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Race Based Discrimination in Emergency Department Utilization; A Quantitative Study

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ABSTRACT

Objectives: Many studies have verified the adverse effects of prolonged emergency department (ED) length of stay (LOS) on outcomes. Patient, physician, hospital, and system factors affect ED LOS. We investigate racial disparities in prolonged ED LOS for admitted patients, controlling for both patients' medical condition and hospital factors that could be responsible for potential disparities.

Methods: We studied 6932 hospital admissions from 994 EDs in the National Hospital Ambulatory Medical Care Survey from 2009-2011. The main outcome was prolonged ED LOS, which was defined as triage to transfer to inpatient bed >6 hours. We use the logit model as the maximum likelihood model of choice. Akaike information criterion, Bayesian information criterion as well as the Pregibon's link test are used to test different specifications of the model.

Results: The mean age of our sample was 57 years; 65% of patients were white, and 54% of them were female. A total of 58.5% of patients experienced prolonged LOS. Overall, 55.4% of whites stayed for more than six hours in the ED, compared to 64.1% of non-whites ($p<0.01$). Among the sample of this study, the average predicted probability of prolonged ED OLS was 0.5798, 0.5791, and 0.5989 in 2009, 2010, and 2011 respectively ($p<0.01$ for each year). On average, compared to white patients, black patients had a 7.3, 1.3, and 6.7 percentage point higher probability of having prolonged ED LOS, controlling for all other variables in 2009, 2010, and 2011 respectively ($p<0.01$).

Conclusions: Non-white patients who are admitted to the main hospital through the ED have a longer ED LOS compared to whites, demonstrating that racial disparities still exist across U.S. hospitals.

Keywords: Racial disparity, emergency department crowding, logit model

ÖZ

Acil servis kullanımında ırk temelli ayrımcılık; kantitatif bir çalışma

Amaç: Pek çok çalışma, uzamış acil servis (AS) kalış süresinin (KS) sonuçlara olan olumsuz etkilerini doğrulamıştır. Hasta, doktor, hastane ve sistem faktörleri AS KS'yi etkiler. Bu çalışmamızda, hem hastaların tıbbi durumunu hem de potansiyel eşitsizliklerden sorumlu olabilecek hastane faktörlerini kontrol ederek, başvuran hastalar için uzamış AS KS'deki ırksal farklılıkları araştırdık.

Yöntem: Çalışmada, 2009-2011 yılları arasında Ulusal Hastane Ayaktan Tıbbi Bakım Araştırması'ndaki 994 AS'den gelen 6932 hasta başvurusu incelendi. Birincil sonuç değişkeni, hastanın triyajından yatağına transferine kadar geçen sürenin 6 saatten uzun olması olarak tanımlanan, uzamış AS KS idi. Tercih edilen maksimum olabilirlik modeli olarak logit modeli, kullanıldı. Modelin farklı özelliklerini test etmek için Akaike informasyon kriterleri, Bayes informasyon kriteri ve Pregibon'un bağlantı testi kullanıldı.

Bulgular: Örneğimizin yaş ortalaması 57 yıl; hastaların %65'i beyaz, %54'ü kadındı. Hastaların toplam %58.5'i uzamış AS KS yaşadı. Genel olarak, beyazların %55.4'ü AS'de altı saatten daha uzun süre kalırken, bu beyaz olmayanlarda % 64.1 olarak saptandı ($p<0.01$). Bu çalışmanın örnekleminde, ortalama uzamış AS KS olasılığı, 2009, 2010 ve 2011'de sırasıyla 0.5798, 0.5791 ve 0.5989 olarak hesaplandı (her yıl için $p<0.01$). Ortalama olarak, beyaz hastalar ile karşılaştırıldığında, siyah hastalar, diğer tüm değişkenleri kontrol ettikten sonra, sırasıyla, 2009, 2010 ve 2011'de 7.3, 1.3 ve 6.7 puanlık uzamış AS KS yaşama olasılığına sahipti ($p<0.01$).

Sonuçlar: Ana hastaneye AS aracılığıyla başvuran, beyaz olmayan hastalarda beyazlara göre daha uzun AS KS görülmektedir ve bu da ABD'deki hastanelerde ırk farklılıklarının halen var olduğunu göstermektedir.

Anahtar kelimeler: Irksal eşitsizlik, acil servis yoğunlaşması, logit modeli

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INTRODUCTION

Patterns of racial and ethnic disparities in the delivery of health care generally, and in emergency health care specifically, have been documented in many studies over the past two decades (1,2). Previous studies show that not only the time to see an emergency physician is longer in black patients3, but also when black patients are admitted, they remain in the emergency department (ED) for a longer period of time before they are transferred to the main hospital (4). Increased ED length of stay (LOS) has been associated with undesirable outcomes such as decreased patient satisfaction, increased mortality and complication rates, and higher levels of ED crowding (5).

ED LOS is affected by patient, physician, hospital, and system factors (6). To recognize where interventions should initiate to decrease disparities, policymakers need to distinguish between disparities that arise out of institutional racism and those related to patient acuity, physician, hospital, and system factors. How best to address these disparities depends upon the cause of the discrepancies in care times. If disparities by race exist within hospitals, the cure will lie in teaching hospital staff and using strategies for the treatment of patients without regard for their race or socioeconomic status. If differences exist between hospitals, then the solution lies in a change of physicians' practices in hospitals that are serving a larger number of racial minorities (4).

To the best of my knowledge, only few studies have examined racial disparities in prolonged ED LOS for admitted patients, controlling both for patients' medical conditions and hospital factors that could explain possible disparities. In this study we are going to determine that whites have a shorter ED LOS compared to non-whites. Our ultimate objective is to examine the effect of race/ethnic factors on prolonged emergency department length of stay in the United States.

METHODS

Study Design

This is a retrospective analysis of the National Hospital Ambulatory Medical Care Survey (NHAMCS) 2009-2011 non-whites.

Study Setting and Population

The National Hospital Ambulatory Medical Care Survey (NHAMCS) is a federally funded survey that has been conducted annually since 1992. NHAMCS is a public free dataset that does not meet the regulatory criteria for human subject research. Therefore, it is not necessary to obtain IRB approval from any agencies (7). The NHAMCS database is a national probability sample of non-institutional general and short-stay hospitals excluding Veterans' Affairs, federal, and military hospitals. The NHAMCS uses a four-stage probability sample including 1) geographic primary sampling units, 2) hospitals within primary sampling units, 3) EDs within hospitals, and 4) patients within EDs. Each hospital in the sample was randomly assigned for a four-week period of data collection. Data are collected in real time by local hospital staff or by a Census Bureau field representative. Local hospital staff or a Census Bureau field representative collect the data in real time or close to the day of the ED visit. More detailed methods of the survey procedures were provided by NCHS (8).

Measures

The main dependent variable was prolonged length of stay (PLOS). Length of stay is a continuous variable defined as the difference between ED arrival time and ED departure time. Prolonged LOS is defined as a LOS>6 hours. We chose 6 hours as a practical time frame for all these activities. This time frame is supported by many studies demonstrating a higher death rate in ICU patients boarded for more than 6 hours in the ED (9).

We excluded patients who left without being seen by a physician, left against medical advice, or were transferred to other hospitals. We also excluded patients for whom complete information on LOS was not recorded. The main independent variable was patient race/ethnicity. Race was coded as a set of dummy variables and included the following categories: White, Black, Hispanic, and other/unknown race. Hospital staff recorded patient race during registration. Patient-level confounders included sex, age, insurance status, patient residence, the unit that the patient was admitted to, type of provider who saw the patient, and severity of the illness. Severity of illness was approximated by the immediacy at which a patient needed to be seen by a physician. We also

included the total number of diagnostic/screening services provided, the total number of procedures provided, total number of medications given in ED, and arrival by ambulance as a proxy for severity of illness. Indication for admission was divided into a binary variable according to whether the visit was related to injury/poisoning or not. Hospital confounders included metropolitan statistical area, increasing of standard treatment spaces in the last two years, having a bed coordinator, using bedside registration, using computer-assisted triage, using a separate fast track unit for non-urgent care, using a separate operating room dedicated to ED patients, using radio frequency identification (RFID) tracking, using an electronic dashboard, and having a physically separate observation or clinical decision unit.

Statistical Analysis

In this study, we use the logit model as the maximum likelihood model of choice. The logit model is appropriate for answering the research question because it fits the binary dependent variable. This analytic model has been used in previous empirical research (10,12). However, earlier studies only used the triage category as a proxy for patient acuity level, which might not accurately reflect the true severity of illness uniformly across hospitals. Hence, we decided to include all variables representing the severity of illness such as number of procedures and number of medications given in the ED. Consequently we come up with two models: 1) the unrestricted model, which includes all variables that represent the severity of illness such as the number of procedures and number of medications given in ED, and 2) the restricted model, which only includes triage category as a proxy for severity. Akaike information criterion (AIC), Bayesian information criterion (BIC) and Pregibon's link test are used to test different specification of these models (Table 1). Based on the results of these tests, we selected the unrestricted model.

All models were assessed in Stata (12). Results are presented as average marginal effects (AME) for ease of interpretation, although the model is not intended to be causal, as omitted variables could be contributing to differences in LOS.

RESULTS

During the three years included in the study (2009-2011), NHAMCS collected data on 100,962 ED admissions from 994 hospitals. Of the 100,962 ED admissions, we analyzed data from 8,828 patients admitted to the main hospital from the emergency department (Table 1). A total of 1,894

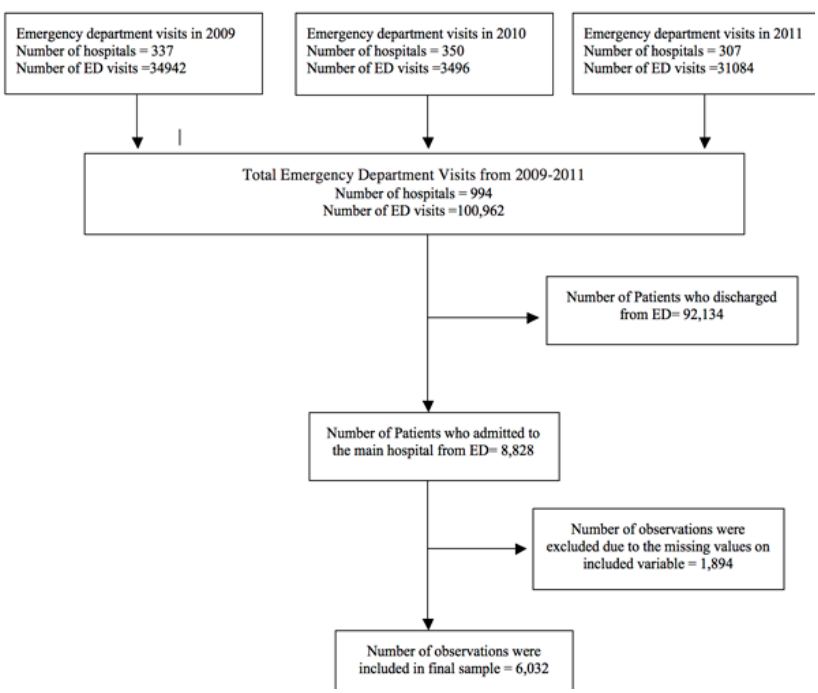

Figure 1: Flow diagram of emergency department visits from 2009-2011 National Hospital Ambulatory Medical Care Survey data set.

Table 1: Results of logit regression analysis and specification tests on two regression models

	2009		2010		2011	
	Unrestricted model	**Restricted model**	**Unrestricted model**	**Restricted model**	**Unrestricted model**	**Restricted model**
Variables						
Black	0.34** (2.69)	0.37** (3.05)	0.07 (0.50)	0.04 (0.29)	0.32* (2.24)	0.29* (2.10)
Hispanic	0.30 (1.91)	0.32* (2.02)	0.02 (0.11)	0.01 (0.03)	0.06 (0.35)	0.04 (0.23)
Other	0.30 (1.39)	0.40 (1.87)	0.24 (1.00)	0.15 (0.65)	0.13 (0.58)	0.01 (0.02)
Age	0.01 (0.58)	0.01 (1.49)	0.01 (0.28)	0.01 (1.22)	0.01** (2.64)	0.01*** (3.91)
Male	-0.08 (-0.91)	-0.07 (-0.80)	-0.11 (-1.18)	-0.09 (-1.04)	-0.01 (-0.01)	-0.01 (-0.14)
Percent population below poverty level in patient's ZIP code						
5.00-9.99 %	0.12 (0.76)	0.08 (0.52)	0.03 (0.17)	0.02 (0.15)	NA[1]	NA
10.00-19.99 %	0.20 (1.05)	0.21 (1.10)	0.30 (1.44)	0.34 (1.69)	NA	NA
20.00 % or more	0.64** (2.62)	0.64** (2.67)	0.44 (1.66)	0.50 (1.90)	NA	NA
Median household income in patient's ZIP code						
$32,794-$40,626	-0.09 (-0.60)	-0.07 (-0.46)	-0.01 (-0.03)	-0.01 (-0.07)	NA	NA
$40,627-$52,387	-0.44* (-2.44)	-0.39* (-2.24)	-0.27 (-1.49)	-0.29 (-1.62)	NA	NA
$52,388 or more	-0.40 (-1.84)	-0.42 (-1.95)	-0.20 (-0.84)	-0.21 (-0.96)	NA	NA
Immediacy						
Emergent	0.79*** (3.33)	0.63*** (2.81)	0.83** (2.73)	0.73*** (2.61)	0.32 (0.97)	0.13*** (0.81)
Urgent	1.03*** (4.47)	0.83*** (3.78)	1.16*** (3.90)	0.97*** (3.82)	0.60 (1.86)	0.53*** (1.78)
Semi-urgent	0.99*** (3.84)	0.78*** (2.96)	0.79* (2.51)	0.68*** (2.16)	0.31 (0.87)	0.18*** (0.76)
Non-urgent	0.71* (1.97)	0.52* (1.08)	2.02*** (5.09)	2.33* (4.88)	0.032 (0.07)	0.22* (0.06)
Visit without nursing triage	0.11 (0.29)	0.09 (0.23)	0.86* (2.11)	0.69 (1.73)	-0.98 (-1.47)	0.79 (-1.23)
Visit is related to injury or poisoning	-0.06 (-0.53)	-0.05 (-0.38)	-0.02 (-0.19)	-0.01 (-0.11)	-0.01 (-0.09)	-0.01 (-0.08)
Number of services	0.06*** (4.16)		0.04** (2.96)		0.07*** (4.51)	
Number of procedures	-0.05 (-0.82)		-0.08 (-1.27)		-0.07 (-1.04)	
Number of meds given in ED	0.11*** (5.00)		0.10*** (4.46)		0.09*** (3.53)	
Type of payment						
Private insurance	-0.41 (1.83)	-0.35 (1.58)	-0.18 (0.83)	-0.14 (0.63)	-0.02 (0.09)	-0.03 (0.12)
Medicare	-0.49* (2.25)	-0.46* (2.04)	-0.03 (0.13)	0.01 (0.01)	-0.07 (0.29)	-0.08 (0.36)
Medicaid	0.48* (2.07)	0.50* (2.21)	0.07 (0.33)	0.01 (0.01)	0.07 (0.27)	0.08 (0.34)
Worker's compensation	0.17 (0.19)	0.23 (0.26)	0.40 (0.31)	0.57 (0.44)	0.77 (0.02)	0.12 (0.03)
Self-pay	0.53* (2.07)	0.40 (1.59)	0.02 (0.07)	0.07 (0.26)	0.06 (0.21)	0.07 (0.26)
Midwest	-0.34** (2.69)	-0.40** (3.26)	-0.33* (2.30)	-0.32* (2.31)	-0.22 (1.40)	-0.24 (1.58)
South	-0.31* (2.54)	-0.31* (2.55)	-0.35** (2.89)	-0.31** (2.66)	-0.12 (0.83)	-0.14 (0.97)
West	-0.34* (2.14)	-0.22 (1.42)	-0.42** (2.66)	-0.30 (1.96)	0.04 (0.24)	-0.01 (0.04)
Non-MSA2	-0.75*** (4.50)	-0.70*** (4.24)	-0.37* (2.08)	-0.48** (2.74)	-1.13*** (5.42)	-1.15*** (5.82)
Weekend	-0.15 (1.55)	-0.18 (1.94)	-0.15 (1.51)	-0.16 (1.58)	-0.06 (0.53)	-0.04 (0.39)
Hospital ownership						
Government	-0.03 (0.26)	-0.05 (0.36)	-0.12 (0.75)	-0.09 (0.56)	-0.53** (3.10)	-0.50** (3.08)
Proprietary	-0.12 (0.52)	0.09 (0.43)	-0.36* (1.98)	-0.42* (2.28)	-0.43 (1.77)	-0.31 (1.33)
In last 2 years, ED has increased # of treatment spaces	-0.05 (0.50)	-0.01 (0.06)	-0.12 (1.04)	-0.06 (0.59)	-0.18 (1.57)	-0.24* (2.09)
Number of days in a week which elective surgeries are scheduled	0.10 (1.83)	0.12* (2.40)	0.13** (2.84)	0.13** (3.00)	0.10 (1.86)	0.13* (2.51)
Having a bed coordinator	-0.33** (2.71)	-0.34** (2.87)	-0.80*** (6.11)	-0.79*** (6.21)	-0.029 (0.20)	-0.01 (0.01)
Use bedside registration	-0.16 (1.26)	-0.10 (0.78)	-0.10 (0.64)	-0.02 (0.13)	-0.26 (1.25)	-0.10 (0.51)
Using computer-assisted triage	-0.28** (2.85)	-0.18 (1.86)	-0.35*** (3.36)	-0.38*** (3.71)	-0.64*** (4.69)	-0.62*** (4.70)
Using separate fast track unit for non-urgent care	-0.28** (2.72)	-0.33*** (3.36)	-0.57*** (5.09)	-0.51*** (4.72)	-0.15 (1.26)	-0.19 (1.71)
Using separate operating room dedicated to ED patients	-0.54 (1.83)	-0.38 (1.34)	-0.42* (2.13)	-0.40* (2.13)	-0.54** (2.83)	-0.44* (2.40)
Using radio frequency identification tracking	0.022 (0.18)	0.03 (0.28)	0.53*** (4.12)	0.60*** (4.69)	0.01 (-0.01)	0.01 (0.77)
Using full capacity protocol	-0.03 (0.31)	-0.02 (0.24)	-0.25** (2.67)	-0.25** (2.63)	-0.06 (0.54)	-0.03 (0.27)
Constant	-1.24* (-2.41)	-0.163 (-0.36)	-1.32* (-2.28)	-0.08 (-0.17)	-0.794 (-1.39)	-0.08 (-0.17)
Sample size	2570	2570	2395	2395	1967	1967
Link test	0.021474	0.022892	0.021247	0.021802	0.021768	0.02296
AIC	1.282884	1.310277	1.244282	1.273756	1.275641	1.296735
BIC	-16624.28	-16606.55	-15401.4	-18112.53	-12196.86	-12205.63

1. Data not available, 2. Metropolitan Statistical Area, * p<0.05**, p<0.01 ***, p<0.001

Table 2: Summary statistics and bivariate analysis of prolonged ED LOS for admitted patients by year.

	2009				2010				2011			
	Overall (N=2,570)	LOS<6h (N= 1,080)	LOS≥6h (N= 1,490)	p value	Overall (N=2,395)	LOS<6h (N= 1,008)	LOS≥6h (N= 1,387)	p value	Overall (N=1,967)	LOS<6h (N= 789)	LOS≥6h (N= 1,178)	p value
	Mean (Standard Deviation) or %				Mean (Standard Deviation) or %				Mean (Standard Deviation) or %			
Variables												
Age	57.2 (23.3)	57.6 (24.4)	56.9 (22.4)	0.45	57.0 (23.0)	56.3 (24.1)	57.6 (22.2)	0.16	57.2 (23.6)	55.7 (24.9)	58.2 (22.6)	0.02
Patient sex				0.77				0.25				0.91
Female	55.53	55.19	55.77		53.57	52.18	54.58		53.13	52.98	53.23	
Male	44.47	44.81	44.23		46.43	47.82	45.42		46.87	47.02	46.77	
Race/Ethnicity				<0.001				0.19				0.02
White	62.84	70.56	57.25		66.97	69.25	65.32		65.33	69.33	62.65	
Black	21.44	17.22	24.5		19.08	17.56	20.19		17.29	14.58	19.10	
Hispanic	10.39	8.06	12.08		9.77	8.93	10.38		10.47	9.51	11.12	
Other	5.33	4.17	6.17		4.18	4.27	4.11		6.91	6.59	7.13	
Percent population below poverty level in patient's ZIP code				<0.001				0.3				N1
Less than 5.00 %	16.07	15.74	16.31		16.95	16.87	17.02		N	N	N	
5.00-9.99 %	26.54	29.63	24.3		27.01	27.58	26.6		N	N	N	
10.00-19.99 %	34.47	36.11	33.29		35.32	36.61	34.39		N	N	N	
20.00 % or more	22.92	18.52	26.11		20.71	18.95	21.99		N	N	N	
Median household income in patient's ZIP code				0.05				0.01				N
Below $32,793	30.16	29.91	30.34		31.23	31.45	31.07		N	N	N	
$32,794-$40,626	25.41	28.06	23.49		23.67	26.69	21.49		N	N	N	
$40,627-$52,387	21.56	20.74	22.15		23.38	21.33	24.87		N	N	N	
$52,388 or more	22.88	21.3	24.03		21.71	20.54	22.57					
Day of the week				0.02				0.07				0.31
Weekday	72.88	70.56	74.56		73.07	71.13	74.48		73.61	72.37	74.45	
Weekend	27.12	29.44	25.44		26.93	28.87	25.52		26.39	27.63	25.55	
Immediacy				<0.001				<0.001				<0.001
Immediate	3.58	4.91	2.62		2.63	4.07	1.59		2.39	3.3	1.78	
Emergent	25.91	26.3	25.64		22.88	23.41	22.49		26.94	27.38	26.66	
Urgent	54.4	49.26	58.12		55.07	49.8	58.9		55.01	49.94	58.4	
Semi-urgent	11.36	12.31	10.67		12.57	15.97	10.09		11.49	13.81	9.93	
Non-urgent	2.18	2.59	1.88		3.38	2.28	4.18		3.1	3.55	2.8	
Visit without nursing triage	2.57	4.63	1.07		3.47	4.46	2.74		1.07	2.03	0.42	

Visit related to injury or poisoning				0.87				0.53				0.59
No	78.68	78.52	78.79		77.91	77.28	78.37		78.8	78.2	79.2	
Yes	21.32	21.48	21.21		22.09	22.72	21.63		21.2	21.8	20.8	
Type of payment				0.24				0.27				0.83
Unknown	4.94	3.89	5.7		5.51	4.86	5.98		5.44	5.45	5.43	
Private insurance	23	22.87	23.09		24.09	26.19	22.57		24.35	25.73	23.43	
Medicare	45.95	47.96	44.5		44.72	43.85	45.35		46.01	45.5	46.35	
Medicaid	18.02	17.59	18.32		19.25	18.35	19.9		17.03	16.48	17.4	
Worker's compensation	0.27	0.19	0.34		0.13	0.2	0.07		0.05	0.00	0.08	
Self-pay	7.82	7.5	8.05		6.3	6.55	6.13		7.12	6.84	7.3	
Hospital ownership				0.41				<0.001				0.003
Non-profit	79.03	80.28	78.12		81	80.56	81.33		81.9	83.65	80.73	
Government	16.54	15.46	17.32		12.28	10.62	13.48		12.96	10.14	14.86	
Proprietary	4.44	4.26	4.56		6.72	8.83	5.19		5.13	6.21	4.41	
Number of services	7.5 (3.5)	7.1 (3.5)	7.9 (3.4)	<0.001	7.8 (3.7)	7.3 (3.7)	8.2 (3.7)	<0.001	7.7 (3.6)	7.2 (3.7)	8.0 (3.5)	<0.001
Number of procedures	1.1 (0.8)	1.1 (0.8)	1.2 (0.8)	0.03	1.1 (0.8)	1.1 (0.8)	1.1 (0.8)	0.16	1.1 (0.7)	1.1 (0.8)	1.1 (0.7)	0.37
Number of meds given in ED	2.5 (2.1)	2.1 (2.0)	2.7 (2.2)	<0.001	2.8 (2.2)	2.4 (2.2)	3.0 (2.3)	<0.001	2.8 (2.2)	2.5 (2.1)	3.0 (2.2)	<0.001
Geographic region				0.01				<0.001				0.16
Northeast	28.44	26.3	30		31.61	24.4	36.84		20.18	20.03	20.29	
Midwest	26.26	28.8	24.43		17.45	19.54	15.93		25.47	27.5	24.11	
South	31.13	32.13	30.4		35.53	39.78	32.44		30.76	31.18	30.48	
West	14.16	12.78	15.17		15.41	16.27	14.78		23.59	21.29	25.13	
MSA2 or non-MSA area				<0.001				<0.001				<0.001
MSA	88.29	80.74	93.76		89.31	82.74	94.09		91.1	84.79	95.33	
Non-MSA	11.71	19.26	6.24		10.69	17.26	5.91		8.9	15.21	4.67	
In the last 2 years, ED has increased # of treatment spaces				0.04				0.89				0.002
Yes	32.68	30.46	34.3		24.34	24.21	24.44		30.91	27	33.53	
No	67.32	69.54	65.7		75.66	75.79	75.56		69.09	73	66.47	
Number of days in a week which elective surgeries are scheduled	5.1 (1.0)	4.9 (1.2)	5.2 (0.8)	<0.001	5.2 (1.1)	5.1 (1.2)	5.3 (1.0)	<0.001	5.1 (1.0)	5.0 (1.3)	5.2 (0.7)	<0.001
Having a bed coordinator				<0.001				<0.001				0.003
Yes	80.93	75.28	85.03		83.01	73.91	89.62		82	78.83	84.13	
No	19.07	24.72	14.97		16.99	26.09	10.38		18	21.17	15.87	
Use bedside registration				0.89				0.04				0.03
No	17.47	17.59	17.38		10.77	12.3	9.66		7.68	9.25	6.62	

Yes	82.53	82.41	82.62		89.23	87.7	90.34		92.32	90.75	93.38	
Using computer-assisted triage				0.04				<0.001				<0.001
No	36.34	38.61	34.7		31.06	37.4	26.46		18.81	24.71	14.86	
Yes	63.66	61.39	65.3		68.94	62.6	73.54		81.19	75.29	85.14	
Using separate fast track unit for non-urgent care				<0.001				<0.001				<0.001
No	42.18	49.44	36.91		30.65	41.57	22.71		31.83	37.52	28.01	
Yes	57.82	50.56	63.09		69.35	58.43	77.29		68.17	62.48	71.99	
Using separate operating room dedicated to ED patients				0.06				<0.001				<0.001
No	2.53	1.85	3.02		8.89	4.96	11.75		10.27	7.1	12.39	
Yes	97.47	98.15	96.98		91.11	95.04	88.25		89.73	92.9	87.61	
Using radio frequency identification tracking				0.16				<0.001				0.15
No	84.47	85.65	83.62		82.96	79.46	85.51		79.26	80.86	78.18	
Yes	15.53	14.35	16.38		17.04	20.54	14.49		20.74	19.14	21.82	
Using full capacity protocol				0.01				0.001				0.01
No	55.76	57.59	54.43		54.49	50.69	57.25		47.18	43.73	49.49	
Yes	44.24	42.41	45.57		45.51	49.31	42.75		52.82	56.27	50.51	

P-values by t-test for continuous variables and chi2 test for binary / categorical variables, 1. Data not available, 2. Metropolitan Statistical Area

observations were excluded due to missing values for included variables. The final sample includes 6,932 observations (Figure 1). Summary statistics of the included variables and bivariate tests (t-test for continuous variables and chi-square test for categorical variables) of the relationship between independent variables and prolonged ED LOS are presented in Table 2. The mean age of our sample was 57 years; 65% of patients were white, and 54% were female. A total of 58.5% of patients spent 6 hours or more in the ED before admission to the main hospital. Overall, 55.4% of whites stayed for more than 6 hours in the ED compared to 64.1% of non-whites ($p<0.01$).

Our primary analysis demonstrated positive associations between being non-white, living in a poor neighborhood, being female and prolonged LOS. The results of both the restricted and unrestricted regression models are presented in Table 1.

The results of this study revealed that the average predicted probability of prolonged ED LOS was 0.5798 with a 95% confidence interval [0.5617-0.5978] in 2009, 0.5791 with a 95% confidence interval [0.5608-0.5974] in 2010, and 0.5989 with a 95% confidence interval [0.5784-0.6194] in 2011 within the sample of this study as presented in Table 3.

The representative person in this sample is a 57-year-old white woman on Medicare with no chief complaint of injury or poisoning in urgent medical condition who lives in a metropolitan statistical area with 10-20% of the population below poverty level, in the median household income bracket below $32,793, located in the South, admitted on a weekday to the ED of a non-profit hospital having a bed coordinator, a separate fast-track unit for non-urgent care, a separate operating room dedicated to ED patients, using bedside registration and computer-assisted triage but no radio frequency identification tracking system and not implementing a full capacity protocol. For this person, eight diagnostic/screening services and one procedure were provided and she received two medications in the ED. The predicted probability of prolonged ED OLS for the representative person in this sample is 0.75% with a standard error of 0.0091 in 2009, 0.75% with a standard error of 0.0093 in 2010, and 0.60% with a standard error of 0.0103 in 2011. (For 2011, data for median income and percentage of poverty in patients' zip code area were not available).

Table 3: Average predicted probability of prolonged ED LOS by year

	Prob (y|xβ)	Delta method Standard Error	P>|z|	95% Conf. Interval		Number of observations
Year of study						
2009	0.5798	0.0091	0.000	0.5617	0.5978	2570
2010	0.5791	0.0093	0.000	0.5608	0.5974	2395
2011	0.5989	0.0104	0.000	0.5784	0.6193	1967

Marginal/differential effect of the key variables of interest with a measure of precision around the reported marginal effects and predictions are presented in table (4).

On average, compared to white patients, black patients had a 7.3 percentage point higher probability of having prolonged ED LOS in 2009, a 1.3 percentage point higher probability of having prolonged ED LOS in 2010, and a 6.7 percentage point higher probability of having prolonged ED LOS in 2011 ($p<0.01$ for each year), controlling for all other variables.

Again controlling for all other variables, on average living in a ZIP code with more than 20% population below the poverty level was associated with a 13.6 percentage point and a 9.2 percentage point higher probability of waiting more than 6 hours in the ED, compared with living in a ZIP code with less than 5% of the population below the poverty level in 2009 and 2010, respectively ($p<0.01$ for both years).

On average, patients admitted to a hospital implementing full capacity protocol, compared to patients admitted to a hospital not implementing full capacity protocol, had a 6.5 percentage point, 5.3 percentage point and 1.2 percentage point lower probability of waiting more than 6 hours in the ED, controlling for all other variables in 2009, 2010, and 2011, respectively ($p<0.01$).

DISCUSSION

Racial and ethnic minorities experience disparities in numerous health status measures and health outcomes. Many studies and reports have recognized that minorities are in poorer health, experience more significant problems accessing care, and often receive lower quality health care than other Americans (13).

The results of this study shows a difference in the probability of having a prolonged ED LOS between white and non-white patients: We found that non-white patients have a statistically significantly higher probability of having a prolonged ED LOS compared to white patients. Our findings showed that even after controlling for patient-level factors, disparities still exists. When we controlled for the effects of patients and hospitals factors, in 2009 we found that black patients on average had a 7.3 percentage point higher probability of waiting more than 6 hours in the ED than non-black patients, demonstrating racial disparities do exist in emergency department length of stay.

Our study also revealed some geographic disparities in ED LOS. ED patients who live in the Northeast region had a longer LOS, which is consistent with previous studies (4). In 2011, controlling for all other variables, a patient who lived in the South on average had a 3.3 percentage point ($p=0.807$) lower probability of waiting more than 6 hours in the ED, compared to a patient with the same characteristics living in the Northeast. This could be because of a larger supply-demand gap for care in hospitals in the northeastern region.

Generally, for-profit hospitals were more efficient in moving patients out of the ED (4,14). Controlling for all other variables, on average in 2011, a patient admitted to a for-profit hospital had a 9.5 percentage point ($p=0.079$) lower probability of waiting more than 6 hours in the ED, compared to a patient with the same characteristics admitted to a not-for-profit hospital.

Consistent with many prior studies, our analysis showed that urban hospitals had longer LOS than non-urban hospitals15. Controlling for all other variables, in 2011 on average patients living in a non-urban had a 25 percentage point ($p<0.01$) lower probability of waiting more than 6 hours in the ED, compared to a patient with the same characteristics who lived in a urban area, suggesting that hospital crowding might be a larger problem in urban areas compared to rural areas.

In general, by adjusting for the effects of patient acuity, physician, hospital, and system factors, the findings of the present study showed that at the patient-level being

Table 4: Average marginal effects of independent variables on prolonged LOS

	2009	2010	2011
	AME1 (Std err)2	AME (Std err)	AME (Std err)
Variables			
Black	0.0727 (0.0267)	0.0138 (0.0279)	0.0674 (0.0294)
Hispanic	0.0665 (0.0343)	0.0389 (0.0349)	0.0134 (0.0377)
Other	0.0653 (0.0461)	0.0509 (0.0516)	0.0275 (0.0473)
Age	0.000327 (0.000563)	0.000155 (0.000553)	0.000157 (0.000591)
Male	-0.0172 (-0.0189)	-0.0225 (-0.0191)	-0.000269 (-0.0214)
Percent population below poverty level in patient's ZIP code			
5.00-9.99 %	0.0276 (0.0362)	0.0301 (0.0353)	NA3
10.00-19.99 %	0.0452 (0.0432)	0.0627 (0.0435)	NA
2.00 % or more	0.1365 (0.0515)	0.0920 (0.0549)	NA
Median household income in patient's ZIP code			
$32,794-$40,626	-0.0194 (-0.0323)	-0.0188 (-0.0321)	NA
$40,627-$52,387	-0.0942 (-0.0381)	-0.0571 (-0.0384)	NA
$52,388 or more	-0.0876 (-0.0470)	-0.0404 (-0.0484)	NA
Immediacy			
Emergent	0.176 (0.0512)	0.177 (0.0623)	0.172 (0.0745)
Urgent	0.228 (0.0493)	0.247 (0.0604)	0.133 (0.0735)
Semi-urgent	0.224 (0.0552)	0.173 (0.0651)	0.168 (0.0794)
Non-urgent	0.159 (0.0798)	0.406 (0.0725)	0.172 (0.0978)
Visit without nursing triage	0.0245 (0.0851)	0.183 (0.0849)	0.215 (0.133)
Visit is related to injury or poisoning	-0.00126 (-0.0228)	-0.00433 (0.0231)	-0.00232 (0.0258)
Number of services	0.0128 (0.00356)	0.0169 (0.00292)	0.0149 (0.00324)
Number of procedures	-0.0107 (-0.0131)	-0.0167 (-0.0132)	-0.0161 (-0.0153)
Number of meds given in ED	0.0248 (0.00489)	0.0213 (0.00472)	0.0191 (0.00535)
Type of payment			
Private insurance	-0.0844 (0.0446)	-0.0383 (0.0455)	-0.0463 (0.0507)
Medicare	-0.102 (0.0435)	-0.0169 (0.0453)	-0.0145 (0.0502)
Medicaid	0.0138 (0.0468)	0.0153 (0.0466)	0.0142 (0.0527)
Worker's compensation	0.0321 (0.165)	0.0838 (0.274)	0.0397 (0.0459)
Self-pay	0.0118 (0.0528)	0.0415 (0.0558)	0.0124 (0.0605)
Midwest	-0.0732 (0.0271)	-0.0695 (0.0305)	-0.0469 (0.0333)
South	-0.0668 (0.0261)	-0.0724 (0.0251)	-0.0267 (0.0322)
West	-0.0728 (0.0341)	-0.0891 (0.0338)	-0.0851 (0.0351)
Non-MSA4	-0.171 (0.0383)	-0.179 (0.0391)	-0.2555 (0.0452)
Weekend	-0.0324 (0.0211)	-0.0322 (0.0214)	-0.0127 (0.0241)
Hospital ownership			
Government	-0.0732 (0.0281)	-0.0248 (0.0332)	-0.0108 (0.0328)
Proprietary	-0.0247 (0.0475)	-0.0781 (0.0401)	-0.0948 (0.0541)
In the last 2 years, ED has increased # of treatment spaces	-0.0106 (0.0211)	-0.0242 (0.0234)	-0.0393 (0.0249)
Number of days in a week which elective surgeries are scheduled	0.0202 (0.0111)	0.0271 (0.00947)	0.0219 (0.0117)
Having a bed coordinator	-0.0735 (0.0275)	-0.105 (0.0289)	-0.0625 (0.0321)
Use bedside registration	-0.0346 (0.0271)	-0.0207 (0.0319)	-0.0541 (0.0421)
Using computer-assisted triage	-0.0608 (0.0209)	-0.0752 (0.0225)	-0.142 (0.0305)
Using separate fast track unit for non-urgent care	0.0605 (0.0224)	-0.122 (0.0244)	-0.0322 (0.0256)
Using separate operating room dedicated to ED patients	-0.111 (0.0566)	-0.0851 (0.0385)	-0.116 (0.0366)
Using radio frequency identification tracking	0.00473 (0.0266)	0.00139 (0.0276)	0.00163 (0.0282)
Using full capacity protocol	-0.0652 (0.0212)	-0.0535 (0.0201)	-0.0122 (0.0228)

1. Average marginal effects, 2. Std err : Standard error, 3. Data not available, 4. Metropolitan Statistical Area, p<0.05**, p<0.01 ***, p<0.001

younger, male, white, rich, living in non-urban areas and being admitted to a hospital using a bed coordinator, bedside registration, separate operating rooms dedicated to ED patients, computer-assisted triage, and implementing full capacity protocol is related to lower probability of prolonged ED LOS, controlling for all other factors.

The implications from our analyses are important for policy not only in the US but also in other countries such as Iran. As the role of ethnic, educational, and socioeconomic factors in access to health care is highly understudied in Iran 16,17,18, knowing the factors that could impact access to different aspects of the healthcare system may help policymakers to design and implement more efficient policies. When patients wait in the ED for long times, usually they do not receive the best quality care, as those patients are usually cared by ED doctors who are busy with other patients. Besides, ED medical attendants may frequently attend to those patients as inpatients while admitting new patients. This can diminish the quality of care for both the admitted and the new patients. Such danger makes the observed racial disparity in ED LOS in this study a quantifiable quality issue in US hospital care.

The large sample size and national scope are strengths of this study, but caveats of our study should be noted. First, patients who left without being seen and patients who were admitted but had missing data could potentially change the median length of stay and resulting harm, depending on the characteristics of those patients. While this proportion of patients was considerable (21.4%), those with full information on prolonged LOS and those with missing information did not differ by race, sex, or age category. Therefore, excluded observations have no meaningful effect on our final results. Second, we use cross-sectional data and not panel or longitudinal data. Because NHAMCS is a national sample collected from multiple EDs and data are de-identified, we cannot use NHAMCS as a panel dataset. Therefore, we report our results for each year separately. Third, our estimates can be biased due to potential omitted variables such as arrival time and number of patient comorbidities even when these are not correlated with the included independent variables. However, the data we use do not provide those measures and therefore we could not include them in our model. Finally, because in the logit model heteroscedasticity could bias the model, we separately run a linear probability model (LPM). The results we found were similar to those we had found when we used the logit model, and because out-of-range predictions in our model were almost zero (0.039%), we also could have used an LPM as an alternative in this case, as heteroscedasticity can be treated much easier in an LPM model.

Racial and ethnic disparities in quality of care persist in almost every area of healthcare for which they have been studied. While emergency medicine's historical commitment and legislative mandate is to provide access to all, future research is needed to determine why racial disparities still exist.

Ethics Committee Approval: Ethics committee approval was received for this study from the local ethics committee.

Informed Consent: Informed consent was obtained.

Author contributions: Conception/Design of study -M.M.; Data acquisition - M.M.; Data analysis/Interpretation - M.M.; Drafting manuscript - M.M., Critical revision of manuscript - M.M.; Final approval and accountability - M.M.,

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