077
	03:00 PM	.087	.754	.973	.820	1.154
	04:00 PM	.090	.015	1.245	1.044	1.485
	05:00 PM	.092	.000	1.539	1.285	1.843
	06:00 PM	.100	.000	2.328	1.913	2.832
	07:00 PM	.103	.000	2.664	2.175	3.263
	08:00 PM	.086	.168	.888	.750	1.051
	09:00 PM	.086	.008	.796	.673	.941
	10:00 PM	.085	.044	.842	.713	.995
	11:00 PM	.087	.000	.722	.609	.856
	12:00 AM (Mid-night)					
Shawal		.060	.857	-	-	-
	01:00 PM	.087	.708	.968	.816	1.148
	02:00 PM	.085	.011	.806	.683	.952
	03:00 PM	.086	.615	.958	.809	1.134
	04:00 PM	.091	.988	.999	.835	1.195
	05:00 PM	.092	.000	1.442	1.205	1.725
	06:00 PM	.100	.000	2.026	1.664	2.466
	07:00 PM	.104	.000	2.341	1.911	2.869
	08:00 PM	.086	.026	.826	.698	.978
	09:00 PM	.085	.001	.759	.643	.897
	10:00 PM	.084	.040	.841	.713	.992
	11:00 PM	.085	.002	.765	.648	.904
	12:00 AM (Mid-night)					

*The reference category is Ramadan.

†This parameter is set to zero because it is redundant.

4. DISCUSSION

This study examined, illustrated, and analyzed the flow pattern of ED visits during the month of Ramadan. Although females presented with a higher number of visits, the gender difference in ED visits was minimum. Nearly half of the patients were in their third and fourth decade of age. This could suggest a minimal presence of geriatric patients with long-standing active issues. The fact that this is a public tertiary care center was reflected in the number of visits by foreign nationals. Throughout the three months included within the study scope, adults were more likely to present to the ED. Although fasting is only obligated to post-pubertal children, a decrease in the number of pediatric patients was observed. Researchers in different Muslim countries presented similar findings (Faruqi et al., 2020; Al-Assaad et al., 2018).

However, other literature findings illustrated a greater volume of pediatric patients during the night (Balhara et al., 2018). In regard to the general volume of visits, the total number of visits remains in decline over successive years. This could be regarded as COVID-19-related modifications in admission policy, in which hospitals reconsidered the priority of patients' admission. A notable decline was observed during the month of Shaaban in the years 2019 and 2020. Shaaban of 2020 correlates with the month of March. And on March 2nd, Saudi health authorities reported the first case of COVID-19 (Nurunnabi, 2021). Subsequently, entry to the country was limited amid the pandemic concern, suspending religious activity in Makkah and Madinah, suspending school and work attendance, banning hookah and tobacco to prevent the spread of the diseases, and imposing quarantine. These measures directly impacted the overall flow of ED during the same period, as illustrated by this study's findings. This case was not specifically related to Saudi Arabia but rather impacted healthcare centers across the globe (Rennert-May et al., 2021).

However, the ED flow was not as significantly impacted as the flow during Shaaban (Figure 1). Moreover, as observed in Figures 2 and 3, the flow pattern presented prime shifts during the three months. Although Shaaban and Shawal presented with a similar curve, Ramadan experienced different shifts, especially during the very early morning (3-6 AM), where a significant increase was noticed compared to other times. This could be attributed to the increased night activity and changing lifestyle. Previous studies explored the high prevalence of Saudi individuals with a short night-time sleep duration and excessive daytime sleeping among Saudis during Ramadan compared to other months (Alghamdi et al., 2020).

Furthermore, this was proven by the decrease in hospital visits during the first few hours of sunrise (7-11 AM), which could be correlated to the excessive daytime sleeping among Saudis during Ramadan. Another remarkable shift was observed during the Iftar period, in which fasting Muslims broke their fasting. The decline was intense compared with other months. Statistical analysis showed an overall significant difference for Ramadan during the morning hours (4-11 AM) (Table 3) and the night (4-7 PM and 9-11 PM) (Table 4). These decrease and increase throughout the day echoed the findings of other studies, presenting similar significance in the ED flow during Ramadan, specifically a decrease at 5 PM and an increase at 8 PM (Faruqi et al., 2020; Al-Assaad et al., 2018). In this study, the confounders, including seasonal and time-related variation, were effectively eliminated using statistical methods that limit such confounders. In addition to this, the large sample size constitutes the study's reliability in which every visit was included.

Limitations

We still need larger multi-center studies among other Muslim countries outside the COVID-19 pandemic to better reflect on how we can better utilize the resources during Ramadan.

5. CONCLUSION

In conclusion, Ramadan is a month of different habits, activities, and social norms. Its impact is significantly reflected in the healthcare system, most notably in ED visits. In some areas, these differences were reported in other studies in other Muslim countries, suggesting a unique constant pattern can be recognized for the month of Ramadan if proper and large-scale studies are conducted to address topics that have not previously been explored.

Author Contributions

IK: Had a significant role in the study's idea and design and reviewed the manuscript. He wrote the protocol and planned and supervised the study.

AA, SA: Designed the study, assisted in data collection and data entry, shared in the statistical design, and help in writing all the manuscript parts (Introduction, Method, Results, Discussion, Conclusion, Abstract) equally.

MA, AA: He assisted in data collection and entry and helped write all the manuscript parts (Introduction, Method, Results, Discussion, Conclusion, Abstract) equally.

MA, SA: She assisted in data collection and data entry and helped in writing all the manuscript parts (Introduction, Method, Results, Discussion, Conclusion, Abstract) equally. She will take the primary responsibility for responding to the reviewers' comments.

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Ethical approval
The study was approved by the Medical Ethics Committee of King Abdulaziz University Hospital. Ethical approval code: 209-22.

Informed consent
Not applicable.

Funding
This study has not received any external funding.

Conflict of interest
The authors declare that there is no conflict of interests.

Data and materials availability
All data sets collected during this study are available upon reasonable request from the corresponding author.

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