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Trends in the utilization of emergency departments in California, 2005-2015: a retrospective analysis

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ABSTRACT

Objectives: To examine current trends and characteristics of patients visiting the ED in order to identify changes in the patient population and detect potential unmet needs in the healthcare system.

Design: A retrospective study.

Setting: We analyzed ED utilization trends between 2005-2015 in California using non-public patient data from California's Office of Statewide Health Planning and Development.

Participants: We included all ED visits in California from 2005 to 2015.

Primary and Secondary Outcome Measures: We analyzed ED visits and visit rates by age, sex, race/ethnicity, payer, and urban/rural trends. We further examined age, sex, race/ethnicity, and urban/rural trends within each payer group for a more granular picture of the patient population. Additionally, we looked at proportion of patients admitted from the ED and distribution of diagnoses.

Results: Between 2005-2015, the number of ED visits increased from 10.2 to 14.2 million in California. ED visit rates increased by 27.8% ($p<0.001$), with the greatest increases among patients aged 5-19 (37.4%, $p<0.001$) and 45-64 years (41.1%, $p<0.001$), non-Hispanic black and Hispanic patients (56.8% and 48.8%, $p<0.001$), the uninsured and Medicaid-insured (36.1%, $p=0.002$; 28.6%, $p<0.001$), and urban residents (28.3%, $p<0.001$). The proportion of ED visits resulting in hospitalization decreased by 18.3%, with decreases across all payer groups.

Conclusions: Our findings reveal considerable unmet healthcare needs and suggest that policies or programs aimed at increasing regular healthcare access among specific patient groups may have the potential to lessen demands on EDs and improve overall healthcare delivery.

Keywords: emergency department; utilization; demand; healthcare delivery

STRENGTHS AND LIMITATIONS OF THIS STUDY

- To our knowledge, this is the first study that has granularly examined patient characteristics and ED use trends longitudinally using a statewide sample size.
- California's initiatives to increase Medicaid enrollment through the ACA and Low Income Health Programs (LIHP) provide a unique opportunity to study how patient characteristics and healthcare needs have changed over time under continual and gradual efforts to increase healthcare access.
- Our data are limited to California residents, potentially limiting the generalizability of our results despite California's diverse population.
- ED visit rates may be overestimated due to the fact that some populations who visit the ED frequently – including patients who are undocumented and homeless, or live in nursing homes, extended-care facilities, prisons, and mental health facilities – are not accounted for in the population denominator.

INTRODUCTION

Emergency departments (EDs) are an integral component of the United States (US) health care system, as they provide the only around-the-clock health care to all, regardless of a patient's ability to pay.[1-4] In the past two decades, the annual number of ED visits in the US has increased by 50%, while the number of EDs has decreased by 11%,[5] raising concerns about the ability of EDs to provide accessible care amidst the rise in demand for emergency care services. Appropriate allocation of resources to meet such demands may require greater focus on ED utilization trends, which reflect the changing patterns of patient healthcare needs and reveal possible factors – including patient conditions, healthcare reform, or insurance coverage changes – that may contribute to the increase in demand for emergency care.[6, 7]

Despite outpatient and primary care expansions and increased strategies aimed at reducing emergency care demand,[8-14] ED visits have continued to rise, with greater reliance on EDs to satisfy unmet needs and provide care unavailable in other parts of the healthcare system.[15] Previous literature suggest that older patients, minorities, lower-income patients, and Medicaid beneficiaries are more likely to use the ED,[16-18] and recent reports have continued to show substantial increases in ED utilization, especially among Medicaid-insured patients.[19-21] However, to our knowledge, no other studies in recent years have granularly examined patient characteristics and trends longitudinally – most studies are either focused on short-term study periods using limited sample sizes to evaluate the impact of the Affordable Care Act (ACA) or do not use appropriate measures to evaluate ED utilization relative to population changes.[22-25]

State-level examinations of the association between health insurance and ED use – particularly in the context of ACA reforms – have yielded complex and often conflicting results.[26] Although evaluating the impact of the ACA on healthcare utilization and outcomes

remains an important task, studies suggest that a more comprehensive assessment of how patient characteristics and healthcare needs have changed may help better design the necessary policies and programs to meet patients' healthcare needs. California's large and diverse population, as well as its initiatives to increase Medicaid enrollment through the ACA and Low Income Health Programs (LIHP) provide a unique opportunity to study how patient characteristics and healthcare needs have changed over time under continual and gradual efforts to increase healthcare access. Thus, we sought to examine state-level trends in emergency care demand from 2005 to 2015 in California. Using state-level data, we analyzed patient age, sex, race/ethnicity, insurance status, and region of care to examine where emergency care demands are most critical and where future resources may be directed to improve care and lessen ED utilization.

METHODS

Study Design and Data Sources

We obtained 2005-2015 non-pubic Patient Discharge Data (PDD), Emergency Department Discharge Data (EDD), Hospital Annual Financial Data, and Hospital Annual Utilization Data from California's Office of Statewide Health Planning and Development (OSHPD), which conducts annual, standardized surveys required of all hospitals and health service facilities in California.[27, 28] To account for changes in California's population over time, we calculated annual ED utilization rates by age, sex, race/ethnicity, insurance payer, and urban/rural residence. We used annual age and sex population estimates provided by the US Census Bureau;[29, 30] state population insurance coverage estimates from the Current Population Survey's Annual Social and Economic Supplements (for the years 2005-2012) and American Community Survey (for the years 2013-2015);[31, 32] and race/ethnicity population

estimates from the California Department of Finance (for the years 2005-2009) and the US Census Bureau (for the years 2010-2015).[33, 34]

Inclusion Criteria and Variable Definition

We included all ED visits in California from 2005 to 2015, and classified ED visits as inpatient if the visit resulted in a hospital admission and outpatient if the visit resulted in treatment-and-release without admission. We designated hospitals as urban or rural based on the corresponding county listed in the non-public PDD documentation.

Statistical Analysis

We analyzed ED visits and visit rates for significant trends in California from 2005 to 2015 by age group (<5 years, 5-19 years, 20-64 years, and 65 years and over); sex (male, female, unknown); race/ethnicity group (non-Hispanic white, non-Hispanic black, Hispanic, Other); payer/insurance status (private, Medicare, Medicaid, uninsured/self-pay, other, unknown); and metropolitan statistical area (rural or urban). Furthermore, we looked at age, sex, race/ethnicity, urban/rural trends by payer for a more granular picture of patient population differences within each insurance group. We obtained International Classification of Disease, 9th Revision, Clinical Modification (ICD-9-CM) codes for principal hospital discharge diagnoses, and categorized them into multi-level diagnoses codes using the Agency for Healthcare Research and Quality's Clinical Classification Software (CCS) to examine changes in conditions observed in the ED over time. We performed all analyses using Stata software (version 14, Stata Corporation, College Station, TX). The University of California, San Francisco Institutional Review Board deemed this study exempt from human subjects review.

RESULTS

Between 2005 and 2015, total annual ED visits in California increased by 39.7% ($p<0.001$), from 10.2 million to 14.2 million (Table 1). ED utilization in California gradually increased across most years in the study period, with two pronounced jumps from 2008 to 2009 (8.1%) and 2014 to 2015 (6.3%). The number of ED visits grew the most among patients aged 45-64 (55.8%; $p<0.001$), female patients (42.5%; $p<0.001$), Hispanic patients (78.4%; $p<0.001$), Medicaid beneficiaries (151.0%; $p=0.001$), and those living in urban areas (40.5%; $p<0.001$).

After adjusting for the 9.3% population growth in California during our study period, we found an overall 27.8% ($p<0.001$) increase in ED visit rates between 2005 and 2015 (Table 2), with significant increases among all patient characteristics examined. In 2015, ED visit rates were the highest among patients aged less than 5 and 65 and over (543 visits and 503 visits per 1,000 California residents aged less than 5 and 65 and over, respectively), non-Hispanic black patients (703 per 1,000), Medicaid-insured patients (747 per 1,000), and rural residents (501 per 1,000). ED visit rates grew the fastest among patients aged 5-19 and 45-64 (37.4% increase, from 196 to 270 per 1,000; and 41.1% increase, from 101 to 142 per 1,000 – in particular, a 232% increase among Medicaid-insured 45-64-year-olds – see Appendix; $p<0.001$ for both), uninsured patients (36.1% increase, from 242 to 330 per 1,000; $p=0.002$), and urban residents (28.3% increase, from 281 to 361 per 1,000; $p<0.001$). Although non-Hispanic black patients had a strikingly higher ED visit rate in 2015, both non-Hispanic black and Hispanic patients experienced similar high levels of ED visit rate growth (56.8% increase, from 448 to 703 per 1,000; and 48.8% increase, from 237 to 353 per 1,000; $p<0.001$ for both) during the study period.

When examining ED discharge and hospital admission trends, the number of ED visits resulting in a discharge ("treat-and-release") increased by 44.5%, from roughly 8.6 to 12.4

million, and the number resulting in a hospital admission increased by 14.2%, from roughly 1.6 million to 1.9 million during the study period. The proportion of ED visits that resulted in a discharge increased by 3.5% from 84.0% of ED visits in 2005 to 86.9% in 2015, while the proportion that resulted in a hospital admission decreased by 18.3% from 16.0% of ED visits in 2005 to 13.1% in 2015 (Figure 1).

ED Visit Patient Composition Trends by Payer

Although ED visit rates increased across all payer groups, the proportion of ED visits from private and uninsured patients decreased by 24.0% (from 35.0% to 26.6%) and 50.1% (from 15.4% to 7.7%), respectively, while the proportion of ED visits from Medicare- and Medicaid-insured patients increased by 13.1% (from 18.7% to 21.1%) and 79.7% (from 22.9% to 41.1%), respectively, during the study period (Figure 2).

We further examined payer composition trends by looking at ED visits resulting in a hospital admission. The number of ED visits resulting in hospitalization grew for Medicaid- (72.0%) and Medicare-insured (18.5%) patients but declined for privately insured (-8.3%) and uninsured (-71.3%) patients. However, we found that the proportion of all ED visits resulting in hospitalization reduced across all payer groups, with decreases of 13.6% for the privately insured, 31.4% for the Medicaid-insured, 25.0% for the Medicare-insured, and 58.8% for the uninsured.

ED Visit Trends by CCS Diagnoses

When we analyzed ED visits by multi-level CCS diagnosis groups, we found that the number of ED visits increased across all CSS diagnoses except for the unclassified conditions group (Figure 3). The top 5 conditions for which ED visits grew the most included infectious and

parasitic diseases (88.2%), diseases of the blood and blood-forming organs (78.7%), mental illness (70.8%), diseases of the musculoskeletal system (64.2%), and diseases of the genitourinary system (60.7%). However, the top 5 most prevalent conditions during the study period were injury and poisoning (20.8%), diseases of the respiratory system (12.8%), ill-defined conditions (12.5%), diseases of the nervous system (8.8%), and diseases of the circulatory system (8.3%).

DISCUSSION

Between 2005 and 2015, ED visit rates increased by 27.8% in California, with the greatest ED visit rate growth among patients aged 5-19 and 45-64 years old, uninsured and Medicaid-insured patients, non-Hispanic black and Hispanic patients, and patients living in urban areas. Despite relatively slower ED visit rate growth trends, the youngest (less than 5 years) and elderly (65 and over) patient cohorts and Medicare-insured patients retained high ED visit rates throughout the study period. Our findings are consistent with prior studies, which have shown high ED utilization by Medicaid-insured, urban-residing, and elderly patients.[14, 17, 18, 35-38] Our findings follow the same increasing trends found in previous investigations of ED utilization trends in California, especially among Medicaid-insured patients;[21, 25] however, our study purposefully includes granular age groups, sex, race/ethnicity, and urban/rural status in addition to payer groups, and employs demographic-specific population measures in order to provide a comprehensive picture of how ED patient demographics have changed relative to the population over the past decade. Compared to ED visit trends in the United States, California experienced a much higher increase in ED visits (31.5% vs. 14.8%) from 2006-2014, but still retained a much lower ED visit rate in 2014 (345 vs 432 per 1,000).[19] California is especially unique in that it is among one of the highest Medicaid-insured states in the country, and has

taken initiatives to increase healthcare access through the ACA and LIHP. Our study provides an opportunity to see how insurance-based initiatives can provide insight into current gaps in the healthcare system and the population's changing healthcare needs.

We observed increasing trends in ED visits among patients aged 45-64, who had the greatest ED utilization rate increase, but the lowest overall ED visit rate, which suggests that patients nearing 65 may have increasingly higher health care needs. Our findings of a 232% increase in absolute visits from Medicaid suggests that individuals who have not yet "aged-in" to Medicare and do not have the means to pay for private insurance may have significant health care needs. There has been evidence of sharp increases in healthcare utilization once patients turn 65 years old,[39] which highlights the tendency for elderly healthcare needs to arise before age 65, and the delayed care resulting from Medicare's age limit. Moreover, given the healthcare needs of patients nearing 65 years old, and Medicare and Medicaid's different purposes and restrictions, shifting the cost of care from Medicaid to Medicare may allow for patients to receive the appropriate treatment, since care received is often influenced by insurance, which could improve overall health outcomes.

Although patients aged 45-64 had the greatest ED visit rate growth, patients aged less than 5 had the highest ED utilization rate as of 2015, outpacing the ED utilization rate for patients 65 and over. This finding, along with the high ED visit rate growth for patients aged 5-19, suggests increasing need for pediatric emergency care. Higher ED utilization by pediatric patients incite the need to re-examine current trends in the availability of EDs equipped to treat children and reorganize ED care to better treat this population. Our finding of high ED utilization rates by pediatric patients could also point to potential barriers in obtaining regular care, which is often difficult for publicly-insured and uninsured patients. Underinsured patients have been

shown to have high ED utilization,[40] and policies aimed at creating more accessible care for underinsured pediatric patients may lessen the demands on EDs.

Meanwhile, patients aged 65 and over retained high steady ED visit rates, which is expected given their high and complex healthcare needs.[37, 38, 41, 42] A portion of these visits, for example, may be a result of providers who refer patients to the ED to receive more advanced acute care not necessarily available in other parts of the health care system,[4, 43] increasing the number of elderly patients with inpatient hospital visits originating from the ED. The consistent high ED utilization trends and current trends in physician referral practices point to a need for improving geriatric care at a systematic level to treat elderly patients effectively and in a timely manner. Previously reported improvements in access to primary care and decreases in delays for seeking outpatient care may partially explain the trends in ED visit rates by Medicare-insured patients,[44] where we observed an overall slow increase in ED visit rates from 2005 to 2015, with slight decreases between 2012 and 2014. Improvements in services available to Medicare patients, including preventative screening and chronic disease management, could have offset some of the demand for ED care among this patient demographic.[17] Although early data suggest that recent Medicare reforms[45, 46] have led to decreases in health care spending[47, 48] and improvements in patients' experience in timely access to non-urgent care,[49] further research may be necessary to determine if primary care access has been truly improved for Medicare-insured patients and whether such improvements can decrease ED utilization overtime.

Current trends show increasingly higher ED visit rates for non-Hispanic black and Hispanic patients, which likely ties in with our findings of increased ED visit rates in urban areas and among uninsured and Medicaid-insured patients as non-Hispanic black and Hispanic populations tend to reside in urban areas and have high rates of Medicaid insurance and un-insurance.[50, 51] Although we found similar ED visit rates between non-Hispanic white and

Hispanic patients, it is possible that the observed number of ED visits by Hispanic patients is overall lower because this demographic may be more likely to avoid visiting the ED for reasons such as language barriers, fear of deportation, and other cultural factors.[52, 53] These trends illustrate substantial gaps in the healthcare system overall, as many patients may have previously avoided seeking care due to lack of health insurance, and suggest that although healthcare access has increased to some extent, disparities still exist,[54] and unmet healthcare needs persist as EDs, acting as "safety nets," continue to provide increasingly more care.

Prior studies have reported high ED utilization rates among Medicaid-insured and uninsured patients,[14, 17, 18, 35, 36] consistent with our findings of large ED visit rate increases by these payer groups. Our findings could reflect a number of trends. First, the use of EDs as "safety nets" has been previously reported,[17, 55] with one study reporting that more than 50% of all acute visits by uninsured patients were sent to emergency physicians, who comprise less than 5% of all physicians in the US[56, 57] Second, difficulty in accessing primary care has been widely cited as a potential source for the increasing trends of ED use by Medicaid-insured patients.[9, 17, 35] Despite initiatives such as the ACA designed to provide low-income individuals with health care access, Medicaid-insured patients increasingly seek care in the ED as a result of untimely access to primary and specialty care,[15] which largely has been attributed to the reluctance of many primary care providers to accept Medicaid insurance due to low reimbursement rates.[9, 58-60] At the same time, however, increasing literature shows that even patients with adequate primary care access are often referred to the ED by their primary care physicians,[24] suggesting that physicians themselves are also relying on the emergency care system to help diagnose and manage patients. Last, the utilization of EDs over other ambulatory care venues by patients of low socioeconomic status is influenced not only by insurance status or affordability, but also by accessibility, availability, perceptions of accommodation, and high

disease burden.[61, 62] These factors are important to consider when exploring potential solutions to improve the accessibility, provision, and quality of care.

Despite increasing numbers of ED visits, the proportion of ED visits resulting in inpatient admissions decreased. Prior studies have indicated that high numbers of complex and urgent patients are being managed in EDs,[63-65] and the decreases in the proportion of admissions seen in our study could indicate that patients with complex conditions are being evaluated, treated, and discharged from the ED rather than being admitted or cared for elsewhere. Although this has potential benefits to healthcare systems, management of high-acuity outpatients in the ED could further contribute to the demands on EDs.

Other changes in ED visit trends included decreases in the proportion of ED visits for conditions related to poisoning/injury, and increases in medical conditions, including infectious/parasitic diseases and mental illness. Consistent with prior literature noting a decrease in ED visit rates for injuries in California from 2005-2011, but an increase for non-injury diagnoses,[66] our findings reveal the changing role of the ED in the health care system, where EDs are treating and providing care for more complex medical conditions. The rise in ED visits for such conditions suggests a need to shift resources to provide care that individuals seeking care in the ED might have trouble finding in other parts of the healthcare system. For example, increasing resources such as mental health professionals and psychiatric inpatient beds may be one solution to reduce the burden of mental health visits on EDs. As chronic illnesses increase in the US[67] and the management of these conditions becomes more complex, it becomes increasingly important to expand services and access to treatments for conditions that drive ED utilization and demand for emergency care.

Limitations

Our study includes several limitations. First, OSHPD collects self-reported data from hospitals, which could introduce potential reporting errors or missing data; however, hospitals submit routine accuracy checks which reduce such errors. Second, our data are limited to California residents and may limit the generalizability of our results despite California's diverse population. Third, US Census Bureau surveys exclude undocumented and homeless populations, as well as individuals residing in nursing homes, extended-care facilities, prisons, and mental health facilities. Many of these individuals visit the ED on a frequent basis, and thus ED visit rates could be overestimated because many of these people are not accounted for in the population denominator.

CONCLUSIONS

Our findings suggest that trends in the demand for emergency care continue to rise and remain at critical levels. ED visit rates in California increased from 2005-2015, across all age groups, and particularly among the uninsured, Medicaid-insured, non-Hispanic black, Hispanic, and urban-residing patients. Increased ED visit rates by Medicaid-insured and uninsured patients may reflect previously and persisting unmet healthcare needs and current limitations in access to care in other parts of the healthcare system. Furthermore, changes in conditions seen in the ED suggest that patient healthcare needs are becoming increasingly great and complex. Rather than focusing solely on efforts to reduce ED use, policymakers may need to recognize that EDs are playing an increasingly vital role in the provision of care and consider ways to incorporate this changing reality into the delivery of health services.

AUTHORS' CONTRIBUTIONS

RYH and MJN contributed to the conception and design of the study. SS and TJN drafted the manuscript. MJN and JG contributed to the analysis of data. RYH provided supervision. RYH, SS, JG, TJN, and MJN contributed to the interpretation of the data and critically reviewed, revised, and approved the manuscript.

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COMPETING INTERESTS STATEMENT

None declared.

ETHICAL APPROVAL

The University of California, San Francisco Committee on Human Research approved this study.

PATIENT CONSENT

Not applicable.

DATA SHARING STATEMENT

The data are available through the California Office of Statewide Health Planning and Development.

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FIGURE LEGEND

Figure 1

Caption: Proportion of discharged and admitted emergency department visits, 2005-2015

Source: Authors' analysis of Emergency Discharge Data and Patient Discharge Data from the California Office of Statewide Health Planning and Development, 2005-2015.

Figure 2

Caption: Proportion of emergency department visits by payer, 2005-2015

Source: Authors' analysis of Emergency Discharge Data and Patient Discharge Data from the California Office of Statewide Health Planning and Development, 2005-2015

Figure 3

Caption: Emergency department visits by diagnosis, 2005-2015

Source: Authors' analysis of Emergency Discharge Data from the California Office of Statewide Health Planning and Development, 2005-2015

Table 1. Descriptive characteristics of emergency department visits, 2005-2015

Characteristic	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	% Change	P-value
Total ED visits	10187048	10172173	10476830	10777904	11654758	11564940	11960916	12407787	12717983	13379768	14228961	39.7%	<0.001
Age group													
<5	1163718	1138675	1208600	1227060	1385661	1301325	1293277	1279965	1296007	1284076	1360921	16.9%	0.002
5-19	1543281	1508767	1548365	1580477	1850406	1704412	1748506	1768990	1851782	1926985	2060762	33.5%	<0.001
20-44	3540709	3503045	3567013	3621196	3858230	3857008	3984261	4158612	4238892	4546171	4817840	36.1%	<0.001
45-64	2169625	2224611	2321347	2441078	2596714	2671541	2794199	2939632	2997090	3197982	3379431	55.8%	<0.001
65+	1769715	1797075	1831505	1908093	1963747	2030654	2140673	2260588	2334212	2424554	2610007	47.5%	<0.001
Sex													
Male	4749677	4744206	4870474	4982441	5361116	5305158	5478365	5674693	5821163	6111803	6533740	37.6%	<0.001
Female	5400871	5426867	5605380	5794994	6293259	6259489	6482298	6732782	6896402	7267461	7694688	42.5%	<0.001
Unknown	36498	1092	973	463	383	290	251	310	418	504	518	-98.6%	0.243
Race/Ethnicity													
NH White	4629083	4678727	4803242	4882971	5136236	5101499	5215676	5364074	5343623	5473429	5670856	22.5%	<0.001
NH Black	995223	1039629	1103005	1163257	1282527	1298439	1349509	1413949	1427593	1497705	1566555	57.4%	<0.001
Hispanic	3003407	3087315	3289467	3489075	3983295	3913063	4120055	4314009	4580423	4911172	5358365	78.4%	<0.001
Other	853928	897019	952814	971168	1060702	1086787	1123314	1160613	1200721	1303590	1447204	69.5%	<0.001
Payer													
Private	3568181	3524078	3607646	3671131	3831600	3596830	3682133	3749377	3635780	3781082	3788784	6.2%	0.002
Medicaid	2330998	2328948	2475271	2652643	3114505	3117815	3229952	3362952	3629446	4858001	5849956	151.0%	0.001
Medicare	1901449	1961387	2021499	2136053	2213792	2329984	2470110	2642609	2728514	2839188	3002826	57.9%	<0.001
Uninsured/self-pay	1569042	1621182	1677550	1697604	1823444	1838886	1882198	1892743	1909953	1386455	1093733	-30.3%	0.527
Other	813974	734799	691266	617190	669627	679615	694036	757560	810812	511859	488805	-39.9%	0.112
Unknown	3404	1779	3598	3283	1790	1810	2487	2546	3478	3183	4857	42.7%	0.307
MSA													
Urban	9833448	9820399	10126757	10425976	11289497	11207639	11601631	12046167	12345194	12994568	13814543	40.5%	<0.001
Rural	353600	351774	350073	351928	365261	357301	359285	361620	372789	385200	414418	17.2%	0.010

Table 2. Emergency department visit rates (per 1000 population), 2005-2015

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	% Change	P-value
Total ED visit rate	284.3	282.4	289.0	294.4	315.3	309.8	317.3	326.0	331.1	344.9	363.5	27.8%	<0.001
Age group													
<5	455.4	448.4	474.8	479.1	544.5	514.3	510.3	508.8	518.5	512.9	542.5	19.1%	<0.001
5-19	195.7	191.3	196.7	200.4	234.0	215.8	223.4	227.3	239.0	250.1	268.9	37.4%	<0.001
20-44	266.9	264.9	270.7	274.5	291.9	290.0	296.3	306.0	309.2	328.6	346.4	29.8%	<0.001
45-64	100.7	102.4	106.1	110.5	116.2	118.1	121.8	127.0	128.3	135.5	142.1	41.1%	<0.001
65+	461.0	464.1	464.0	470.3	471.5	474.8	485.9	490.6	486.6	486.2	503.0	9.1%	<0.001
Sex													
Male	266.4	264.7	270.1	273.6	291.7	285.9	292.5	300.1	305.1	317.2	336.0	26.2%	<0.001
Female	300.1	299.9	307.7	315.0	338.7	333.3	341.7	351.6	356.7	372.2	390.6	30.1%	<0.001
Race/Ethnicity													
NH White	294.5	299.4	308.8	315.3	336.8	339.6	347.9	358.2	357.4	366.8	381.1	29.4%	<0.001
NH Black	448.2	469.0	497.7	524.7	581.5	593.7	615.1	642.3	646.9	675.1	702.9	56.8%	<0.001
Hispanic	237.1	238.9	249.5	259.5	288.8	278.1	287.8	296.8	310.6	328.0	352.9	48.8%	<0.001
Other	185.3	191.6	199.8	199.9	214.7	211.3	213.6	215.7	217.6	230.2	249.2	34.4%	<0.001
Payer													
Private	171.0	166.2	168.9	174.7	196.9	180.1	186.5	181.8	186.1	184.6	181.4	6.1%	0.012
Medicaid	580.9	574.7	596.5	605.6	611.2	638.0	623.6	654.1	645.2	731.6	747.3	28.6%	<0.001
Medicare	459.2	490.6	492.0	501.3	497.7	496.4	516.7	539.1	529.8	528.7	536.9	16.9%	<0.001
Uninsured/self-pay	242.2	251.5	263.6	255.8	249.0	254.4	253.5	278.9	293.8	290.8	329.7	36.1%	0.002
MSA													
Urban	281.0	279.1	286.0	291.5	312.6	307.2	314.8	323.6	328.5	342.3	360.6	28.3%	<0.001
Rural	425.7	421.8	418.7	419.9	435.1	425.0	429.0	434.7	451.0	466.3	500.8	17.6%	0.010

Note: ED visit rate denominator includes the population of the corresponding characteristic (e.g. ED visits by male patients in given year/total male population in given year in CA).

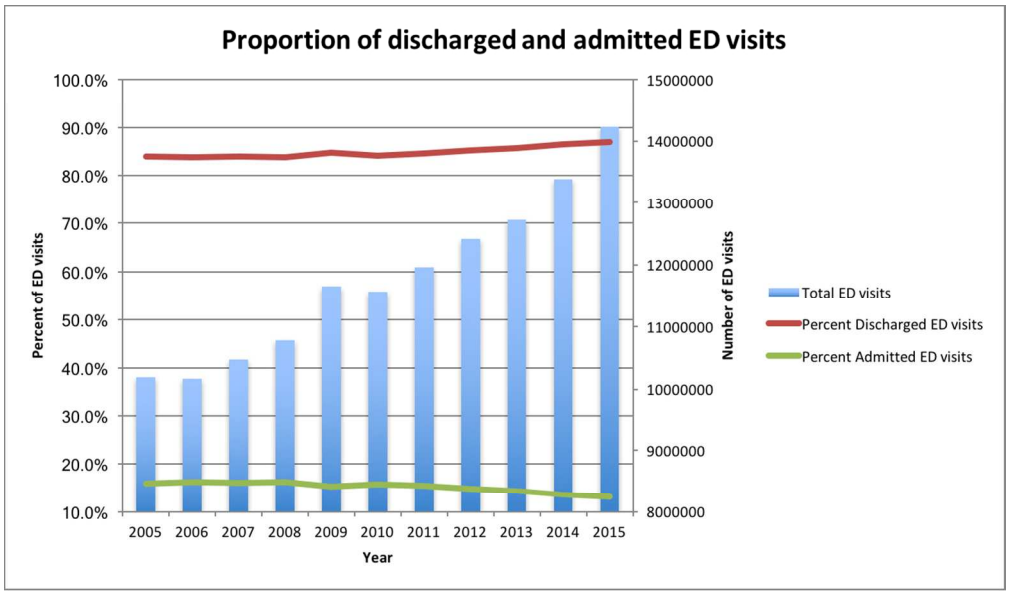

Figure 1. Proportion of discharged and admitted emergency department visits, 2005-2015 *Source: Authors' analysis of Emergency Discharge Data and Patient Discharge Data from the California Office of Statewide Health Planning and Development, 2005-2015*

111x65mm (300 x 300 DPI)

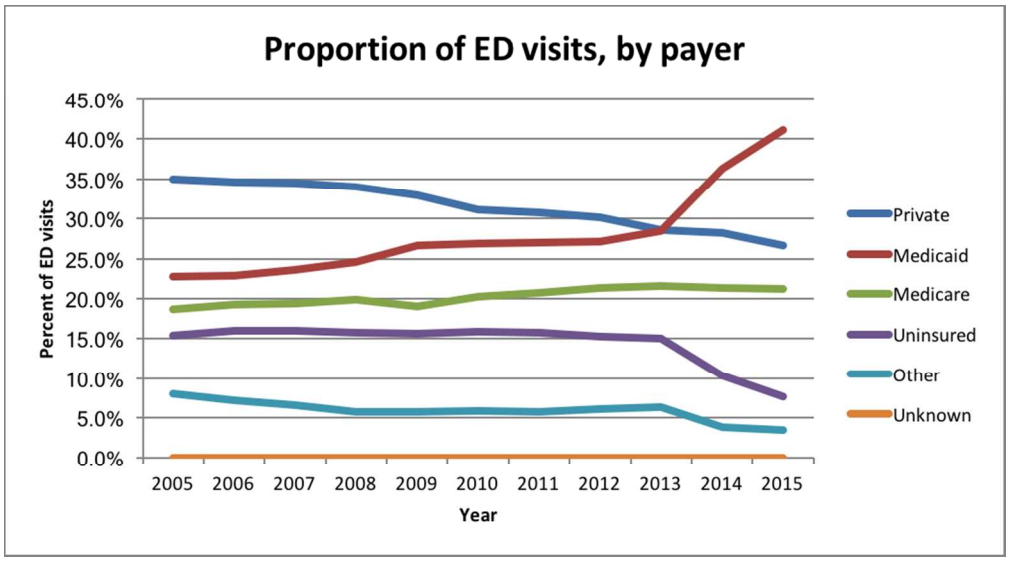

Figure 2. Proportion of emergency department visits by payer, 2005-2015 *Source: Authors' analysis of Emergency Discharge Data and Patient Discharge Data from the California Office of Statewide Health Planning and Development, 2005-2015*

88x48mm (300 x 300 DPI)

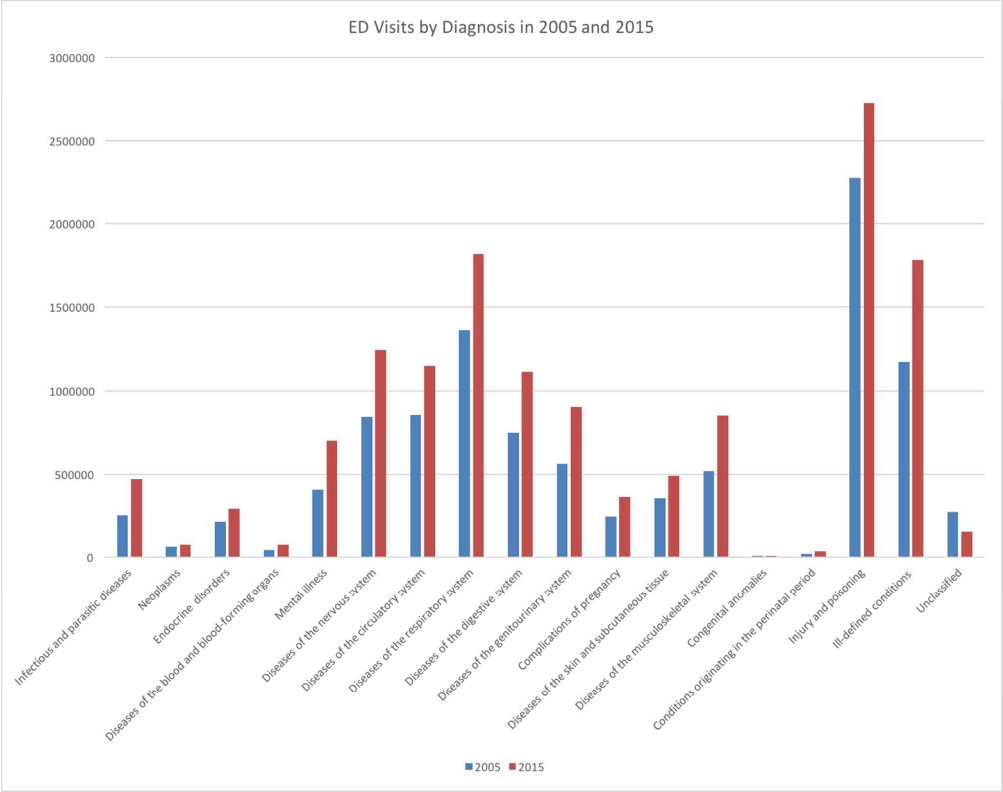

Figure 3. Emergency department visits by diagnosis, 2005-2015 *Source: Authors' analysis of Emergency Discharge Data from the California Office of Statewide Health Planning and Development, 2005-2015*

129x102mm (300 x 300 DPI)

APPENDIX

Table A. Emergency department visit trends 2005-2015, privately insured

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	% Change
Age group, years												
<5	429459	408964	425124	430059	459516	418544	410245	391188	361352	340709	323370	-24.70%
5-19	708116	687035	692650	705363	793381	711824	723207	711686	669511	657252	638977	-9.76%
20-44	1346838	1326662	1345311	1351430	1363911	1281028	1337662	1387663	1362165	1460033	1466015	8.85%
45-64	937683	950346	983027	1011740	1036109	1016319	1034170	1078507	1056692	1130772	1157000	23.39%
65+	146085	151071	161534	172539	178683	169115	176849	180333	186060	192316	203422	39.25%
Sex												
Male	1663208	1644771	1683651	1703166	1770583	1651551	1690084	1709483	1652877	1712209	1737064	4.44%
Female	1900535	1878899	1923691	1967771	2060874	1945181	1991951	2039774	1982812	2068747	2051590	7.95%
Race/Ethnicity												
White	1735384	1764498	1829347	1838610	1889460	1763218	1787345	1804017	1742043	1764406	1728905	-0.37%
Black	259335	274790	290607	294616	314387	301938	312298	322555	305612	308854	303153	16.90%
Hispanic	819647	859756	926181	981879	1087422	1016798	1064338	1094322	1066446	1144353	1166619	42.33%
Other	330650	366942	401212	413098	446058	433656	447306	456385	449984	479157	506248	53.11%
Unknown	423165	258092	160299	142928	94273	81220	70846	72098	71695	84312	83859	-80.18%

Table B. Emergency department visit trends 2005-2015, Medicaid insured

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	% Change
Age group, years												
<5	542614	544552	593483	628214	747939	717052	718256	724611	768987	780620	888449	63.73%
5-19	522055	514867	545227	586634	747137	710344	745759	776316	903245	1009845	1190903	128.12%
20-44	793956	788866	824338	878460	1010731	1054531	1098763	1159400	1216910	1860400	2327443	193.15%
45-64	402904	413617	441945	484342	532408	557115	590926	625197	658112	1115845	1337561	231.98%
65+	69469	67046	70278	74993	76290	78773	76248	77428	82192	91291	105600	52.01%
Sex												
Male	957166	949817	1012699	1085992	1281902	1274150	1320155	1376332	1501034	2129754	2598751	171.50%
Female	1371554	1379005	1462442	1566587	1832524	1843597	1909759	1986582	2128339	2728127	3251043	137.03%
Race/Ethnicity												
White	731384	719852	754567	794179	895803	906345	922269	941378	960099	1382263	1669637	128.28%
Black	308077	319736	342370	377544	432888	438186	457551	482857	508968	680050	772846	150.86%
Hispanic	1048204	1060758	1151617	1254527	1534361	1511196	1590293	1676984	1866746	2389237	2903001	176.95%
Other	181239	181922	188889	188165	218784	232492	232486	235241	257996	360311	464135	156.09%
Unknown	62094	46680	37828	38228	32669	29596	27353	26492	35637	46140	40337	-35.04%

Table C. Emergency department visit trends 2005-2015, Medicare insured

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	% Change
Age group, years												
<5	8243	4200	5373	6251	5090	10439	10503	11613	13680	14754	12550	52.25%
5-19	10797	6279	6593	8337	7945	12708	14009	16263	19637	22658	21148	95.87%
20-44	143152	140675	148033	160620	167879	179749	188514	205036	206723	215200	212123	48.18%
45-64	275977	295922	318067	346547	370181	393129	420238	459603	477958	505885	522212	89.22%
65+	1463280	1514311	1543433	1614298	1662697	1733959	1836846	1950094	2010516	2080691	2234793	52.72%
Sex												
Male	821355	844714	867868	917990	950000	1006743	1066235	1142955	1189472	1240239	1318555	60.53%
Female	1077719	1116566	1153548	1218014	1263757	1323213	1403845	1499617	1538996	1598904	1684217	56.28%
Race/Ethnicity												
White	1222354	1258172	1299775	1346473	1382103	1441869	1510711	1599925	1624635	1663996	1742676	42.57%
Black	159263	170620	181588	198505	211765	224865	238157	257281	264718	277381	290440	82.37%
Hispanic	297507	315033	334522	371907	399036	431504	469415	517413	549923	583293	626736	110.66%
Other	156948	164791	176161	190060	197222	212005	231632	249920	268873	285875	315090	100.76%
Unknown	65377	52771	29453	29108	23666	19741	20195	18070	20365	28643	27884	-57.35%

Table D. Emergency department visit trends 2005-2015, uninsured

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	% Change
Age group, years												
<5	115388	120322	125362	114960	120588	107766	107416	105162	106741	101823	95770	-17.00%
5-19	199444	209014	216387	206858	222832	199173	194820	189107	189898	165966	143520	-28.04%
20-44	848935	887578	913148	931697	996065	1015494	1030280	1055437	1072956	777655	587183	-30.83%
45-64	346667	368433	385732	411485	451282	483683	515769	509668	504880	303459	227679	-34.32%
65+	58608	35835	36921	32604	32677	32770	33913	33369	35478	37552	39581	-32.46%
Sex												
Male	859641	890163	912620	922018	984241	994896	1018562	1026193	1028873	748368	603828	-29.76%
Female	705696	730669	764579	775460	839104	843907	863567	866453	880913	637901	489743	-30.60%
Race/Ethnicity												
White	593788	617404	649223	648562	697406	709652	710073	713594	695377	459614	335463	-43.50%
Black	178541	196121	209552	221673	242739	252220	260977	257628	244939	171578	137722	-22.86%
Hispanic	584084	626675	646508	659205	719615	712070	742101	745133	795756	610154	490429	-16.03%
Other	112259	119253	125578	125144	135331	141106	145983	148282	146588	120039	105257	-6.24%
Unknown	100370	61729	46689	43020	28353	23838	23064	28106	27293	25070	24862	-75.23%

STROBE 2007 (v4) checklist of items to be included in reports of observational studies in epidemiology*

Checklist for cohort, case-control, and cross-sectional studies (combined)

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-5
Objectives	3	State specific objectives, including any pre-specified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5-6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5-6
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	6
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	n/a
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6
Bias	9	Describe any efforts to address potential sources of bias	n/a
Study size	10	Explain how the study size was arrived at	6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6
		(*b*) Describe any methods used to examine subgroups and interactions	6
		(*c*) Explain how missing data were addressed	n/a
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed	n/a

		Cross-sectional study—If applicable, describe analytical methods taking account of sampling strategy	
		(*e*) Describe any sensitivity analyses	n/a
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7
		(b) Give reasons for non-participation at each stage	n/a
		(c) Consider use of a flow diagram	n/a
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	7-8
		(b) Indicate number of participants with missing data for each variable of interest	n/a
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	n/a
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	7
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	n/a
		Cross-sectional study—Report numbers of outcome events or summary measures	n/a
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	n/a
		(*b*) Report category boundaries when continuous variables were categorized	n/a
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	8-9
Discussion			
Key results	18	Summarise key results with reference to study objectives	9
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	14
Generalisability	21	Discuss the generalisability (external validity) of the study results	14
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	15

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.
Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Trends in the utilization of emergency departments in California, 2005-2015: a retrospective analysis

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Trends in the utilization of emergency departments in California, 2005-2015: a retrospective analysis

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ABSTRACT

Objectives: To examine current trends and characteristics of patients visiting the emergency department (ED) and identify changes in the composition of ED visits over time to better direct the allocation of acute care resources.

Design: A retrospective study.

Setting: We analyzed ED utilization trends between 2005 and 2015 in California using non-public patient data from California's Office of Statewide Health Planning and Development.

Participants: We included all ED visits in California from 2005 to 2015.

Primary and Secondary Outcome Measures: We analyzed ED visits and visit rates by age, sex, race/ethnicity, payer, and urban/rural trends. We further examined age, sex, race/ethnicity, and urban/rural trends within each payer group for a more granular picture of the patient population. Additionally, we looked at the proportion of patients admitted from the ED and distribution of diagnoses.

Results: Between 2005 and 2015, the annual number of ED visits increased from 10.2 to 14.2 million in California. ED visit rates increased by 27.8% ($p<0.001$), with the greatest increases among patients aged 5-19 (37.4%, $p<0.001$) and 45-64 years (41.1%, $p<0.001$), non-Hispanic Black and Hispanic patients (56.8% and 48.8%, $p<0.001$), the uninsured and Medicaid-insured (36.1%, $p=0.002$; 28.6%, $p<0.001$), and urban residents (28.3%, $p<0.001$). The proportion of ED visits resulting in hospitalization decreased by 18.3%, with decreases across all payer groups.

Conclusions: Our findings reveal an increasing demand for emergency care and may reflect current limitations in accessing care in other parts of the healthcare system. Policymakers may need to recognize the increasingly vital role that EDs are playing in the provision of care and consider ways to incorporate this changing reality into the delivery of health services.

Keywords: emergency department; utilization; demand; healthcare delivery

STRENGTHS AND LIMITATIONS OF THIS STUDY

- This study examines patient characteristics and emergency department (ED) use trends longitudinally using a dataset containing all ED visits for the state of California.
- California's initiatives to increase Medicaid enrollment through the Affordable Care Act and Low Income Health Programs provide a unique opportunity to study how patient characteristics and healthcare needs have changed over time under continual and gradual efforts to increase healthcare access.
- Our data are limited to California residents, potentially limiting the generalizability of our results despite California's diverse population.
- ED visit rates may be slightly overestimated due to the fact that some populations who visit the ED frequently – including patients who are undocumented and homeless, or live in nursing homes, extended-care facilities, prisons, and mental health facilities – are not accounted for in the population denominator.

INTRODUCTION

Emergency departments (EDs) are an integral component of the United States (US) health care system, as they provide the only around-the-clock health care to all, regardless of a patient's ability to pay.[1] In the past two decades, the annual number of ED visits in the US has increased by 50%, while the number of EDs has decreased by 11%,[2] raising concerns about the ability of EDs to provide accessible care amidst the rise in demand for emergency care services. Appropriate allocation of resources to meet such demands may require greater focus on ED utilization trends, which reflect the changing patterns of patient healthcare needs and reveal possible factors – including patient conditions, healthcare reform, or insurance coverage changes – that may contribute to the increase in demand for emergency care.[3,4]

Despite outpatient and primary care expansions and increased strategies aimed at reducing emergency care demand,[5-8] ED visits have continued to rise, with greater reliance on EDs to provide care that may be unavailable in other parts of the healthcare system.[9] Previous literature suggest that older patients, minorities, lower-income patients, and Medicaid beneficiaries are more likely to use the ED,[10] and recent reports have continued to show substantial increases in ED utilization, especially among Medicaid-insured patients.[11] However, most studies have either focused on short-term study periods using limited sample sizes to evaluate the impact of the Affordable Care Act (ACA) or have not incorporated measures to evaluate ED utilization relative to population changes.[12-15]

State-level examinations of the association between health insurance and ED use – particularly in the context of ACA reforms – have yielded complex and often conflicting results.[16] Although evaluating the impact of the ACA on healthcare utilization and outcomes remains an important task, our study provides a more comprehensive assessment of how patient characteristics and healthcare needs have changed over an 11-year period in California – one of

the largest and most diverse states in the country[17] – to help better design the necessary policies and programs to meet patients' healthcare needs. Additionally, California's initiatives to increase enrollment in Medicaid (a government health insurance program for qualified low-income or disabled people) through the ACA and Low Income Health Programs (LIHP) provide a unique opportunity to study how patient characteristics and healthcare needs have changed over time under continual and gradual efforts to increase healthcare access. Thus, we sought to examine state-level trends in emergency care demand from 2005 to 2015 in California. Using state-level data, we analyzed patient age, sex, race/ethnicity, insurance status, and region of care to examine where emergency care demands are most critical and where future resources may be directed to improve care and lessen ED utilization. We hypothesized that ED visit rates would increase between 2005 and 2015, particularly among minority, Medicaid-insured, and uninsured patients.

METHODS

Study Design and Data Sources

We obtained 2005-2015 non-public Patient Discharge Data (PDD), Emergency Department Data (EDD), Hospital Annual Financial Data, and Hospital Annual Utilization Data from California's Office of Statewide Health Planning and Development (OSHPD), which conducts annual, standardized surveys required of all hospitals and health service facilities in California.[18,19] To account for changes in California's population over time, we calculated annual ED utilization rates by age, sex, race/ethnicity, insurance payer, and urban/rural residence. We used annual age and sex population estimates provided by the US Census Bureau;[20,21] state population insurance coverage estimates from the Current Population Survey's Annual Social and Economic Supplements (for the years 2005-2012) and American

Community Survey (for the years 2013-2015);[22,23] and race/ethnicity population estimates from the California Department of Finance (for the years 2005-2009) and the US Census Bureau (for the years 2010-2015).[24,25]

Inclusion Criteria and Variable Definition

We included all ED visits in California from 2005 to 2015, and classified ED visits as inpatient if the visit resulted in a hospital admission and outpatient if the visit resulted in treatment-and-release without admission. All observation stays that initially came through the ED – whether they were admitted to the inpatient setting or discharged directly from the ED – were captured in our dataset. We designated hospitals as urban or rural based on the corresponding county listed in the non-public PDD documentation.

Patient Involvement

Patients were not involved in the development of the research question, outcome measures, or study design. We did not actively recruit patients for this study, and the results will not be disseminated to the study participants as we used unidentified data and have no way of contacting the patients.

Statistical Analysis

We analyzed ED visits and visit rates for significant trends in California from 2005 to 2015 by age group (<5 years, 5-19 years, 20-44 years, 45-64 years, and 65 years and over); sex (male, female, unknown); race/ethnicity group (non-Hispanic White, non-Hispanic Black, Hispanic, Other); payer/insurance status (private, Medicare, Medicaid, uninsured/self-pay, other, unknown); and metropolitan statistical area (rural or urban). Furthermore, we looked at age, sex,

race/ethnicity, urban/rural trends by payer/insurance status for a more granular picture of patient population differences within each insurance group. We obtained International Classification of Disease, 9th Revision, Clinical Modification (ICD-9-CM) codes for principal hospital discharge diagnoses for 2005-2014, and categorized them into multi-level diagnoses codes using the Agency for Healthcare Research and Quality's Clinical Classification Software (CCS) to examine changes in conditions observed in the ED over time. We clustered 2015 diagnoses into multi-level CCS categories using single-level CCS categorizations provided in the data, which accounted for the transition from ICD-9 to ICD-10 coding in October 2015. We performed all analyses using Stata software (version 14, Stata Corporation, College Station, TX). The University of California, San Francisco Institutional Review Board approved this study.

RESULTS

Between 2005 and 2015, total annual ED visits in California increased by 39.7% ($p<0.001$), from 10.2 million to 14.2 million (Supplementary Table 1). ED utilization in California gradually increased across most years in the study period, with two pronounced jumps from 2008 to 2009 (8.1%) and 2014 to 2015 (6.3%). The number of ED visits grew the most among patients aged 45-64 (55.8%; $p<0.001$), female patients (42.5%; $p<0.001$), Hispanic patients (78.4%; $p<0.001$), Medicaid beneficiaries (151.0%; $p=0.001$), and those living in urban areas (40.5%; $p<0.001$).

After adjusting for the 9.3% population growth in California during our study period, we found an overall 27.8% ($p<0.001$) increase in ED visit rates between 2005 and 2015 (Table 1), with significant increases among all patient characteristics examined. In 2015, ED visit rates were the highest among patients aged less than 5 and 65 and over (543 visits and 503 visits per 1,000 California residents aged less than 5 and 65 and over, respectively), non-Hispanic Black

patients (703 per 1,000), Medicaid-insured patients (747 per 1,000), and rural residents (501 per 1,000). ED visit rates grew the fastest among patients aged 5-19 (37.4% increase, from 196 to 269 per 1,000) and 45-64 (41.1% increase, from 101 to 142 per 1,000) ($p<0.001$ for both) – in particular, a 232% increase among Medicaid-insured 45-64-year-olds (Supplementary Table 2) – uninsured patients (36.1% increase, from 242 to 330 per 1,000; $p=0.002$), and urban residents (28.3% increase, from 281 to 361 per 1,000; $p<0.001$). Although non-Hispanic Black patients had a strikingly higher ED visit rate in 2015, both non-Hispanic Black and Hispanic patients experienced similar high levels of ED visit rate growth (56.8% increase, from 448 to 703 per 1,000; and 48.8% increase, from 237 to 353 per 1,000, respectively; $p<0.001$ for both) during the study period. See Supplementary Tables 3-5 for additional results on ED visits stratified by insurance groups (privately insured, Medicare insured, and uninsured, respectively).

When examining ED discharge and hospital admission trends, the number of ED visits resulting in a discharge ("treat-and-release") increased by 44.5%, from 8.6 million to 12.4 million, and the number resulting in a hospital admission increased by 14.2%, from roughly 1.6 million to 1.9 million during the study period. The proportion of ED visits that resulted in a discharge increased by 3.5% (from 84.0% of ED visits in 2005 to 86.9% in 2015), while the proportion that resulted in a hospital admission decreased by 18.3% (from 16.0% of ED visits in 2005 to 13.1% in 2015; Figure 1).

ED Visit Patient Composition Trends by Payer

Although ED visit rates increased across all payer groups, the proportion of ED visits from private and uninsured patients decreased by 24.0% (from 35.0% to 26.6%) and 50.1% (from 15.4% to 7.7%), respectively, while the proportion of ED visits from Medicare- and

Medicaid-insured patients increased by 13.1% (from 18.7% to 21.1%) and 79.7% (from 22.9% to 41.1%), respectively, during the study period (Figure 2).

We further examined payer composition trends by looking at ED visits resulting in a hospital admission. The number of ED visits resulting in hospitalization grew for Medicaid- and Medicare-insured patients by 72.0% and 18.5%, respectively, but declined for privately insured and uninsured patients by 8.3% and 71.3%, respectively. However, we found that the proportion of all ED visits resulting in hospitalization reduced across all payer groups, with decreases of 13.6% for the privately insured, 31.4% for the Medicaid-insured, 25.0% for the Medicare-insured, and 58.8% for the uninsured.

ED Visit Trends by CCS Diagnoses

When we analyzed ED visits by multi-level CCS diagnosis groups, we found that the number of ED visits increased across all CSS diagnoses except for the unclassified conditions group (Figure 3). The top 3 conditions for which ED visits grew the most included infectious and parasitic diseases (88.2%), diseases of the blood and blood-forming organs (78.7%), and mental illness (70.8%). However, the top 3 most prevalent conditions during the study period were injury and poisoning (20.6%), diseases of the respiratory system (12.8%), and ill-defined conditions (12.5%).

DISCUSSION

Between 2005 and 2015, ED visit rates increased by 27.8% in California, with the greatest ED visit rate growth among patients aged 5-19 and 45-64 years old, uninsured and Medicaid-insured patients, non-Hispanic Black and Hispanic patients, and patients living in urban areas. Despite relatively slower ED visit rate growth trends, the youngest (less than 5

years) and elderly (65 and over) patient groups as well as Medicare-insured patients retained high ED visit rates throughout the study period.

Our findings are consistent with previous studies,[8,10,15] and suggest that healthcare needs tend to exist across the entire age spectrum, albeit for a range of reasons. Patients aged less than 5 had the highest ED utilization rate as of 2015, outpacing the ED utilization rate for patients 65 and over. This finding, along with the high ED visit rate growth for patients aged 5-19, potentially suggests a need for coordinated acute care for the pediatric population, as well as the need to re-examine the availability and role of EDs equipped to treat children, particularly among underinsured pediatric patients. On the other hand, while patients aged 45-64 had the lowest overall ED visit rate during the study period, this group experienced the greatest ED utilization rate increase. This suggests that patients nearing 65 may have significant health care needs given prior evidence of sharp increases in healthcare utilization once patients turned 65 years old.[26] Meanwhile, patients aged 65 and over retained high steady ED visit rates.[27] The consistent high ED utilization rates and current trends in providers who refer elderly patients to the ED [28,29] suggests a need for improving geriatric care at a systemic level to treat elderly patients effectively and in a timely manner.

Our results revealed that ED utilization rates grew the fastest among non-Hispanic Black and Hispanic patients. Although we found similar ED visit rates between non-Hispanic White and Hispanic patients, it is possible that the observed number of ED visits by Hispanic patients is overall lower because this demographic may be more likely to avoid visiting the ED for reasons such as language barriers, fear of deportation, and other cultural factors.[30] These trends may point to substantial gaps in the healthcare system, specifically for racial/ethnic minorities. They may also suggest that although healthcare access has increased to some extent, disparities still exist [31] as EDs, acting as “safety nets,” continue to provide increasingly more care.

Prior studies have reported high ED utilization rates among Medicaid-insured and uninsured patients,[8,10,32] consistent with our findings of large ED visit rate increases in these payer groups. Our findings could reflect a number of trends. First, the use of EDs as "safety nets" has been previously reported,[33] with one study reporting that more than 50% of all acute visits by uninsured patients were to emergency physicians, who comprise less than 5% of all physicians in the US.[34] Second, difficulty in accessing primary care has been widely cited as a potential source for the increasing trends of ED use by Medicaid-insured patients.[5,32] Despite initiatives such as the ACA – designed to provide low-income individuals with health care access – Medicaid-insured patients increasingly seek care in the ED as a result of untimely access to primary and specialty care.[9] The high use of EDs by Medicaid-insured patients has been largely attributed to the reluctance of many primary care providers to accept Medicaid insurance due to low reimbursement rates.[5,35] At the same time, however, increasing literature shows that even patients with adequate primary care access are often referred to the ED by their primary care physicians,[14] suggesting that physicians themselves are also relying on the emergency care system to help diagnose and manage patients. Last, the utilization of EDs over other ambulatory care venues by patients of low socioeconomic status is influenced not only by insurance status or affordability, but also by accessibility, availability, perceptions of accommodation, and high disease burden.[36,37] These factors are important to consider when exploring potential solutions to improve the accessibility, provision, and quality of care.

Despite increasing numbers of ED visits, the proportion of ED visits resulting in inpatient admissions decreased. Prior studies have indicated that high numbers of complex and urgent patients are being managed in EDs,[38,39] and the decreases in the proportion of admissions seen in our study could indicate that patients with complex conditions are being evaluated, treated, and discharged from the ED rather than being admitted or cared for elsewhere. Although

this has potential benefits to healthcare systems, management of high-acuity outpatients in the ED could further contribute to the demands on EDs.

Other changes in ED visit trends included decreases in the proportion of ED visits for conditions related to injury and poisoning and increases in the proportion of medical conditions, including infectious and parasitic diseases and mental illness. Consistent with prior evidence of a decrease in ED visit rates for injuries in California from 2005-2011 but an increase for non-injury diagnoses,[40] our findings reveal the changing role of the ED in the health care system, where EDs are treating and providing care for more complex medical conditions. As chronic illnesses increase in the US[41] and the management of these conditions becomes more complex, it will become critical to expand services and access to treatments for conditions that drive ED utilization and demand for emergency care.

Limitations

Our study includes several limitations. First, OSHPD collects retrospective, self-reported data from hospitals, which could introduce potential reporting errors or missing data; however, hospitals submit routine accuracy checks using OSHPD's Medical Information Reporting for California (MIRCal) online system, which reduces such errors. Second, our data are limited to California residents and may limit the generalizability and applicability of our results on a national or global level, despite California's diverse and high Medicaid-insured population. Third, US Census Bureau surveys exclude undocumented and homeless populations, as well as individuals residing in nursing homes, extended-care facilities, prisons, and mental health facilities. Many of these individuals visit the ED on a frequent basis, and thus ED visit rates could be overestimated because many of these people are not accounted for in the population denominator.

CONCLUSIONS

Our findings suggest that the demand for emergency care continues to rise. ED visit rates in California increased from 2005-2015, across all age groups, and particularly among the uninsured, Medicaid-insured, non-Hispanic Black, Hispanic, and urban-residing patients. Increased ED visit rates by Medicaid-insured and uninsured patients may reflect current limitations in accessing care in other parts of the healthcare system. Furthermore, changes in conditions seen in the ED suggest that patient healthcare needs are becoming increasingly great and complex. Rather than focusing solely on efforts to reduce ED use, policymakers may need to recognize that EDs are playing an increasingly vital role in the provision of care and consider ways to incorporate this changing reality into the delivery of health services.

AUTHORS' CONTRIBUTIONS

RYH and MJN contributed to the conception and design of the study. SS and TJN drafted the manuscript. MJN and JG contributed to the analysis of data. RYH provided supervision. RYH, SS, JG, TJN, and MJN contributed to the interpretation of the data and critically reviewed, revised, and approved the manuscript.

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COMPETING INTERESTS STATEMENT

None declared.

ETHICAL APPROVAL

The University of California, San Francisco Institutional Review Board approved this study.

PATIENT CONSENT

Not applicable.

DATA SHARING STATEMENT

The data are available through the California Office of Statewide Health Planning and Development.

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FIGURE LEGEND

Figure 1

Caption: Proportion of California emergency department visits resulting in admission vs. discharge, 2005-2015

Source: Authors' analysis of Emergency Discharge Data and Patient Discharge Data from the California Office of Statewide Health Planning and Development, 2005-2015.

Figure 2

Caption: Proportion of California emergency department visits by payer, 2005-2015

Source: Authors' analysis of Emergency Discharge Data and Patient Discharge Data from the California Office of Statewide Health Planning and Development, 2005-2015

Figure 3

Caption: California emergency department visits by diagnosis, 2005 and 2015

Source: Authors' analysis of Emergency Discharge Data from the California Office of Statewide Health Planning and Development, 2005 and 2015

Table 1. California emergency department visit rates (per 1000 population), 2005-2015

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	% Change	P-value
Total ED visit rate	284.3	282.4	289.0	294.4	315.3	309.8	317.3	326.0	331.1	344.9	363.5	27.8%	<0.001
Age group													
<5	455.4	448.4	474.8	479.1	544.5	514.3	510.3	508.8	518.5	512.9	542.5	19.1%	<0.001
5-19	195.7	191.3	196.7	200.4	234.0	215.8	223.4	227.3	239.0	250.1	268.9	37.4%	<0.001
20-44	266.9	264.9	270.7	274.5	291.9	290.0	296.3	306.0	309.2	328.6	346.4	29.8%	<0.001
45-64	100.7	102.4	106.1	110.5	116.2	118.1	121.8	127.0	128.3	135.5	142.1	41.1%	<0.001
65+	461.0	464.1	464.0	470.3	471.5	474.8	485.9	490.6	486.6	486.2	503.0	9.1%	<0.001
Sex													
Male	266.4	264.7	270.1	273.6	291.7	285.9	292.5	300.1	305.1	317.2	336.0	26.2%	<0.001
Female	300.1	299.9	307.7	315.0	338.7	333.3	341.7	351.6	356.7	372.2	390.6	30.1%	<0.001
Race/Ethnicity													
NH White	294.5	299.4	308.8	315.3	336.8	339.6	347.9	358.2	357.4	366.8	381.1	29.4%	<0.001
NH Black	448.2	469.0	497.7	524.7	581.5	593.7	615.1	642.3	646.9	675.1	702.9	56.8%	<0.001
Hispanic	237.1	238.9	249.5	259.5	288.8	278.1	287.8	296.8	310.6	328.0	352.9	48.8%	<0.001
Other	185.3	191.6	199.8	199.9	214.7	211.3	213.6	215.7	217.6	230.2	249.2	34.4%	<0.001
Payer													
Private	171.0	166.2	168.9	174.7	196.9	180.1	186.5	181.8	186.1	184.6	181.4	6.1%	0.012
Medicaid	580.9	574.7	596.5	605.6	611.2	638.0	623.6	654.1	645.2	731.6	747.3	28.6%	<0.001
Medicare	459.2	490.6	492.0	501.3	497.7	496.4	516.7	539.1	529.8	528.7	536.9	16.9%	<0.001
Uninsured/self-pay	242.2	251.5	263.6	255.8	249.0	254.4	253.5	278.9	293.8	290.8	329.7	36.1%	0.002
MSA													
Urban	281.0	279.1	286.0	291.5	312.6	307.2	314.8	323.6	328.5	342.3	360.6	28.3%	<0.001
Rural	425.7	421.8	418.7	419.9	435.1	425.0	429.0	434.7	451.0	466.3	500.8	17.6%	0.010

Note: ED visit rate denominator includes the population of the corresponding characteristic (e.g. ED visits by male patients in given year/total male population in given year in CA).

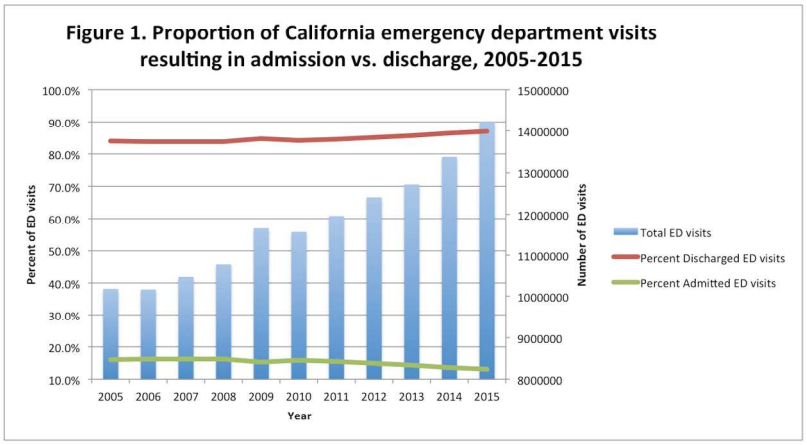

Figure 1. Proportion of California emergency department visits resulting in admission vs. discharge, 2005-2015

279x215mm (300 x 300 DPI)

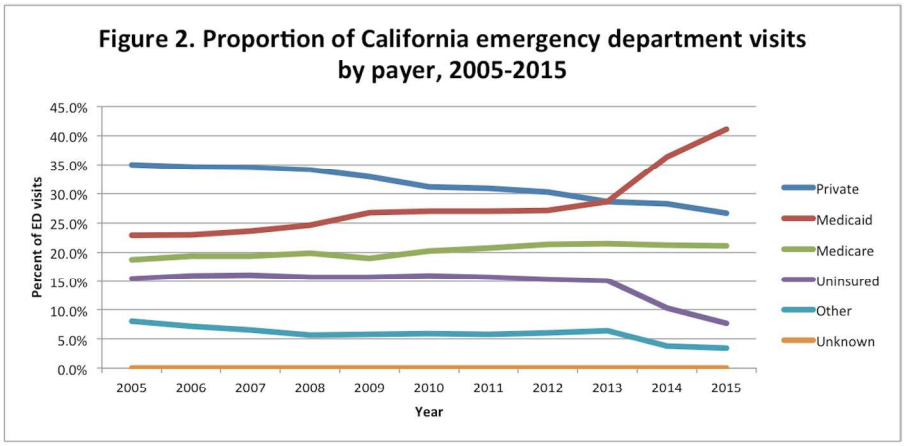

Figure 2. Proportion of California emergency department visits by payer, 2005-2015

215x279mm (300 x 300 DPI)

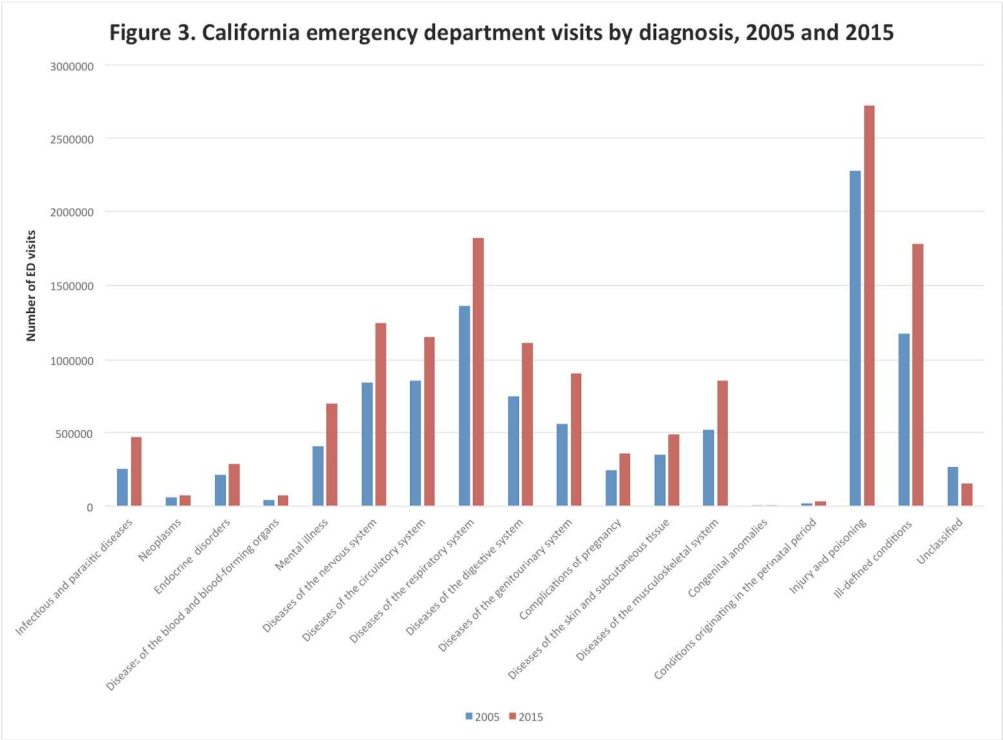

Figure 3. California emergency department visits by diagnosis, 2005 and 2015

279x215mm (300 x 300 DPI)

SUPPLEMENTARY MATERIALS

Supplementary Table 1. Descriptive characteristics of California emergency department visits, 2005-2015

Characteristic	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	% Change	P-value
Total ED visits	10187048	10172173	10476830	10777904	11654758	11564940	11960916	12407787	12717983	13379768	14228961	39.7%	<0.001
Age group													
<5	1163718	1138675	1208600	1227060	1385661	1301325	1293277	1279965	1296007	1284076	1360921	16.9%	0.002
5-19	1543281	1508767	1548365	1580477	1850406	1704412	1748506	1768990	1851782	1926985	2060762	33.5%	<0.001
20-44	3540709	3503045	3567013	3621196	3858230	3857008	3984261	4158612	4238892	4546171	4817840	36.1%	<0.001
45-64	2169625	2224611	2321347	2441078	2596714	2671541	2794199	2939632	2997090	3197982	3379431	55.8%	<0.001
65+	1769715	1797075	1831505	1908093	1963747	2030654	2140673	2260588	2334212	2424554	2610007	47.5%	<0.001
Sex													
Male	4749677	4744206	4870474	4982441	5361116	5305158	5478365	5674693	5821163	6111803	6533740	37.6%	<0.001
Female	5400871	5426867	5605380	5794994	6293259	6259489	6482298	6732782	6896402	7267461	7694688	42.5%	<0.001
Unknown	36498	1092	973	463	383	290	251	310	418	504	518	-98.6%	0.243
Race/Ethnicity													
NH White	4629083	4678727	4803242	4882971	5136236	5101499	5215676	5364074	5343623	5473429	5670856	22.5%	<0.001
NH Black	995223	1039629	1103005	1163257	1282527	1298439	1349509	1413949	1427593	1497705	1566555	57.4%	<0.001
Hispanic	3003407	3087315	3289467	3489075	3983295	3913063	4120055	4314009	4580423	4911172	5358365	78.4%	<0.001
Other	853928	897019	952814	971168	1060702	1086787	1123314	1160613	1200721	1303590	1447204	69.5%	<0.001
Payer													
Private	3568181	3524078	3607646	3671131	3831600	3596830	3682133	3749377	3635780	3781082	3788784	6.2%	0.002
Medicaid	2330998	2328948	2475271	2652643	3114505	3117815	3229952	3362952	3629446	4858001	5849956	151.0%	0.001
Medicare	1901449	1961387	2021499	2136053	2213792	2329984	2470110	2642609	2728514	2839188	3002826	57.9%	<0.001
Uninsured/self-pay	1569042	1621182	1677550	1697604	1823444	1838886	1882198	1892743	1909953	1386455	1093733	-30.3%	0.527
Other	813974	734799	691266	617190	669627	679615	694036	757560	810812	511859	488805	-39.9%	0.112
Unknown	3404	1779	3598	3283	1790	1810	2487	2546	3478	3183	4857	42.7%	0.307
MSA													
Urban	9833448	9820399	10126757	10425976	11289497	11207639	11601631	12046167	12345194	12994568	13814543	40.5%	<0.001
Rural	353600	351774	350073	351928	365261	357301	359285	361620	372789	385200	414418	17.2%	0.010

Supplementary Table 2. California emergency department visits, 2005-2015 – Medicaid insured

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	% Change
Age group, years												
<5	542614	544552	593483	628214	747939	717052	718256	724611	768987	780620	888449	63.73%
5-19	522055	514867	545227	586634	747137	710344	745759	776316	903245	1009845	1190903	128.12%
20-44	793956	788866	824338	878460	1010731	1054531	1098763	1159400	1216910	1860400	2327443	193.15%
45-64	402904	413617	441945	484342	532408	557115	590926	625197	658112	1115845	1337561	231.98%
65+	69469	67046	70278	74993	76290	78773	76248	77428	82192	91291	105600	52.01%
Sex												
Male	957166	949817	1012699	1085992	1281902	1274150	1320155	1376332	1501034	2129754	2598751	171.50%
Female	1371554	1379005	1462442	1566587	1832524	1843597	1909759	1986582	2128339	2728127	3251043	137.03%
Race/Ethnicity												
White	731384	719852	754567	794179	895803	906345	922269	941378	960099	1382263	1669637	128.28%
Black	308077	319736	342370	377544	432888	438186	457551	482857	508968	680050	772846	150.86%
Hispanic	1048204	1060758	1151617	1254527	1534361	1511196	1590293	1676984	1866746	2389237	2903001	176.95%
Other	181239	181922	188889	188165	218784	232492	232486	235241	257996	360311	464135	156.09%
Unknown	62094	46680	37828	38228	32669	29596	27353	26492	35637	46140	40337	-35.04%

Supplementary Table 3. California emergency department visits, 2005-2015 – privately insured

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	% Change
Age group, years												
<5	429459	408964	425124	430059	459516	418544	410245	391188	361352	340709	323370	-24.70%
5-19	708116	687035	692650	705363	793381	711824	723207	711686	669511	657252	638977	-9.76%
20-44	1346838	1326662	1345311	1351430	1363911	1281028	1337662	1387663	1362165	1460033	1466015	8.85%
45-64	937683	950346	983027	1011740	1036109	1016319	1034170	1078507	1056692	1130772	1157000	23.39%
65+	146085	151071	161534	172539	178683	169115	176849	180333	186060	192316	203422	39.25%
Sex												
Male	1663208	1644771	1683651	1703166	1770583	1651551	1690084	1709483	1652877	1712209	1737064	4.44%
Female	1900535	1878899	1923691	1967771	2060874	1945181	1991951	2039774	1982812	2068747	2051590	7.95%
Race/Ethnicity												
White	1735384	1764498	1829347	1838610	1889460	1763218	1787345	1804017	1742043	1764406	1728905	-0.37%
Black	259335	274790	290607	294616	314387	301938	312298	322555	305612	308854	303153	16.90%
Hispanic	819647	859756	926181	981879	1087422	1016798	1064338	1094322	1066446	1144353	1166619	42.33%
Other	330650	366942	401212	413098	446058	433656	447306	456385	449984	479157	506248	53.11%
Unknown	423165	258092	160299	142928	94273	81220	70846	72098	71695	84312	83859	-80.18%

Supplementary Table 4. Emergency department visits, 2005-2015 – Medicare insured

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	% Change
Age group, years												
<5	8243	4200	5373	6251	5090	10439	10503	11613	13680	14754	12550	52.25%
5-19	10797	6279	6593	8337	7945	12708	14009	16263	19637	22658	21148	95.87%
20-44	143152	140675	148033	160620	167879	179749	188514	205036	206723	215200	212123	48.18%
45-64	275977	295922	318067	346547	370181	393129	420238	459603	477958	505885	522212	89.22%
65+	1463280	1514311	1543433	1614298	1662697	1733959	1836846	1950094	2010516	2080691	2234793	52.72%
Sex												
Male	821355	844714	867868	917990	950000	1006743	1066235	1142955	1189472	1240239	1318555	60.53%
Female	1077719	1116566	1153548	1218014	1263757	1323213	1403845	1499617	1538996	1598904	1684217	56.28%
Race/Ethnicity												
White	1222354	1258172	1299775	1346473	1382103	1441869	1510711	1599925	1624635	1663996	1742676	42.57%
Black	159263	170620	181588	198505	211765	224865	238157	257281	264718	277381	290440	82.37%
Hispanic	297507	315033	334522	371907	399036	431504	469415	517413	549923	583293	626736	110.66%
Other	156948	164791	176161	190060	197222	212005	231632	249920	268873	285875	315090	100.76%
Unknown	65377	52771	29453	29108	23666	19741	20195	18070	20365	28643	27884	-57.35%

Supplementary Table 5. Emergency department visits 2005-2015 – uninsured

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	% Change
Age group, years												
<5	115388	120322	125362	114960	120588	107766	107416	105162	106741	101823	95770	-17.00%
5-19	199444	209014	216387	206858	222832	199173	194820	189107	189898	165966	143520	-28.04%
20-44	848935	887578	913148	931697	996065	1015494	1030280	1055437	1072956	777655	587183	-30.83%
45-64	346667	368433	385732	411485	451282	483683	515769	509668	504880	303459	227679	-34.32%
65+	58608	35835	36921	32604	32677	32770	33913	33369	35478	37552	39581	-32.46%
Sex												
Male	859641	890163	912620	922018	984241	994896	1018562	1026193	1028873	748368	603828	-29.76%
Female	705696	730669	764579	775460	839104	843907	863567	866453	880913	637901	489743	-30.60%
Race/Ethnicity												
White	593788	617404	649223	648562	697406	709652	710073	713594	695377	459614	335463	-43.50%
Black	178541	196121	209552	221673	242739	252220	260977	257628	244939	171578	137722	-22.86%
Hispanic	584084	626675	646508	659205	719615	712070	742101	745133	795756	610154	490429	-16.03%
Other	112259	119253	125578	125144	135331	141106	145983	148282	146588	120039	105257	-6.24%
Unknown	100370	61729	46689	43020	28353	23838	23064	28106	27293	25070	24862	-75.23%

STROBE 2007 (v4) checklist of items to be included in reports of observational studies in epidemiology*

Checklist for cohort, case-control, and cross-sectional studies (combined)

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-5
Objectives	3	State specific objectives, including any pre-specified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5-6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5-6
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	6
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	n/a
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5-6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6
Bias	9	Describe any efforts to address potential sources of bias	n/a
Study size	10	Explain how the study size was arrived at	6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6
		(*b*) Describe any methods used to examine subgroups and interactions	6
		(*c*) Explain how missing data were addressed	n/a
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed	n/a

		Cross-sectional study—If applicable, describe analytical methods taking account of sampling strategy	
		(*e*) Describe any sensitivity analyses	n/a
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7
		(b) Give reasons for non-participation at each stage	n/a
		(c) Consider use of a flow diagram	n/a
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	7-8
		(b) Indicate number of participants with missing data for each variable of interest	n/a
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	n/a
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	7
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	n/a
		Cross-sectional study—Report numbers of outcome events or summary measures	n/a
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	n/a
		(*b*) Report category boundaries when continuous variables were categorized	n/a
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	8-9
Discussion			
Key results	18	Summarise key results with reference to study objectives	9
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	12
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	9-12
Generalisability	21	Discuss the generalisability (external validity) of the study results	12
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	14

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.
Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Trends in the utilization of emergency departments in California, 2005-2015: a retrospective analysis

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Trends in the utilization of emergency departments in California, 2005-2015: a retrospective analysis

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ABSTRACT

Objective: To examine current trends in the characteristics of patients visiting California emergency departments (EDs) in order to better direct the allocation of acute care resources.

Design: A retrospective study.

Setting: We analyzed ED utilization trends between 2005 and 2015 in California using non-public patient data from California's Office of Statewide Health Planning and Development.

Participants: We included all ED visits in California from 2005 to 2015.

Primary and Secondary Outcome Measures: We analyzed ED visits and visit rates by age, sex, race/ethnicity, payer, and urban/rural trends. We further examined age, sex, race/ethnicity, and urban/rural trends within each payer group for a more granular picture of the patient population. Additionally, we looked at the proportion of patients admitted from the ED and distribution of diagnoses.

Results: Between 2005 and 2015, the annual number of ED visits increased from 10.2 to 14.2 million in California. ED visit rates increased by 27.8% ($p<0.001$), with the greatest increases among patients aged 5-19 (37.4%, $p<0.001$) and 45-64 years (41.1%, $p<0.001$), non-Hispanic Black and Hispanic patients (56.8% and 48.8%, $p<0.001$), the uninsured and Medicaid-insured (36.1%, $p=0.002$; 28.6%, $p<0.001$), and urban residents (28.3%, $p<0.001$). The proportion of ED visits resulting in hospitalization decreased by 18.3%, with decreases across all payer groups.

Conclusions: Our findings reveal an increasing demand for emergency care and may reflect current limitations in accessing care in other parts of the healthcare system. Policymakers may need to recognize the increasingly vital role that EDs are playing in the provision of care and consider ways to incorporate this changing reality into the delivery of health services.

Keywords: emergency department; utilization; demand; healthcare delivery

STRENGTHS AND LIMITATIONS OF THIS STUDY

- This study examines patient characteristics and emergency department (ED) use trends longitudinally using a dataset containing all ED visits for the state of California.
- California's initiatives to increase Medicaid enrollment through the Affordable Care Act and Low Income Health Programs provide a unique opportunity to study how patient characteristics and healthcare needs have changed over time under continual and gradual efforts to increase healthcare access.
- Our data are limited to California residents, potentially limiting the generalizability of our results despite California's diverse population.
- ED visit rates may be slightly overestimated due to the fact that some populations who visit the ED frequently – including patients who are undocumented and homeless, or live in nursing homes, extended-care facilities, prisons, and mental health facilities – are not accounted for in the population denominator.

INTRODUCTION

Emergency departments (EDs) are an integral component of the United States (US) health care system, as they provide the only around-the-clock health care to all, regardless of a patient's ability to pay.[1] In the past two decades, the annual number of ED visits in the US has increased by 50%, while the number of EDs has decreased by 11%,[2] raising concerns about the ability of EDs to provide accessible care amidst the rise in demand for emergency care services. Appropriate allocation of resources to meet such demands may require greater focus on ED utilization trends, which reflect the changing patterns of patient healthcare needs and reveal possible factors – including patient conditions, healthcare reform, or insurance coverage changes – that may contribute to the increase in demand for emergency care.[3,4]

Despite outpatient and primary care expansions and increased strategies aimed at reducing emergency care demand,[5-8] ED visits have continued to rise, with greater reliance on EDs to provide care that may be unavailable in other parts of the healthcare system.[9] Previous literature suggest that older patients, minorities, lower-income patients, and Medicaid beneficiaries are more likely to use the ED,[10] and recent reports have continued to show substantial increases in ED utilization, especially among Medicaid-insured patients.[11] However, most studies have either focused on short-term study periods using limited sample sizes to evaluate the impact of the Affordable Care Act (ACA) or have not incorporated measures to evaluate ED utilization relative to population changes.[12-15]

State-level examinations of the association between health insurance and ED use – particularly in the context of ACA reforms – have yielded complex and often conflicting results.[16] Although evaluating the impact of the ACA on healthcare utilization and outcomes remains an important task, our study provides a more comprehensive assessment of how patient characteristics and healthcare needs have changed over an 11-year period in California – one of

the largest and most diverse states in the country[17] – to help better design the necessary policies and programs to meet patients' healthcare needs. Additionally, California's initiatives to increase enrollment in Medicaid (a government health insurance program for qualified low-income or disabled people) through the ACA and Low Income Health Programs (LIHP) provide a unique opportunity to study how patient characteristics and healthcare needs have changed over time under continual and gradual efforts to increase healthcare access. Thus, we sought to examine state-level trends in emergency care demand from 2005 to 2015 in California. Using state-level data, we analyzed patient age, sex, race/ethnicity, insurance status, and region of care to examine where emergency care demands are most critical and where future resources may be directed to improve care and lessen ED utilization. We hypothesized that ED visit rates would increase between 2005 and 2015, particularly among minority, Medicaid-insured, and uninsured patients.

METHODS

Study Design and Data Sources

We obtained 2005-2015 non-public Patient Discharge Data (PDD), Emergency Department Data (EDD), Hospital Annual Financial Data, and Hospital Annual Utilization Data from California's Office of Statewide Health Planning and Development (OSHPD), which conducts annual, standardized surveys required of all hospitals and health service facilities in California.[18,19] To account for changes in California's population over time, we calculated annual ED utilization rates by age, sex, race/ethnicity, insurance payer, and urban/rural residence. We used annual age and sex population estimates provided by the US Census Bureau;[20,21] state population insurance coverage estimates from the Current Population Survey's Annual Social and Economic Supplements (for the years 2005-2012) and American

Community Survey (for the years 2013-2015);[22,23] and race/ethnicity population estimates from the California Department of Finance (for the years 2005-2009) and the US Census Bureau (for the years 2010-2015).[24,25]

Inclusion Criteria and Variable Definition

We included all ED visits in California from 2005 to 2015, and classified ED visits as inpatient if the visit resulted in a hospital admission and outpatient if the visit resulted in a discharge directly from the ED without admission. All observation stays that initially came through the ED – whether they were admitted to the inpatient setting or discharged directly from the ED – were captured in our dataset and categorized as either a hospital admission or ED discharge. We designated hospitals as urban or rural based on the corresponding county listed in the non-public PDD documentation.

Patient Involvement

Patients were not involved in the development of the research question, outcome measures, or study design. We did not actively recruit patients for this study, and the results will not be disseminated to the study participants as we used unidentified data and have no way of contacting the patients.

Statistical Analysis

We analyzed ED visits and visit rates using a linear regression model to test for significant linear temporal trends in California from 2005 to 2015 by age group (<5 years, 5-19 years, 20-44 years, 45-64 years, and 65 years and over); sex (male, female, unknown); race/ethnicity group (non-Hispanic White, non-Hispanic Black, Hispanic, Other);

payer/insurance status (private, Medicare, Medicaid, uninsured/self-pay, other, unknown); and metropolitan statistical area (rural or urban). Furthermore, we looked at age, sex, race/ethnicity, urban/rural trends by payer/insurance status for a more granular picture of patient population differences within each insurance group. We obtained International Classification of Disease, 9th Revision, Clinical Modification (ICD-9-CM) codes for principal hospital discharge diagnoses for 2005-2014, and categorized them into multi-level diagnoses codes using the Agency for Healthcare Research and Quality's Clinical Classification Software (CCS) to examine changes in conditions observed in the ED over time. We clustered 2015 primary diagnoses into multi-level CCS categories using single-level CCS categorizations provided in the data, which accounted for the transition from ICD-9 to ICD-10 coding in October 2015. We performed all analyses using Stata software (version 14, Stata Corporation, College Station, TX). The University of California, San Francisco Institutional Review Board approved this study.

RESULTS

Between 2005 and 2015, total annual ED visits in California increased by 39.7% ($p<0.001$), from 10.2 million to 14.2 million (Supplementary Table 1). ED utilization in California gradually increased across most years in the study period, with two pronounced jumps from 2008 to 2009 (8.1%) and 2014 to 2015 (6.3%). The number of ED visits grew the most among patients aged 45-64 (55.8%; $p<0.001$), female patients (42.5%; $p<0.001$), Hispanic patients (78.4%; $p<0.001$), Medicaid beneficiaries (151.0%; $p=0.001$), and those living in urban areas (40.5%; $p<0.001$).

After adjusting for the 9.3% population growth in California during our study period, we found an overall 27.8% ($p<0.001$) increase in ED visit rates between 2005 and 2015 (Table 1), with significant increases among all patient characteristics examined. In 2015, ED visit rates

were the highest among patients aged less than 5 and 65 and over (543 visits and 503 visits per 1,000 California residents aged less than 5 and 65 and over, respectively), non-Hispanic Black patients (703 per 1,000), Medicaid-insured patients (747 per 1,000), and rural residents (501 per 1,000). ED visit rates grew the fastest among patients aged 5-19 (37.4% increase, from 196 to 269 per 1,000) and 45-64 (41.1% increase, from 101 to 142 per 1,000) ($p<0.001$ for both) – in particular, a 232% increase among Medicaid-insured 45-64-year-olds (Supplementary Table 2) – uninsured patients (36.1% increase, from 242 to 330 per 1,000; $p=0.002$), and urban residents (28.3% increase, from 281 to 361 per 1,000; $p<0.001$). Although non-Hispanic Black patients had a strikingly higher ED visit rate in 2015, both non-Hispanic Black and Hispanic patients experienced similar high levels of ED visit rate growth (56.8% increase, from 448 to 703 per 1,000; and 48.8% increase, from 237 to 353 per 1,000, respectively; $p<0.001$ for both) during the study period. See Supplementary Tables 3-5 for additional results on ED visits stratified by insurance groups (privately insured, Medicare insured, and uninsured, respectively).

When examining ED discharge and hospital admission trends, the number of ED visits resulting in a discharge increased by 44.5%, from 8.6 million to 12.4 million, and the number resulting in a hospital admission increased by 14.2%, from roughly 1.6 million to 1.9 million during the study period. The proportion of ED visits that resulted in a discharge increased by 3.5% (from 84.0% of ED visits in 2005 to 86.9% in 2015), while the proportion that resulted in a hospital admission decreased by 18.3% (from 16.0% of ED visits in 2005 to 13.1% in 2015; Figure 1).

ED Visit Patient Composition Trends by Payer

Although ED visit rates increased across all payer groups, the proportion of ED visits from private and uninsured patients decreased by 24.0% (from 35.0% to 26.6%) and 50.1%

(from 15.4% to 7.7%), respectively, while the proportion of ED visits from Medicare- and Medicaid-insured patients increased by 13.1% (from 18.7% to 21.1%) and 79.7% (from 22.9% to 41.1%), respectively, during the study period (Figure 2).

We further examined payer composition trends by looking at ED visits resulting in a hospital admission. The number of ED visits resulting in hospitalization grew for Medicaid- and Medicare-insured patients by 72.0% and 18.5%, respectively, but declined for privately insured and uninsured patients by 8.3% and 71.3%, respectively. However, we found that the proportion of all ED visits resulting in hospitalization reduced across all payer groups, with decreases of 13.6% for the privately insured, 31.4% for the Medicaid-insured, 25.0% for the Medicare-insured, and 58.8% for the uninsured.

ED Visit Trends by CCS Diagnoses

When we analyzed ED visits by multi-level CCS diagnosis groups, we found that the number of ED visits increased across all CSS diagnoses except for the unclassified conditions group (Figure 3). The top 3 conditions for which ED visits grew the most included infectious and parasitic diseases (88.2%), diseases of the blood and blood-forming organs (78.7%), and mental illness (70.8%). However, the top 3 most prevalent conditions during the study period were injury and poisoning (20.6%), diseases of the respiratory system (12.8%), and ill-defined conditions (12.5%).

DISCUSSION

Between 2005 and 2015, ED visit rates increased by 27.8% in California, with the greatest ED visit rate growth among patients aged 5-19 and 45-64 years old, uninsured and Medicaid-insured patients, non-Hispanic Black and Hispanic patients, and patients living in

urban areas. Despite relatively slower ED visit rate growth trends, the youngest (less than 5 years) and elderly (65 and over) patient groups as well as Medicare-insured patients retained high ED visit rates throughout the study period.

Our findings are consistent with previous studies,[8,10,15] and suggest that healthcare needs tend to exist across the entire age spectrum, albeit for a range of reasons. Patients aged less than 5 had the highest ED utilization rate as of 2015, outpacing the ED utilization rate for patients 65 and over. This finding, along with the high ED visit rate growth for patients aged 5-19, potentially suggests a need for coordinated acute care for the pediatric population, as well as the need to re-examine the availability and role of EDs equipped to treat children, particularly among underinsured pediatric patients. On the other hand, while patients aged 45-64 had the lowest overall ED visit rate during the study period, this group experienced the greatest ED utilization rate increase. This suggests that patients nearing 65 may have significant health care needs given prior evidence of sharp increases in healthcare utilization once patients turned 65 years old.[26] Meanwhile, patients aged 65 and over retained high steady ED visit rates.[27] The consistent high ED utilization rates and current trends in providers who refer elderly patients to the ED [28,29] suggests a need for improving geriatric care at a systemic level to treat elderly patients effectively and in a timely manner.

Our results revealed that ED utilization rates grew the fastest among non-Hispanic Black and Hispanic patients. Although we found similar ED visit rates between non-Hispanic White and Hispanic patients, it is possible that the observed number of ED visits by Hispanic patients is overall lower because this demographic may be more likely to avoid visiting the ED for reasons such as language barriers, fear of deportation, and other cultural factors.[30] These trends may point to substantial gaps in the healthcare system, specifically for racial/ethnic minorities. They

may also suggest that although healthcare access has increased to some extent, disparities still exist [31] as EDs, acting as "safety nets," continue to provide increasingly more care.

Prior studies have reported high ED utilization rates among Medicaid-insured and uninsured patients,[8,10,32] consistent with our findings of large ED visit rate increases in these payer groups. Our findings could reflect a number of trends. First, the use of EDs as "safety nets" has been previously reported,[33] with one study reporting that more than 50% of all acute visits by uninsured patients were to emergency physicians, who comprise less than 5% of all physicians in the US.[34] Second, difficulty in accessing primary care has been widely cited as a potential source for the increasing trends of ED use by Medicaid-insured patients.[5,32] Despite initiatives such as the ACA – designed to provide low-income individuals with health care access – Medicaid-insured patients increasingly seek care in the ED as a result of untimely access to primary and specialty care.[9] The high use of EDs by Medicaid-insured patients has been largely attributed to the reluctance of many primary care providers to accept Medicaid insurance due to low reimbursement rates.[5,35] At the same time, however, increasing literature shows that even patients with adequate primary care access are often referred to the ED by their primary care physicians,[14] suggesting that physicians themselves are also relying on the emergency care system to help diagnose and manage patients. Last, the utilization of EDs over other ambulatory care venues by patients of low socioeconomic status is influenced not only by insurance status or affordability, but also by accessibility, availability, perceptions of accommodation, and high disease burden.[36,37] These factors are important to consider when exploring potential solutions to improve the accessibility, provision, and quality of care.

Despite increasing numbers of ED visits, the proportion of ED visits resulting in inpatient admissions decreased. Prior studies have indicated that high numbers of complex and urgent patients are being managed in EDs,[38,39] and the decreases in the proportion of admissions

seen in our study could indicate that patients with complex conditions are being evaluated, treated, and discharged from the ED rather than being admitted or cared for elsewhere. Although this has potential benefits to healthcare systems, management of high-acuity outpatients in the ED could further contribute to the demands on EDs.

Other changes in ED visit trends included decreases in the proportion of ED visits for conditions related to injury and poisoning and increases in the proportion of medical conditions, including infectious and parasitic diseases and mental illness. Consistent with prior evidence of a decrease in ED visit rates for injuries in California from 2005-2011 but an increase for non-injury diagnoses,[40] our findings reveal the changing role of the ED in the health care system, where EDs are treating and providing care for more complex medical conditions. As chronic illnesses increase in the US[41] and the management of these conditions becomes more complex, it will become critical to expand services and access to treatments for conditions that drive ED utilization and demand for emergency care.

Limitations

Our study includes several limitations. First, OSHPD collects retrospective, self-reported data from hospitals, which could introduce potential reporting errors or missing data; however, hospitals submit routine accuracy checks using OSHPD's Medical Information Reporting for California (MIRCal) online system, which reduces such errors. Second, our data are limited to California residents and may limit the generalizability and applicability of our results on a national or global level, despite California's diverse and high Medicaid-insured population. Third, US Census Bureau surveys exclude undocumented and homeless populations, as well as individuals residing in nursing homes, extended-care facilities, prisons, and mental health facilities. Many of these individuals visit the ED on a frequent basis, and thus ED visit rates

could be overestimated because many of these people are not accounted for in the population denominator.

CONCLUSIONS

Our findings suggest that the demand for emergency care continues to rise. ED visit rates in California increased from 2005-2015, across all age groups, and particularly among the uninsured, Medicaid-insured, non-Hispanic Black, Hispanic, and urban-residing patients. Increased ED visit rates by Medicaid-insured and uninsured patients may reflect current limitations in accessing care in other parts of the healthcare system. Furthermore, changes in conditions seen in the ED suggest that patient healthcare needs are becoming increasingly great and complex. Rather than focusing solely on efforts to reduce ED use, policymakers may need to recognize that EDs are playing an increasingly vital role in the provision of care and consider ways to incorporate this changing reality into the delivery of health services.

AUTHORS' CONTRIBUTIONS

RYH and MJN contributed to the conception and design of the study. SS and TJN drafted the manuscript. MJN and JG contributed to the analysis of data. RYH provided supervision. RYH, SS, JG, TJN, and MJN contributed to the interpretation of the data and critically reviewed, revised, and approved the manuscript.

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COMPETING INTERESTS STATEMENT

None declared.

ETHICAL APPROVAL

The University of California, San Francisco Institutional Review Board approved this study.

PATIENT CONSENT

Not applicable.

DATA SHARING STATEMENT

The data are available through the California Office of Statewide Health Planning and Development.

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FIGURE LEGEND

Figure 1

Caption: Proportion of California emergency department visits resulting in admission vs. discharge, 2005-2015

Source: Authors' analysis of Emergency Discharge Data and Patient Discharge Data from the California Office of Statewide Health Planning and Development, 2005-2015.

Figure 2

Caption: Proportion of California emergency department visits by payer, 2005-2015

Source: Authors' analysis of Emergency Discharge Data and Patient Discharge Data from the California Office of Statewide Health Planning and Development, 2005-2015

Figure 3

Caption: California emergency department visits by diagnosis, 2005 and 2015

Source: Authors' analysis of Emergency Discharge Data from the California Office of Statewide Health Planning and Development, 2005 and 2015

Table 1. California emergency department visit rates (per 1000 population), 2005-2015

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	% Change	P-value
Total ED visit rate	284.3	282.4	289.0	294.4	315.3	309.8	317.3	326.0	331.1	344.9	363.5	27.8%	<0.001
Age group													
<5	455.4	448.4	474.8	479.1	544.5	514.3	510.3	508.8	518.5	512.9	542.5	19.1%	<0.001
5-19	195.7	191.3	196.7	200.4	234.0	215.8	223.4	227.3	239.0	250.1	268.9	37.4%	<0.001
20-44	266.9	264.9	270.7	274.5	291.9	290.0	296.3	306.0	309.2	328.6	346.4	29.8%	<0.001
45-64	100.7	102.4	106.1	110.5	116.2	118.1	121.8	127.0	128.3	135.5	142.1	41.1%	<0.001
65+	461.0	464.1	464.0	470.3	471.5	474.8	485.9	490.6	486.6	486.2	503.0	9.1%	<0.001
Sex													
Male	266.4	264.7	270.1	273.6	291.7	285.9	292.5	300.1	305.1	317.2	336.0	26.2%	<0.001
Female	300.1	299.9	307.7	315.0	338.7	333.3	341.7	351.6	356.7	372.2	390.6	30.1%	<0.001
Race/Ethnicity													
NH White	294.5	299.4	308.8	315.3	336.8	339.6	347.9	358.2	357.4	366.8	381.1	29.4%	<0.001
NH Black	448.2	469.0	497.7	524.7	581.5	593.7	615.1	642.3	646.9	675.1	702.9	56.8%	<0.001
Hispanic	237.1	238.9	249.5	259.5	288.8	278.1	287.8	296.8	310.6	328.0	352.9	48.8%	<0.001
Other	185.3	191.6	199.8	199.9	214.7	211.3	213.6	215.7	217.6	230.2	249.2	34.4%	<0.001
Payer													
Private	171.0	166.2	168.9	174.7	196.9	180.1	186.5	181.8	186.1	184.6	181.4	6.1%	0.012
Medicaid	580.9	574.7	596.5	605.6	611.2	638.0	623.6	654.1	645.2	731.6	747.3	28.6%	<0.001
Medicare	459.2	490.6	492.0	501.3	497.7	496.4	516.7	539.1	529.8	528.7	536.9	16.9%	<0.001
Uninsured/self-pay	242.2	251.5	263.6	255.8	249.0	254.4	253.5	278.9	293.8	290.8	329.7	36.1%	0.002
MSA													
Urban	281.0	279.1	286.0	291.5	312.6	307.2	314.8	323.6	328.5	342.3	360.6	28.3%	<0.001
Rural	425.7	421.8	418.7	419.9	435.1	425.0	429.0	434.7	451.0	466.3	500.8	17.6%	0.010

Note: ED visit rate denominator includes the population of the corresponding characteristic (e.g. ED visits by male patients in given year/total male population in given year in CA).

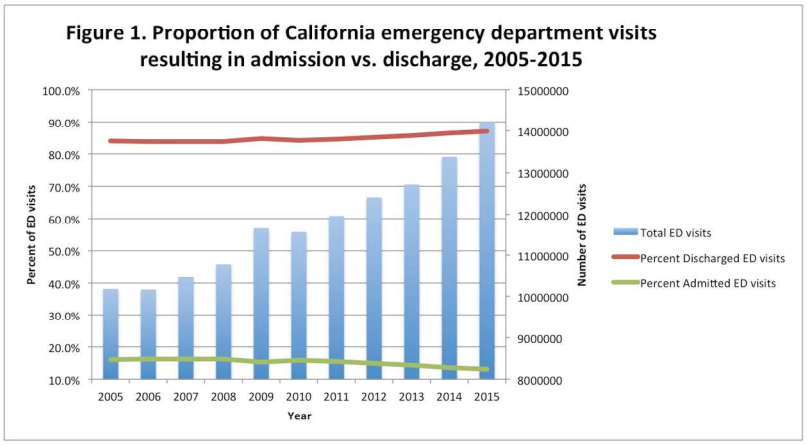

Figure 1. Proportion of California emergency department visits resulting in admission vs. discharge, 2005-2015

279x215mm (300 x 300 DPI)

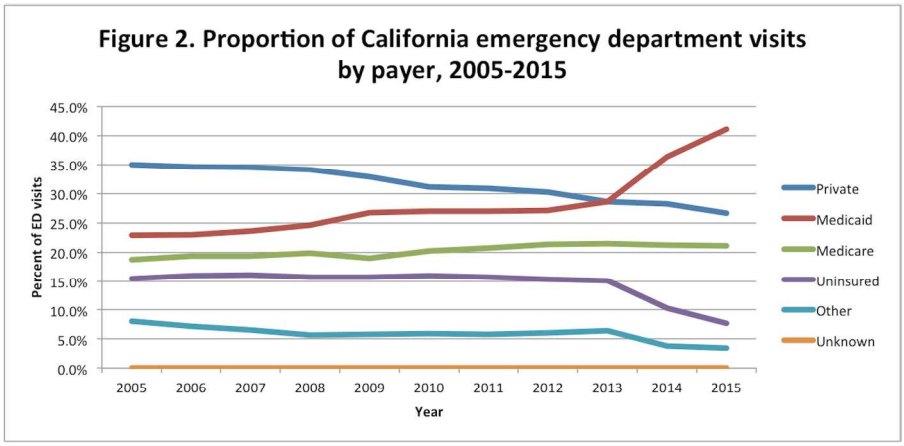

Figure 2. Proportion of California emergency department visits by payer, 2005-2015

215x279mm (300 x 300 DPI)

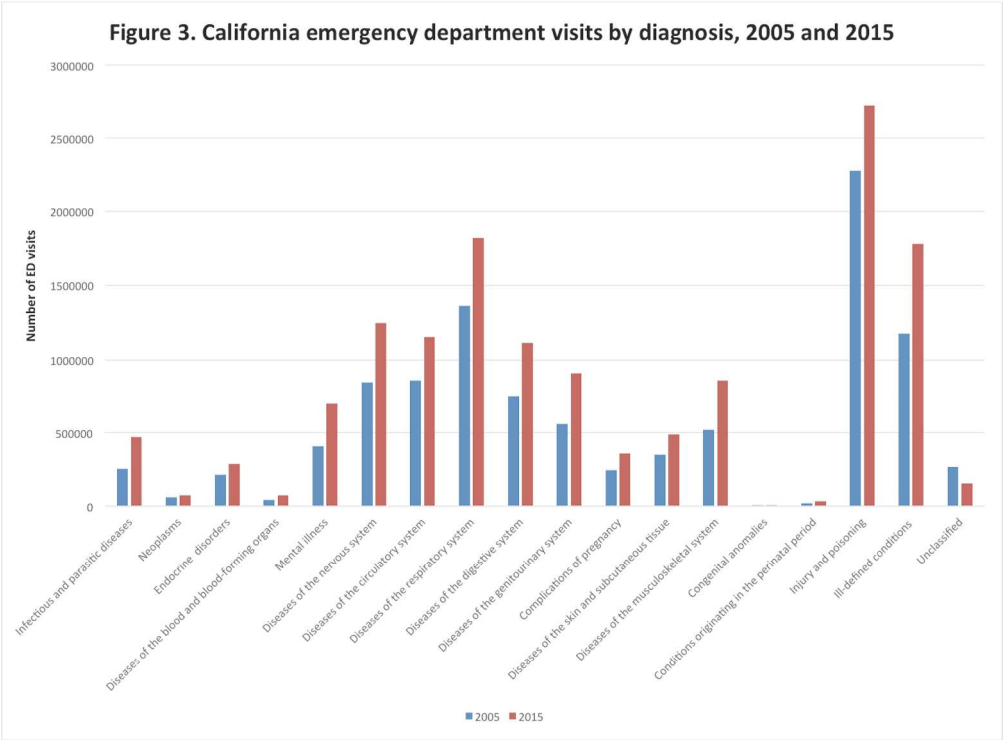

Figure 3. California emergency department visits by diagnosis, 2005 and 2015

279x215mm (300 x 300 DPI)

SUPPLEMENTARY MATERIALS

Supplementary Table 1. Descriptive characteristics of California emergency department visits, 2005-2015

Characteristic	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	% Change	P-value
Total ED visits	10187048	10172173	10476830	10777904	11654758	11564940	11960916	12407787	12717983	13379768	14228961	39.7%	<0.001
Age group													
<5	1163718	1138675	1208600	1227060	1385661	1301325	1293277	1279965	1296007	1284076	1360921	16.9%	0.002
5-19	1543281	1508767	1548365	1580477	1850406	1704412	1748506	1768990	1851782	1926985	2060762	33.5%	<0.001
20-44	3540709	3503045	3567013	3621196	3858230	3857008	3984261	4158612	4238892	4546171	4817840	36.1%	<0.001
45-64	2169625	2224611	2321347	2441078	2596714	2671541	2794199	2939632	2997090	3197982	3379431	55.8%	<0.001
65+	1769715	1797075	1831505	1908093	1963747	2030654	2140673	2260588	2334212	2424554	2610007	47.5%	<0.001
Sex													
Male	4749677	4744206	4870474	4982441	5361116	5305158	5478365	5674693	5821163	6111803	6533740	37.6%	<0.001
Female	5400871	5426867	5605380	5794994	6293259	6259489	6482298	6732782	6896402	7267461	7694688	42.5%	<0.001
Unknown	36498	1092	973	463	383	290	251	310	418	504	518	-98.6%	0.243
Race/Ethnicity													
NH White	4629083	4678727	4803242	4882971	5136236	5101499	5215676	5364074	5343623	5473429	5670856	22.5%	<0.001
NH Black	995223	1039629	1103005	1163257	1282527	1298439	1349509	1413949	1427593	1497705	1566555	57.4%	<0.001
Hispanic	3003407	3087315	3289467	3489075	3983295	3913063	4120055	4314009	4580423	4911172	5358365	78.4%	<0.001
Other	853928	897019	952814	971168	1060702	1086787	1123314	1160613	1200721	1303590	1447204	69.5%	<0.001
Payer													
Private	3568181	3524078	3607646	3671131	3831600	3596830	3682133	3749377	3635780	3781082	3788784	6.2%	0.002
Medicaid	2330998	2328948	2475271	2652643	3114505	3117815	3229952	3362952	3629446	4858001	5849956	151.0%	0.001
Medicare	1901449	1961387	2021499	2136053	2213792	2329984	2470110	2642609	2728514	2839188	3002826	57.9%	<0.001
Uninsured/self-pay	1569042	1621182	1677550	1697604	1823444	1838886	1882198	1892743	1909953	1386455	1093733	-30.3%	0.527
Other	813974	734799	691266	617190	669627	679615	694036	757560	810812	511859	488805	-39.9%	0.112
Unknown	3404	1779	3598	3283	1790	1810	2487	2546	3478	3183	4857	42.7%	0.307
MSA													
Urban	9833448	9820399	10126757	10425976	11289497	11207639	11601631	12046167	12345194	12994568	13814543	40.5%	<0.001
Rural	353600	351774	350073	351928	365261	357301	359285	361620	372789	385200	414418	17.2%	0.010

Supplementary Table 2. California emergency department visits, 2005-2015 – Medicaid insured

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	% Change
Age group, years												
<5	542614	544552	593483	628214	747939	717052	718256	724611	768987	780620	888449	63.73%
5-19	522055	514867	545227	586634	747137	710344	745759	776316	903245	1009845	1190903	128.12%
20-44	793956	788866	824338	878460	1010731	1054531	1098763	1159400	1216910	1860400	2327443	193.15%
45-64	402904	413617	441945	484342	532408	557115	590926	625197	658112	1115845	1337561	231.98%
65+	69469	67046	70278	74993	76290	78773	76248	77428	82192	91291	105600	52.01%
Sex												
Male	957166	949817	1012699	1085992	1281902	1274150	1320155	1376332	1501034	2129754	2598751	171.50%
Female	1371554	1379005	1462442	1566587	1832524	1843597	1909759	1986582	2128339	2728127	3251043	137.03%
Race/Ethnicity												
White	731384	719852	754567	794179	895803	906345	922269	941378	960099	1382263	1669637	128.28%
Black	308077	319736	342370	377544	432888	438186	457551	482857	508968	680050	772846	150.86%
Hispanic	1048204	1060758	1151617	1254527	1534361	1511196	1590293	1676984	1866746	2389237	2903001	176.95%
Other	181239	181922	188889	188165	218784	232492	232486	235241	257996	360311	464135	156.09%
Unknown	62094	46680	37828	38228	32669	29596	27353	26492	35637	46140	40337	-35.04%

Supplementary Table 3. California emergency department visits, 2005-2015 – privately insured

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	% Change
Age group, years												
<5	429459	408964	425124	430059	459516	418544	410245	391188	361352	340709	323370	-24.70%
5-19	708116	687035	692650	705363	793381	711824	723207	711686	669511	657252	638977	-9.76%
20-44	1346838	1326662	1345311	1351430	1363911	1281028	1337662	1387663	1362165	1460033	1466015	8.85%
45-64	937683	950346	983027	1011740	1036109	1016319	1034170	1078507	1056692	1130772	1157000	23.39%
65+	146085	151071	161534	172539	178683	169115	176849	180333	186060	192316	203422	39.25%
Sex												
Male	1663208	1644771	1683651	1703166	1770583	1651551	1690084	1709483	1652877	1712209	1737064	4.44%
Female	1900535	1878899	1923691	1967771	2060874	1945181	1991951	2039774	1982812	2068747	2051590	7.95%
Race/Ethnicity												
White	1735384	1764498	1829347	1838610	1889460	1763218	1787345	1804017	1742043	1764406	1728905	-0.37%
Black	259335	274790	290607	294616	314387	301938	312298	322555	305612	308854	303153	16.90%
Hispanic	819647	859756	926181	981879	1087422	1016798	1064338	1094322	1066446	1144353	1166619	42.33%
Other	330650	366942	401212	413098	446058	433656	447306	456385	449984	479157	506248	53.11%
Unknown	423165	258092	160299	142928	94273	81220	70846	72098	71695	84312	83859	-80.18%

Supplementary Table 4. Emergency department visits, 2005-2015 – Medicare insured

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	% Change
Age group, years												
<5	8243	4200	5373	6251	5090	10439	10503	11613	13680	14754	12550	52.25%
5-19	10797	6279	6593	8337	7945	12708	14009	16263	19637	22658	21148	95.87%
20-44	143152	140675	148033	160620	167879	179749	188514	205036	206723	215200	212123	48.18%
45-64	275977	295922	318067	346547	370181	393129	420238	459603	477958	505885	522212	89.22%
65+	1463280	1514311	1543433	1614298	1662697	1733959	1836846	1950094	2010516	2080691	2234793	52.72%
Sex												
Male	821355	844714	867868	917990	950000	1006743	1066235	1142955	1189472	1240239	1318555	60.53%
Female	1077719	1116566	1153548	1218014	1263757	1323213	1403845	1499617	1538996	1598904	1684217	56.28%
Race/Ethnicity												
White	1222354	1258172	1299775	1346473	1382103	1441869	1510711	1599925	1624635	1663996	1742676	42.57%
Black	159263	170620	181588	198505	211765	224865	238157	257281	264718	277381	290440	82.37%
Hispanic	297507	315033	334522	371907	399036	431504	469415	517413	549923	583293	626736	110.66%
Other	156948	164791	176161	190060	197222	212005	231632	249920	268873	285875	315090	100.76%
Unknown	65377	52771	29453	29108	23666	19741	20195	18070	20365	28643	27884	-57.35%

Supplementary Table 5. Emergency department visits 2005-2015 – uninsured

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	% Change
Age group, years												
<5	115388	120322	125362	114960	120588	107766	107416	105162	106741	101823	95770	-17.00%
5-19	199444	209014	216387	206858	222832	199173	194820	189107	189898	165966	143520	-28.04%
20-44	848935	887578	913148	931697	996065	1015494	1030280	1055437	1072956	777655	587183	-30.83%
45-64	346667	368433	385732	411485	451282	483683	515769	509668	504880	303459	227679	-34.32%
65+	58608	35835	36921	32604	32677	32770	33913	33369	35478	37552	39581	-32.46%
Sex												
Male	859641	890163	912620	922018	984241	994896	1018562	1026193	1028873	748368	603828	-29.76%
Female	705696	730669	764579	775460	839104	843907	863567	866453	880913	637901	489743	-30.60%
Race/Ethnicity												
White	593788	617404	649223	648562	697406	709652	710073	713594	695377	459614	335463	-43.50%
Black	178541	196121	209552	221673	242739	252220	260977	257628	244939	171578	137722	-22.86%
Hispanic	584084	626675	646508	659205	719615	712070	742101	745133	795756	610154	490429	-16.03%
Other	112259	119253	125578	125144	135331	141106	145983	148282	146588	120039	105257	-6.24%
Unknown	100370	61729	46689	43020	28353	23838	23064	28106	27293	25070	24862	-75.23%

STROBE 2007 (v4) checklist of items to be included in reports of observational studies in epidemiology*

Checklist for cohort, case-control, and cross-sectional studies (combined)

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-5
Objectives	3	State specific objectives, including any pre-specified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5-6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5-6
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	6
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	n/a
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5-6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5-6
Bias	9	Describe any efforts to address potential sources of bias	n/a
Study size	10	Explain how the study size was arrived at	6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6-7
		(*b*) Describe any methods used to examine subgroups and interactions	6-7
		(*c*) Explain how missing data were addressed	n/a
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed	n/a

		Cross-sectional study—If applicable, describe analytical methods taking account of sampling strategy	
		(*e*) Describe any sensitivity analyses	n/a
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7
		(b) Give reasons for non-participation at each stage	n/a
		(c) Consider use of a flow diagram	n/a
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	7-9
		(b) Indicate number of participants with missing data for each variable of interest	n/a
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	n/a
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	7
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	n/a
		Cross-sectional study—Report numbers of outcome events or summary measures	n/a
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	n/a
		(*b*) Report category boundaries when continuous variables were categorized	n/a
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	8-9
Discussion			
Key results	18	Summarise key results with reference to study objectives	9-10
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	12-13
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	9-12
Generalisability	21	Discuss the generalisability (external validity) of the study results	12
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	14

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.
Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.