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Trends in Medical and Surgical Admission Length of Stay by Race/Ethnicity and Socioeconomic Status: A Time Series Analysis

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Abstract

Background: Length of stay (LOS), a metric of hospital efficiency, differs by race/ethnicity and socioeconomic status (SES) and longer LOS is associated with adverse health outcomes. Historically, projects to improve LOS efficiency have yielded LOS reductions by 0.3 to 0.7 days per admission.

Objective: To assess differences in average adjusted length of stay (aALOS) over time by race/ethnicity, and SES stratified by discharge destination (home or non-home).

Method: Data were obtained from 2009-2014 Healthcare Cost and Utilization Project State Inpatient Datasets for New York, New Jersey, and Florida. Multivariate generalized linear models were used to examine trends in aALOS differences by race/ethnicity, and by high vs low SES patients (defined first vs fourth quartile of median income by zip code) controlling for patient, disease and hospital characteristics.

Results: For those discharged home, racial/ethnic and SES aALOS differences remained stable from 2009 to 2014. However, among those discharged to non-home destinations, Black vs White aALOS differences increased from 0.21 days in Q1 2009, (95% confidence interval (CI): 0.13 to 0.30) to 0.32 days in Q3 2013, (95% CI: 0.23 to 0.40), and for low vs high SES patients from 0.03 days in Q1 2009 (95% CI: -0.04 to 0.1) to 0.26 days, (95% CI: 0.19 to 0.34). Notably, for patients not discharged home, racial/ethnic and SES aALOS differences increased and persisted after Q3 2011, coinciding with the introduction of the Affordable Care Act (ACA).

Conclusion: Further research to understand the ACA's policy impact on hospital efficiencies, and relationship to racial/ethnic and SES differences in LOS is warranted.

Keywords

length of stay, hospital, racial and ethnic, socioeconomic, time series.

Introduction

Hospital length of stay (LOS) is used as a management tool to assess the operational aspects of inpatient treatment and the resources required to deliver care.[1] There is increasing evidence that hospitals have found the need to actively manage LOS not just for the financial well-being of their systems, but also because of adverse outcomes associated with emergency department boarding,[2] ambulance diversion due to high bed occupancy,[3] and delays in discharge.[4] Furthermore, longer LOS itself has been associated with adverse clinical outcomes for patients, including risk of readmission in the Medicare population,[5] nosocomial infections from multi-drug resistance organisms in the era of increasing antibiotic resistance,[6,7] and other in-hospital adverse events.[4,8]

Several studies have revealed racial/ethnic and socioeconomic status (SES) differences in adjusted LOS in medical and surgical admissions.[9-15] However, no prior studies have described how these differences vary over time. As hospitals seek greater market

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share, higher bed occupancy rates, and increased net revenue,[16] they may seek efficiencies in LOS to lower costs.[17,18] Since the introduction of the inpatient prospective payment system which uses diagnosis-related groups (DRG), there has been a general trend toward shorter LOS.[19] Strategies to reduce LOS, including use of multi-disciplinary ward-based activities[20,21] and changes to work flow management,[22,23] have lowered average LOS from 0.3 to 0.7 days.[21,22,24] Although the mechanisms driving racial/ethnic and socioeconomic LOS differences remain unclear, such strategies may have greater impact on racial and ethnic minorities and patients with low socioeconomic status (SES) by favoring patients with commercial insurance[25] and/or with more financial resources to manage their medical conditions outside the hospital.[26]

To cast light on this, we analyzed a 2009-2013 all-payer dataset of hospitalizations from 3 states to examine differences in adjusted LOS by race/ethnicity and SES over time by discharge destination. We hypothesized that over time, LOS differences by race/ethnicity and SES between patients discharged to home and non-home destinations would follow the same trajectory.

Methods

Data Source and Population

We created an analytical file of all-payer inpatient discharges from years 2009 to 2014 using the New York, Florida, and New Jersey State Inpatient Databases (SID) from the Health Cost and Utilization project (HCUP). The study population was patients 18 years of age or older, discharged alive with a medical or surgical diagnosis, based on DRGs with LOS greater than or equal to 1 day. We categorized DRGs by whether they are more likely to be managed on a medical or surgical ward using methods described elsewhere.[15] We excluded patients admitted to non-acute care and critical access hospitals (CAH) because of federally mandated LOS obligations for CAHs (Supplement).

Study Outcome

Our outcome was yearly-quarter average adjusted LOS (aALOS) by race/ethnicity, and by SES (defined as median income by patient zip code, in quartiles), stratified by discharge destination (home vs non-home destinations [i.e., acute rehabilitation, skilled nursing facilities, long-term acute care hospitals]). Hospitalizations were stratified by discharge destination (home vs non-home destinations) because patients with higher LOS have a higher likelihood of discharge to non-home destinations. This may be the result of severity of illness, deconditioning as an inpatient, and time required for post-discharge facility placement.[21,27]

We calculated the aALOS by race/ethnicity and SES, using 2 separate models informed by a conceptual framework described elsewhere.[15] This framework describes how patient-level factors (e.g., age, race/ethnicity), disease-related factors (e.g., comorbidities, and admission diagnosis), and hospital-related factors influence a patient's LOS (Supplement). In both models, we treated LOS as a gamma-distributed variable given its non-zero, right-skewed distribution.[28] In the first model, our exposure was race/ethnicity (using White as reference). In the second model, our exposure was SES (using low SES [patients residing in the lowest 25% of ZIP codes by income—first quartile] as reference, compared to high SES [defined as the patients residing in the top 25% ZIP codes by income—fourth quartile])—in line with previous work.[29] In both models, we controlled for patient age, sex, and health insurance (Medicare, Medicaid, private insurance, self-pay), admission-related characteristics (whether admission was on a weekend or not, and whether admission was urgent, elective, or emergent, or other), number of chronic diseases, Elixhauser-related mortality score, and incorporated separate intercepts for each DRG, each hospital, and each time-quarter to account for differences between DRGs, between hospitals, and seasonality of aALOS. Standard errors were clustered at the hospital level.

Statistical Analysis

By race/ethnicity, and SES, we summarized continuous variables with means and standard deviations or median and interquartile range, where appropriate, and categorical variables with percentages. We assessed differences across the range of covariates using ANOVA, Kruskal-Wallis, and chi-square tests where appropriate. Model variables were checked for multicollinearity using variation inflation factors.

We calculated the aALOS differences by race/ethnicity and SES for each year-quarter of the study period using the *margins* command in STATA on each model. Then we assessed racial/ethnic and SES trend differences using variance-weighted linear regression. A 2-sided α of 0.05 was used to assess statistical significance.

All analyses were performed in SAS (Version 9.4) and STATA (Version 16). This research was approved by the institutional review board of the Weill Cornell Medical College.

Results

Characteristics of Study Subjects

In Tables 1 and 2, we summarize the patient characteristics of inpatient admissions to acute care hospitals across the 3 states from 2009 to 2014 by race/ethnicity (Table 1), and low vs high SES (Table 2). In total, we analyzed 22,499,653 admissions. Tables 1 and 2 show that admissions discharged to non-home destinations were, on average, significantly older than admissions discharged home, had higher Elixhauser-related mortality scores, had more chronic conditions, were more likely to be Medicare-insured, and had a higher unadjusted median LOS across all racial/ethnic groups and between low and high SES patients (all $P < 0.001$).

Table 1. Admission-Level Characteristics, Stratified by Discharge Destination, New York, Florida, and New Jersey 2009 to 2014 by Race/Ethnicity.

	Race/ethnicity								
	White			Black			Hispanic		
	Home	Non-home	P-value	Home	Non-home	P-value	Home	Non-home	P-value
Discharges, n	11,495,371	4,215,210		3,004,982	845,753		2,404,399	533,938	
Female, %	49.86	56.76	<.001	55.1	53.15	<.001	51.93	51.89	0.6
Age in years, mean (sd)	62.61 (17.62)	74.41 (15.49)	<.001	54.37 (17.45)	65.08 (17.49)	<.001	56.71 (18.77)	69.22 (17.53)	<.001
Number of chronic conditions, mean (sd)	5.14 (3.06)	6.72 (3.18)	<.001	4.75 (2.97)	6.44 (3.19)	<.001	4.21 (2.97)	6.05 (3.25)	<.001
Elixhauser-related mortality score, mean (sd)	3.64 (8.19)	7.63 (10.44)	<.001	3.41 (8.16)	7.54 (10.68)	<.001	2.95 (7.62)	6.74 (10.35)	<.001
Proportion of weekend admissions, %	19.37	21.78	<.001	22.08	21.97	.03	21.48	22.17	<.001
Admission type, %			<.001			<.001			<.001
Emergency	68.4	76.04		82.27	82.38		80.88	81.29	
Urgent	10.53	8.87		6.06	6.38		6.08	6.62	
Elective	20.52	14.24		11.04	10.56		12.29	11.21	
Other	0.55	0.85		0.63	0.68		0.75	0.88	
Insurance, %			<.001			<.001			<.001
Medicare[1]	53.08	79.72		38.97	63.62		39.49	68.23	
Medicaid	7.84	4.69		24.31	18.1		24.02	15.56	
Private Insurance	30.09	11.15		22.77	11.22		20.92	9.51	
Self-pay	5.12	1.96		9.04	3.38		10.45	3.54	
Other	3.87	2.48		4.92	3.68		5.12	3.17	
Proportion of medical admissions, %	68.81	70.33	<.001	80.02	75.93	<.001	74.14	74.65	<.001
LOS, median (IQR)	3 (2-5)	5 (3-9)	<.001	3 (2-6)	6 (3-10)	<.001	3 (2-5)	5 (3-9)	<.001

Abbreviations: IQR—Interquartile range; LOS—Length of stay; sd—Standard Deviation; SES—socioeconomic status.
[1]Admissions in Quartile 2 and 3 were included in the model, but characteristics not reported.

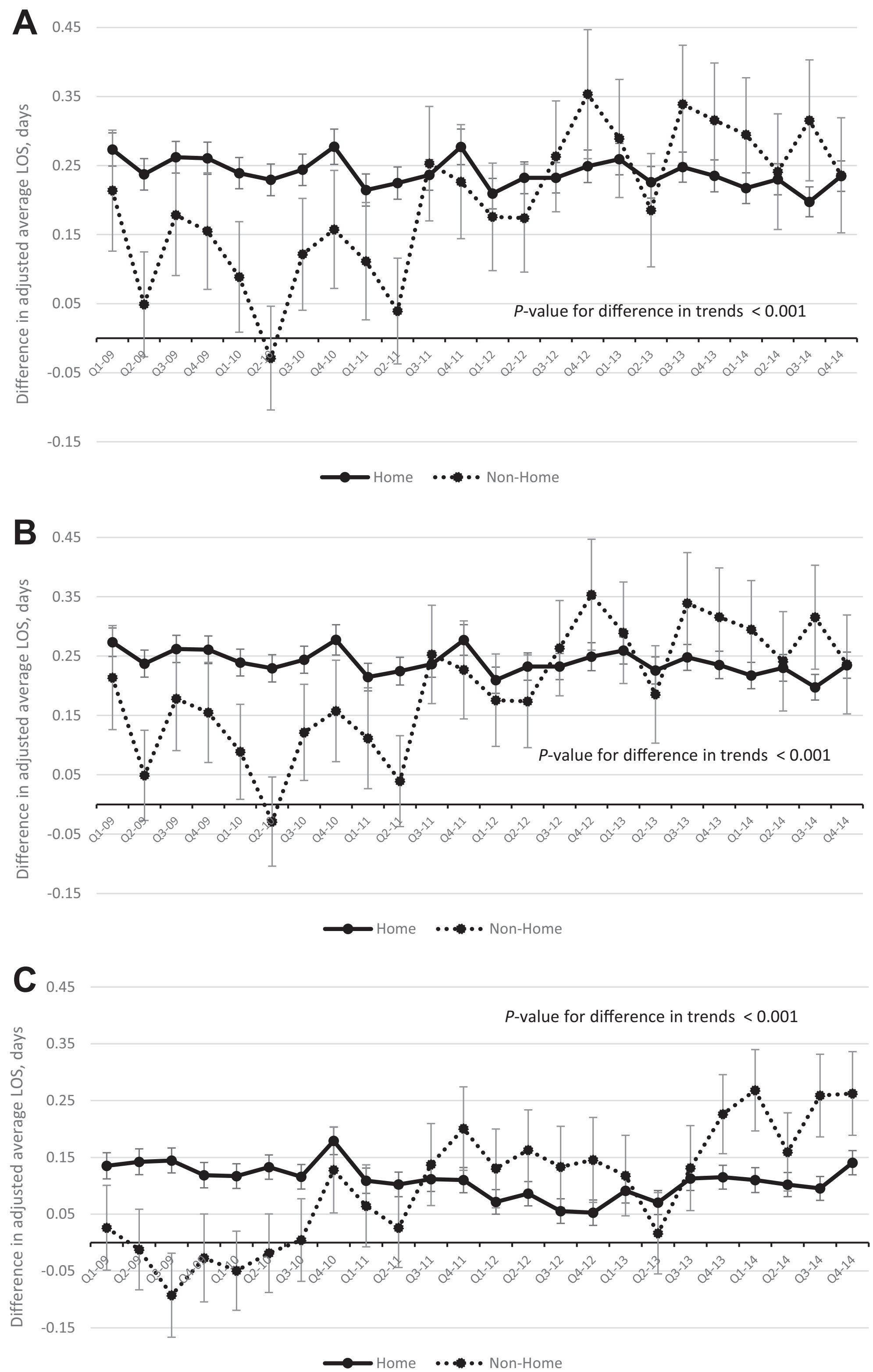

Figure 1. Racial/ethnic and socioeconomic status (SES) differences in average adjusted length of stay (aALOS)* by discharge destination, medical and surgical admissions in New York, Florida, and New Jersey, 2009 to 2014. A, Black vs White (reference). B, Hispanic vs White (reference). C, Low SES vs High SES (reference). * aALOS calculated using 2 multi-variate generalized linear models treating length of stay as a gamma-distributed variable. Model 1 assessed race/ethnicity as the exposure, and controlled for age, sex, health insurance type (Medicare, Medicaid, private insurance, or self-pay), indicator of weekend admission, urgency of admission (elective, emergent, urgent, or other), number of chronic conditions, Elixhauser-related mortality score, and individual intercepts for time-quarter, diagnosis-related group, and hospital, with standard errors clustered at hospital level. Model 2 assessed SES as its exposure, with the same control variables as Model 1.

Table 2. Admission-Level Characteristics, Stratified by Discharge Destination, New York, Florida, and New Jersey 2009 to 2014 by Socioeconomic Status.

	Socioeconomic status[1]					
	Quartile 1 (low SES)[2]			Quartile 4 (high SES)[3]		
	Home	Non-home	P-value	Home	Non-home	P-value
Discharges, n	5,064,922	1,586,232		3,803,309	1,244,572	
Female, %	52.32	54.47	<.001	49.31	56.78	<.001
Age in years, mean (sd)	58.38 (18.12)	70.16 (17.02)	<.001	61.75 (18.14)	74.60 (15.64)	<.001
Number of chronic conditions, mean (sd)	4.98 (3.07)	6.63 (3.25)	<.001	4.68 (2.98)	6.45 (3.11)	<.001
Elixhauser-related mortality score, mean (sd)	3.35 (8.14)	7.36 (10.54)	<.001	3.56 (7.95)	7.63 (10.37)	<.001
Proportion of weekend admissions, %	21.08	22.15	<.001	19.12	21.35	<.001
Admission type, %			<.001			<.001
Emergency	76.56	78.97		69.71	76.09	
Urgent	8.42	8.52		8.86	7.69	
Elective	14.35	11.69		20.92	15.4	
Other	0.67	0.82		0.51	0.81	
Insurance, %			<.001			<.001
Medicare[1]	46.52	72.97		48.21	78.41	
Medicaid	20.2	12.07		7.06	4.25	
Private Insurance	20.02	9.1		36.94	13.53	
Self-pay	8.7	3.02		4.35	1.6	
Other	4.55	2.83		3.44	2.21	
Proportion of medical admissions, %	75.60	74.04	<.001	66.93	68.52	<.001
LOS, median (IQR)	3 (2-5)	5 (3-9)	<.001	3 (2-5)	5 (3-9)	<.001

Abbreviations: IQR—Interquartile range; LOS—Length of stay; sd—Standard Deviation; SES—socioeconomic status.
[1]Admissions in Quartile 2 and 3 were included in the model, but characteristics not reported.
[2]Low SES admissions are defined as admissions of patients falling in the first quartile of median income by patient zip code.
[3]High SES admissions are defined as admissions of patients falling in the fourth quartile of median income by patient zip code.

Table 3 reports the aALOS by year across all racial/ethnic and SES groups by discharge destination. Statistically significant declines were in aALOS were seen for each racial/ethnic and SES group and by discharge destinations (*P*-value for trend < 0.001), with the greatest decline in high SES patients (0.79 days, 95% CI: −0.80 to −0.79), then White patients (0.64 days, 95% CI: −0.64 to −0.64), and the smallest among Black patients (0.51 days, 95% CI: −0.51 to −0.51). Declines in aALOS among admissions discharged to home decreased by comparable rates across all demographic groups, but by lesser amounts than for non-home destinations.

Figure 1A-C show the trends in racial and SES differences in aALOS by discharge destination by year quarter. Black vs White aALOS differences for discharge home declined very little from 0.27 days in Q1 2009 (95% CI: 0.25-0.3) to 0.23 days in Q4 2014 (95% CI 0.21 to 0.26). However, Black-White differences for patients discharged to non-home destinations trended upward from 0.21 days in Q1 2009 (95% CI: 0.13 to 0.30), reaching its largest difference of 0.34 days in Q3 2013 (95% CI: 0.25 to 0.42). Likewise, low vs high SES aALOS for those discharged home remained stable over the study time period, from 0.14 days in Q1 2009 (95% CI: 0.11 to 0.16) to 0.14 days in Q4 2014 (95% CI: 0.12 to 0.16) but increased for discharges to non-home destinations from 0.03 days in Q1 2009 (−95% CI: −0.04 to 0.10) to 0.26 days in Q4 2014 (95% CI: 0.19 to 0.34). For Hispanic discharges, the picture was different. For those discharged home, aALOS relative to Whites remained virtually identical (0.04 days in Q1 2009, 95% CI: 0.01 to 0.06; 0.05 days in Q4 2014, 95% CI: 0.03 to 0.08). For those discharged to non-home destinations, the relative advantage in terms of shorter aALOS in Q1 2009 (−0.14 days, 95% CI: −0.23 to −0.04) was no longer evident in Q4 2014 (0.01 days, 95% CI: −0.08 to 0.1).

The aALOS trends comparing those discharged to home vs non-home were significant for all 3 sets of comparisons (*P*-value for trend differences < 0.001, Figure 1A-C). Notably for all 3 sets of comparisons, compared to the aALOS trend discharged home, the aALOS trend line for discharge to non-home rose and remained elevated after Q3 2011.

Discussion

In our analysis of an all-payer admission dataset across 3 states over the period 2009 through 2014, we found that for patients discharged to non-home destinations, trends in racial/ethnic and SES aALOS differences increased significantly. However, they remained stable for those discharged home.

To our knowledge, this is the first study to examine trends in adjusted LOS differences by race/ethnicity and SES in a US setting across both medical and surgical admissions. Our findings reinforce and generalize the findings from previous studies in 3 ways. First, our analysis used a large comprehensive

Table 3. Average Adjusted Length of Stay (aALOS)[1] From 2009 to 2014 in Days, by Race/Ethnicity and Socioeconomic Status (SES), Stratified by Discharge Destination.[2]

		2009	2010	2011	2012	2013	2014	Difference in aALOS, 2009 to 2014 (95% CI)
White admissions								
All		5.42	5.31	5.27	5.13	5.04	4.97	−0.44 (−0.45 to −0.44)
Discharge destination	Home[3]	4.50	4.42	4.37	4.27	4.19	4.13	−0.37 (−0.37 to −0.37)
	Non-Home[4]	8.13	7.96	7.93	7.69	7.57	7.50	−0.64 (−0.64 to −0.64)
Black admissions								
All		5.67	5.55	5.51	5.38	5.31	5.21	−0.46 (−0.46 to −0.46)
Discharge destination	Home[3]	4.76	4.67	4.61	4.50	4.43	4.35	−0.41 (−0.41 to −0.41)
	Non-Home[4]	8.28	8.05	8.08	7.93	7.85	7.77	−0.51 (−0.51 to −0.51)
Hispanic admissions								
All		5.37	5.25	5.22	5.07	4.96	4.93	−0.44 (−0.44 to −0.44)
Discharge destination	Home[3]	4.54	4.44	4.40	4.27	4.19	4.15	−0.39 (−0.39 to −0.39)
	Non-Home[4]	8.00	7.83	7.88	7.65	7.49	7.47	−0.52 (−0.52 to −0.52)
Low SES admissions[5]								
All		5.50	5.40	5.35	5.20	5.11	5.05	−0.46 (−0.46 to −0.46)
Discharge destination	Home[3]	4.62	4.52	4.46	4.33	4.27	4.21	−0.41 (−0.41 to −0.41)
	Non-Home[4]	8.13	7.97	7.99	7.79	7.64	7.60	−0.53 (−0.53 to −0.53)
High SES admissions[6]								
All		5.39	5.27	5.23	5.11	5.00	4.91	−0.48 (−0.48 to −0.48)
Discharge destination	Home[3]	4.48	4.39	4.35	4.26	4.17	4.10	−0.38 (−0.38 to −0.38)
	Non-Home[4]	8.16	7.95	7.88	7.65	7.52	7.36	−0.79 (−0.79 to −0.79)

[1]ALOS calculated using 2 multi-variate generalized linear models treating length of stay as a gamma-distributed variable. Model 1 assessed race/ethnicity as the exposure, and controlled for age, sex, health insurance type (Medicare, Medicaid, private insurance, or self-pay), indicator of weekend admission, urgency of admission (elective, emergent, urgent, or other), number of chronic conditions, Elixhauser-related mortality score, and individual intercepts for time-year, diagnosis-related group, and hospital, with standard errors clustered at hospital level. Model 2 assessed SES as its exposure, with the same control variables as Model 1.
[2]P-value for trend across all admissions by discharge destination was less than 0.001.
[3]Home defined as discharge to home with or without home services.
[4]Non-Home defined as discharge to either acute rehabilitation, skilled nursing facilities, long-term acute care hospitals.
[5]Low SES admissions are defined as patient admissions falling in the first quartile of median income by patient zip code.
[6]High SES admissions are defined as patient admissions falling in the fourth quartile of median income by patient zip code.

dataset of medical and surgical admissions from diverse states in the US which allowed us to detect aALOS differences, compared to studies which have examined racial/ethnic and SES differences within only specific diseases or procedures.[11,12,30-32] Second, because our analysis controlled for differences in admission diagnoses using DRGs our findings have broader applicability to policies focused on LOS metrics at the ward and hospital level, rather than for individuals diagnoses. Third, our findings demonstrate that like previous studies examining trends in LOS in general,[31,33] there is a general decline in adjusted LOS across the study time period by race/ethnicity and SES (Table 3). These declines were seen regardless of discharge destination. However, our analysis highlights that these improvements are unequal, and favor White patients relative to minority patients, and high SES patients relative to low SES patients.

Third, neither racial/ethnic nor SES differences were not seen in analyses of trends for individual medical and surgical diagnoses of policy importance. This may reflect the concerted attempts by hospitals (e.g., discharge protocols,[34,35] checklists,[35] care management[36]) to manage quality outcomes, processes and health-related outcomes in these patient subgroups because of related financial penalties. Furthermore, observed racial/ethnic and SES differences in aALOS may reflect the case mix at the ward-level. This is not surprising, given the literature focused on improving patient LOS has focused on large-scale, organizational mechanisms such as patient flow, communication strategies, rather than individual diagnoses, which have little practical applicability on medical and surgical wards which house patients with various conditions.

We found that racial/ethnic and SES differences in aALOS range from 0.15 to 0.25 days for those discharged home, and from 0.10 to 0.35 days for those discharged elsewhere. Given that previously studied strategies to lower average adjusted LOS across wards and healthcare systems led to reductions in average LOS by 0.3 to 0.7 days,[21,22,24] these persistent differences in aALOS along racial/ethnic socioeconomic lines may be both clinically consequential to patients and financially important for hospitals.

It is unclear why racial/ethnic and SES differences in aALOS remained stable for patients discharged home over the study period but increased for discharges to non-home destinations. The relationship between LOS and discharge to non-home destinations is complex. Patients who spend more time in hospital may be sicker, be subject to more procedures and testing, and thus be subject to more deconditioning. As a result, they may require more intense rehabilitation services to regain sufficient functional improvement before returning to the community. Moreover, discharge to home vs non-home destinations is subject to insurance pre-authorization, patient preferences, and may also depend upon sufficient caregiver support for safe discharge.

Our analysis suggested an inflection point in time where aALOS differences by race/ethnicity and SES begin increasing, starting after Q3 2011. Our study period overlaps with the 2011 Affordable Care Act's (ACA) introduction. As part of its suite of policy changes, Center of Medicare and Medicaid Services introduced its Hospital Readmission Reduction Program (HRRP). The HRRP penalized hospitals for higher than anticipated readmissions across 3 targeted conditions, pneumonia, heart failure, and AMI (COPD, coronary artery bypass graft surgery, and elective TKR/THR were added later). Analyses from the HRRP revealed that despite its introduction in October 2012, anticipatory effects related to the changes in hospital adjusted readmission rates began as early as 2011 after the passage of the ACA.[37] Furthermore, the effects of the HRRP extend beyond only Medicare Fee-for-service patients to other payer groups,[38] and non-targeted conditions.[39] Longer LOS has been associated with lower readmission rates in coronary disease,[40] in heart failure,[20] in COPD,[41] and in the general medical and surgical population.[42] However, other studies have demonstrated an inverse,[43-45] or inconsistent relationship for patients discharged to skilled nursing facilities.[46] Whether this policy may be associated with the change in trends of aALOS differences for non-home discharged patients observed in this analysis requires further study.

This study had 5 limitations. First, our data is limited to only 3 states. However, the states included in our study have large, diverse populations that should make our findings generalizable. Second, we used an area-based SES measure rather than an individual measure. Area-based SES measures have been shown to have limited validity when compared to composite measures of SES at the individual level, which employ measures of social capital, educational status, and employment.[47] Sadly, the SES variables available in the SID from HCUP limit more detailed analyses. As data collection focused on individual-level socioeconomic information continues to improve, researchers may in the future undertake more nuanced SES-related analyses. Third, the lack of a direct SES measure may also confound the estimated relationship between race/ethnicity and aALOS. Fourth, we did not have information on patient preferences or caregiver support which may influence a patient's discharge destination, despite controlling for a number of patient, disease, and hospital-related factors. And lastly, we were not directly able to control for other confounding variables between race/ethnicity, SES and LOS because they were not available in our dataset. This includes prior utilization, which has been shown to be associated with worsening severity of underlying illness, and LOS.[48]

Further research should examine the drivers of increasing differences in aALOS associated with race/ethnicity and SES, including whether hospital-based healthcare policies implemented during the study time period, possibility coinciding with the introduction of ACA, may have been associated with the differences observed in this study.

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Declaration of Conflicting Interests

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Supplemental Material

Supplemental material for this article is available online.

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