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Concussion-Related Health Care Utilization Among Medicaid Insured Children in Ohio: Rural and Urban Differences

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Abstract

Purpose: The current study examines rural-urban differences in trends in rates and type of concussion-related health care utilization over time from 2008 to 2016 among Medicaid insured children in Ohio.

Methods: We analyzed Medicaid claims for health care utilization for diagnosed concussions among children aged ≤18 years between April 1, 2008, and December 31, 2016. We compared the trends in rates of concussion-related health care utilization between children who lived in rural and urban areas using Poisson regressions. We examined trends in the type of concussion-related health care utilization by location of residence using linear regressions.

Findings: We found a significant increase in health care utilization for concussion over time, with rates of treated concussion consistently higher in rural children compared to urban children ($P < .0001$) throughout the study period. Although initial care at the Emergency Department (ED) remained the most common type of initial concussion-related health care utilization for rural children throughout the study period, the most common type of initial care sought by urban children shifted over time from the ED to primary care providers (PCPs). For both rural and urban children, PCPs remained the most common type of follow-up care sought throughout the study period, with no significant rural-urban differences in the trends of follow-up care sought through PCPs over time.

Conclusions: We observed significant rural-urban differences in the trends in rates and types of concussion-related health care utilization over time from 2008 to 2016. Future studies are needed to further our understanding of the effect of these observed rural-urban differences on concussion recovery.

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Supporting Information

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Keywords

children; concussion laws; health care utilization; location of residence; Medicaid

Concussion, a type of mild traumatic brain injury, is a significant public health issue, especially among children and adolescents.[1] Each year, an average of 283,000 US children and adolescents aged <18 years seek care in Emergency Departments (EDs) for sports- and recreational-related concussions, with rates highest among males and children aged 10–14 and 15–17 years.[1] One approach that has been adopted in the United States to increase awareness about concussion and reduce the prevalence and severity of this injury is the enactment of youth traumatic brain injury (TBI) laws, commonly referred to as concussion laws.[2–5] Between 2009 and 2014, all US states and Washington, DC, enacted a state-level concussion law. Ohio State's concussion law, enacted on April 26, 2013, includes the following 3 key tenets similar to most state concussion laws: (1) immediate removal of an athlete from play after a suspected concussion; (2) clearance from a health professional before an athlete can return to play (RTP); and (3) mandatory concussion education for parents, athletes, and/or coaches.[2,3,6–8]

Following the enactment of state concussion laws, studies have found an increase in reported concussions as well as concussion-related health care utilization, largely thought to be due to increased concussion awareness.[2,4,5,8–11] Studies also show a shift in the type of initial and follow-up health care utilization for concussion from prelaw to postlaw.[2,7,9] Tarimala and associates[12] found a significant increase in follow-up medical care for concussion from prelaw to postlaw among Medicaid insured children in Ohio, with an observed shift from radiology and ambulance services in the prelaw period to primary care providers (PCPs) in the postlaw period. These findings suggest that state concussion laws may have contributed to increased health care utilization for concussion, increasing interactions with medical professionals for injury diagnosis and/or clearance to RTP.[2,4,5,7,9,10]

Existing studies show that rural residents, especially low-income rural children, have less access to health care compared to their urban counterparts, mainly due to the lack of availability of PCPs in rural areas and travel distance to health care providers.[13–15] Prior research has also found significant differences in the etiology and severity of TBI among rural and urban children, with an increased severity of injury among rural children.[16–20] Stewart et al[16] reported a higher ED visit rate for concussion among urban children as compared to rural children. Despite these important differences between rural and urban children, the influence of location of residence on trends in rates and type of concussion-related health care utilization over time has not been well examined. Given the mandatory medical clearance required by concussion laws, examining the potential rural-urban differences in concussion-related health care utilization could provide empirical data to inform resource planning, and subsequently to provide optimal concussion care for rural and urban children. This study aimed to (1) compare the trends in rates of concussion-related health care utilization over time from 2008 to 2016 between Medicaid insured children living in rural and urban areas in Ohio, and (2) examine the trends in type of concussion-

related health care utilization sought throughout the study period by location of residence (rural or urban).

Methods

Study Design and Population

This retrospective cohort study analyzed Medicaid claims for pediatric concussions, obtained from the Partners For Kids (PFK) database. PFK is a pediatric accountable care organization that provides health care coverage to approximately 330,000 low-income children aged 0 to 21 years with Medicaid managed care health insurance plans in central and southeastern Ohio.[21] The PFK database stores detailed information on medical claims, including date and type of health care utilization, diagnosis, procedure(s), medication(s) prescribed, and treating physician(s) and facilities. It also provides patients' demographic and Medicaid enrollment information.[21]

For the purposes of this study, medical claims for children aged ≤18 years who were treated for a diagnosed concussion between April 1, 2008, and December 31, 2016, were analyzed. We identified concussions using the following International Classification of Diseases, Ninth and Tenth Revisions, Clinical Modification (ICD-9-CM and ICD-10-CM) codes: 850.0, 850.1, 850.11, 850.12, 850.2, 850.3, 850.4, 850.5, 850.9, and codes beginning with S06.0.[22] We selected all injuries with at least one of the aforementioned concussion diagnosis codes during the study period (n = 17,406). To ensure the concussion-related health care utilizations analyzed in this study were truly the first medical encounter for the concussion, we excluded the following 34 injuries: (1) injuries that occurred among children who were not continuously enrolled in PFK for a period of 30 days or more before their initial concussion-related health care utilization (n = 7, 0.04%) and (2) injuries with the initial concussion-related health care utilization before April 1, 2008, or after December 31, 2016 (n = 27, 0.16%). We also excluded injuries with co-occurring severe TBI diagnosis codes (n = 198, 1.14%) and injuries with missing location of residence information (n = 166, 0.96%). A total of 398 injuries were excluded from analysis.

For children with multiple concussion-related health care utilizations, a period of at least 90 days without an additional health care utilization for concussion was required before the patient was eligible. For children with multiple concussion-related ED encounters, a period of at least 30 days without a concussion-related ED encounter was required.[12] The final sample comprised 15,601 unique patients, 17,008 unique treated concussions, and 41,075 total medical provider claims. The Institutional Review Board at the authors' primary institution approved this study.

Study Variables/Measures

Rate of concussion-related health care utilization, an injury-level variable, was calculated as the number of treated concussions among Medicaid insured children (≤18 years) in a month divided by the total number of PFK enrollees aged ≤18 years in the same month, then multiplied by 10,000. A concussion was counted in a particular month based on the date of the initial health care utilization for concussion (not on the date of injury). *Rate of*

concussion-related health care utilization in rural (or urban) children was calculated as the number of treated concussions among children (≤18 years) living in *rural (or urban)* areas in a month divided by the total number of PFK enrollees at the same age living in *rural (or urban)* areas in the same month, then multiplied by 10,000.[12,21]

Type of initial (or follow-up) health care utilization for concussion, a claim-level variable, was classified based on the primary specialty of the provider associated with each claim: (1) ED, (2) PCP, (3) specialty care (eg, sports medicine, radiology), and (4) all others (eg, diagnostic testing, home health, consultations). Proportions of each type of initial (or follow-up) health care utilization for concussion were calculated and analyzed as one of the outcomes of interest.

Law Period, an injury-level variable, was measured as prelaw and postlaw based on the effective date of Ohio's concussion law, April 26, 2013.

Location of residence (rural or urban) was defined based on the ZIP Code of the patient's billing address and then coded using The US Census Bureau's rural-urban classification[23] and the Health Resources and Services Administration's Federal Office of Rural Health Policy (FORHP) data files (see supplementary material).[24]

Demographic variables included patient sex and age group (<5 years, 5–9 years, 10–14 years, 15–18 years) based on age at initial concussion-related health care utilization.

Statistical Analysis

Descriptive statistics were used to describe and compare sex and age distributions of concussion-related health care utilization by location of residence (rural vs urban). We first calculated rates of health care utilization for concussion per 10,000 PFK member years by location of residence and modeled the changes in the rates over time, at injury level, by location of residence using Poisson regressions, adjusting for sex and age groups. We included an interaction term (year of concussion-related health care utilization by location of residence) in the Poisson regression models to determine rural-urban differences in trends in the rates of concussion-related health care utilization. We then calculated proportions of each type of health care utilization over time by location of residence and by initial or follow-up visit. We modeled the changes in proportions of type of health care utilization over time at the claim level, stratified by initial or follow-up visit, by location of residence using simple linear regression. We included an interaction term (type of concussion-related health care utilization by location of residence) in the simple linear regression models to determine rural-urban differences in trends in the type of concussion-related health care utilization. Data were analyzed using SAS® 9.4 (SAS Institute Inc., Cary, NC). An α level of 0.05 was set a priori as the threshold for significance in all analyses.

Results

Characteristics of Treated Concussions

Of the 17,008 treated concussions, 64.0% were among males, 72.4% were sustained by children aged 10 to 18 years, and nearly two-thirds (66.0%) were sustained by children

who resided in urban areas (Table 1). Over half (n = 9,422, 55.4%) of treated concussions occurred following the enactment of Ohio's concussion law on April 26, 2013.

Trends in the Rate of Concussion-Related Health Care Utilization

We observed consistently higher rates of concussion-related health care utilization per 10,000 PFK membership years in rural children as compared to urban children throughout the study period, adjusting for sex, age, and year ($P < .0001$) (Figure 1). For both rural and urban children, we observed a significant increase in the rate of concussion-related health care utilization over time, with a turning point in the rates of concussion-related health care utilization in 2013, followed by the flattening of the rates after 2013 (Figure 1). We also observed a seasonal trend in rates of concussion-related health care utilization throughout the study period, with the highest rates occurring in the third quarter (July to September) of each year (data not tabled).

Trends in the Type of Health Care Utilization for Concussion

Initial Medical Care—While during the earlier study period the highest proportion of claims for initial care, for both rural and urban children, was for care sought through an ED physician, we observed significant rural-urban differences in the trends in proportions of initial care sought through the ED over time ($P = .0054$) (Figure 2A). Specifically, we observed a significant decrease in the proportions of initial care sought from ED physicians among urban children during the study period (from 49.5% in 2008 to 37.4% in 2016, $P = .0071$), whereas, during the same period, the proportions of initial care sought through the ED remained unchanged among rural children ($P = .5711$) (Figure 2A).

Furthermore, while the proportions of initial care through PCPs increased among both rural (from 19.9% in 2008 to 38.2% in 2016, $P = .0072$) and urban (from 16.0% in 2008 to 47.6% in 2016, $P < .001$) children (Figure 2B) over time, a significantly greater increase in such trends was observed in urban children ($P = .0172$) (Figure 2B).

The proportions of claims for initial care sought from specialty care providers significantly decreased for both rural ($P = .0294$) and urban ($P = .0104$) children (Figure 2C) over time, as did the proportion of claims for other health care providers ($P = .0182$ for rural children; $P = .0095$ for urban children) (Figure 2D). No significant rural-urban differences, however, were observed in the trends in initial care sought from specialty care providers ($P = .7686$) (Figure 2C) or other health care providers ($P = .6714$) (Figure 2D).

Follow-Up Medical Care—Throughout the study period, for both rural and urban children, the highest proportion of claims for follow-up care was for care sought through PCPs (Figure 2F). No significant rural-urban differences in the trends of follow-up care sought through PCPs were observed ($P = .8999$) (Figure 2F). For both rural and urban children, the lowest proportion of claims for follow-up care was for care sought through the ED, although there were significant rural-urban differences in the trends over time ($P = .0464$) (Figure 2E). Specifically, the proportion of claims for follow-up care sought through ED physicians significantly decreased over time among urban children (9.14% in 2008 to

2.40% in 2016; $P = .0006$), but no such trend was observed among rural children ($P = .1490$) (Figure 2E).

While no rural-urban differences in trends of proportions of follow-up care sought from specialty care providers ($P = .2427$) (Figure 2G) and other health care providers ($P = .8576$) (Figure 2H) were observed, the proportions of claims for follow-up care sought from other health care providers significantly decreased over time among both rural ($P = .0139$) and urban ($P = .0034$) children (Figure 2H).

Discussion

This study described the effect of location of residence on trends in the rates and type of concussion-related health care utilization over time from 2008 to 2016 among Medicaid insured children aged ≤18 years from rural and urban areas in Ohio. Our findings showed an increase in concussion-related health care utilization over time; rates of treated concussion were higher in rural than urban children throughout the study period. Significant rural-urban differences in patterns of concussion-related health care utilization were also observed. This study fills an important gap in the literature by identifying rural-urban differences in patterns of health care utilization for concussion over time among Medicaid insured children living in rural or urban areas in Ohio. These findings may have important implications for policy makers, clinicians, state Medicaid programs, and concussion prevention advocates. For example, understanding service utilization patterns by geographic region is essential to ensuring that clinicians are trained and available for the demands of their geographic region. Further research identifying the sociodemographic and environmental factors contributing to such differences is urgently needed.

Our results showed that rates of concussion-related health care utilization were consistently higher in rural children throughout the study period. These results suggest that rural children with Medicaid might be at greater risk for concussion or more likely to seek concussion-related care than urban children with Medicaid. This finding is inconsistent with previous research that found a higher ED concussion visit rate among urban children as compared to rural children.[16] Prior studies[25–29] have found a higher risk of all cause injury in rural areas, as compared to urban areas, which may partly explain the higher rate of concussion-related health care utilization among rural children with Medicaid. Additional research is needed to investigate factors contributing to the higher concussion-related health care utilization rates observed in rural children, which could potentially inform the development of tailored strategies to treat and prevent pediatric concussions in rural and urban areas.

We found different trends in the type of initial concussion-related health care utilization sought over time from 2008 to 2016 in rural and urban children. Rural children were most likely to seek initial care from the ED throughout the study period, while the most common initial medical care sought for urban children changed over time from the ED to PCPs. In addition, we found that the proportion of initial care from ED physicians remained unchanged over time among rural children, whereas it significantly decreased among urban children during the same period. The proportion of initial medical care sought through PCPs increased over time among both rural and urban children. One potential explanation for the

observed shift in type of initial medical care sought for concussion is increased awareness of guidelines that recommend seeking initial medical care from a PCP following a concussion. Another potential explanation is that, following the enactment of Ohio State's concussion law in 2013, families sought medical care for less serious cases of concussion and therefore chose to go to a PCP as opposed to the ED. Perhaps this shift in the most common type of initial care sought was not observed among rural children due to problems with the accessibility of PCPs in rural areas or as a result of limited ambulatory care hours and fewer primary care alternatives in rural areas, requiring an ED visit for PCP-treatable conditions such as concussion. Rural EDs may also be more integrated with the primary health care system, which may have contributed to this observed trend.[13,30] These findings may suggest that more region-specific health care delivery planning is warranted. Future studies should examine factors associated with these observed rural-urban differences in service utilization such as barriers in access to health care for rural Medicaid insured children after concussion. Identifying barriers in access to health care could potentially help develop strategies that improve access to PCPs following concussion, especially for rural children.

Our results showed that for both rural and urban children, follow-up care sought at a PCP remained the most common throughout the study period, with the proportion of claims for follow-up care remaining stable over time for both rural and urban children. This finding is consistent with prior research[31] that suggests PCPs are frequently the health care provider of choice for follow-up care for concussion as they know the child best and are often the most accessible. ED physicians and other health care providers may therefore refer concussed youth to PCPs for follow-up care to ensure the safe return to normal activities such as school and sport following concussion. Results also showed that the proportion of claims for follow-up care through specialists increased among urban children during the study period, while the proportion of follow-up care with ED physicians (urban children only) and other health care providers (both rural and urban children) decreased. The reason for these observations is not immediately clear, although this may be a response to clinical need or an increased supply of specialists within urban areas in central and southeastern Ohio. Further work needs to be done to understand the variations in type of follow-up care sought by location of residence. Nonetheless, our findings, in line with others,[31,32] highlight the need to formally train PCPs about concussion management and provide them with educational and referral support to care for concussed youth.

Consistent with prior studies,[7,8,33] we found a seasonal trend in rates of concussion-related health care utilization, with rates highest in quarter 3 (July-September) of each year throughout the study period, regardless of location of residence. This apparent seasonal trend in rates of concussion-related health care utilization may be due to seasonal-related activities in quarter 3 that carry an increased risk of concussion, that is, American football, soccer, cycling, and all-terrain vehicle (ATV) use. Another potential explanation for the observed seasonal trend is the large amount of national attention on the potential short- and long-term effects of concussion on football players, leading to increased identification and improved diagnosis of concussion among the pediatric population, especially among youth football players. These results further emphasize the importance of improving prevention efforts, especially among seasonal-related activities associated with an increased risk of concussion.

Limitations

This study has several limitations that warrant attention. First, we classified location of residence by the residential ZIP Code of the patient's billing address. This may have resulted in the misclassification of patient's location of residence as some ZIP Codes cover large areas that include both rural and urban regions. Second, we only examined concussion-related health care utilization for treated concussions; thus, our results are likely an underestimate of the number of concussions. Third, we did not examine mechanism of injury or other potential confounders, including the enactment of the Affordable Care Act or increased media coverage of concussion during the study period that may have affected trends in the rates and type of initial and follow-up health care utilization for concussion among Medicaid insured children. Fourth, our results were based on Medicaid insured, low-income children in central and southeastern Ohio, and our findings may not generalize to all Medicaid insured children across the United States nor youth with different types of health insurance. Future work should use national data to confirm the observed findings across states and among children ≤18 years with different types of health insurance (ie, Medicaid insured vs private insurance). Finally, the observed rural-urban differences in trends in rates and types of concussion-related health care utilization over time in this study cannot be solely attributed to the enactment of Ohio State's concussion law.

Conclusions

Our findings showed increased concussion-related health care utilization rates over time from 2008 to 2016 for both rural and urban children, with rates consistently higher in rural children throughout the study period. We also observed a shift in the type of initial and follow-up health care utilization for concussion over time with different trends in rural and urban children. These findings add to the current literature on how location of residence may influence the rates and type of concussion-related health care utilization. The results of this study suggest that strategies to prevent pediatric concussion are needed, especially in rural areas. Future studies that use national data are needed to confirm the observed effects of location of residence on concussion-related health care utilization.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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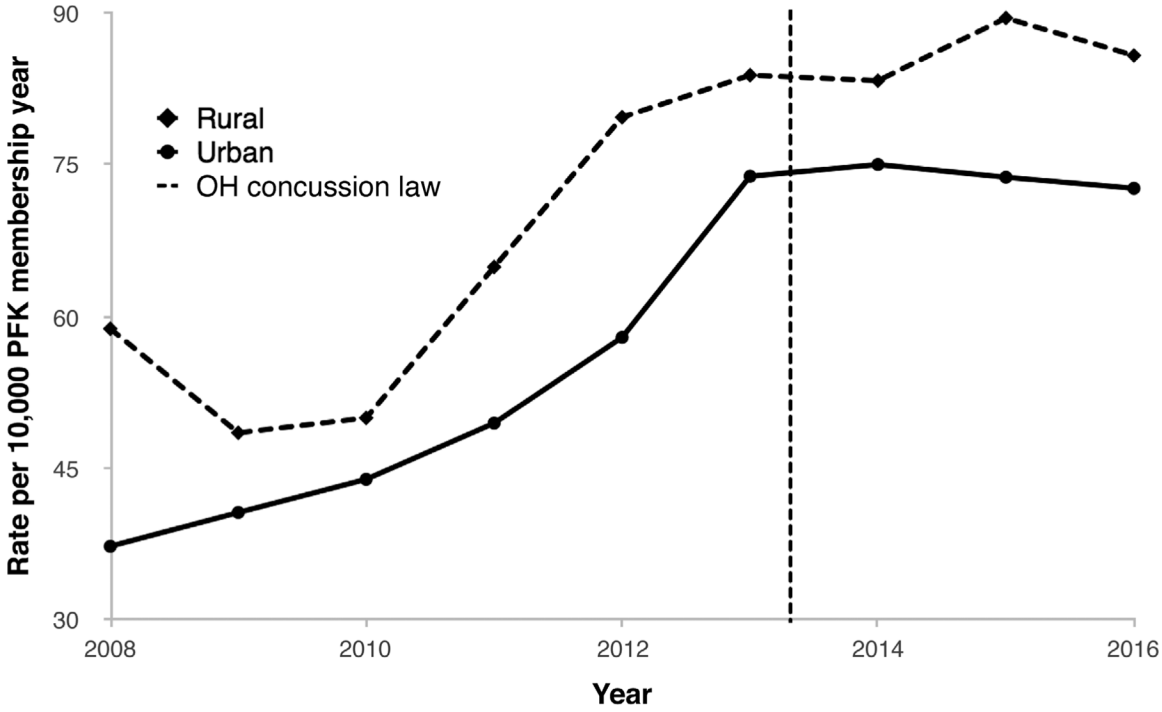

Figure 1. Rate of Concussion-Related Health Care Utilization per 10,000 PFK Membership Year Throughout the Study Period by Location of Residence (Rural or Urban).

Note: The vertical dashed line represents the Ohio concussion law effective date of April 26, 2013; difference in trends in the rates were modeled using Poisson regressions, adjusting for sex, age, and year.

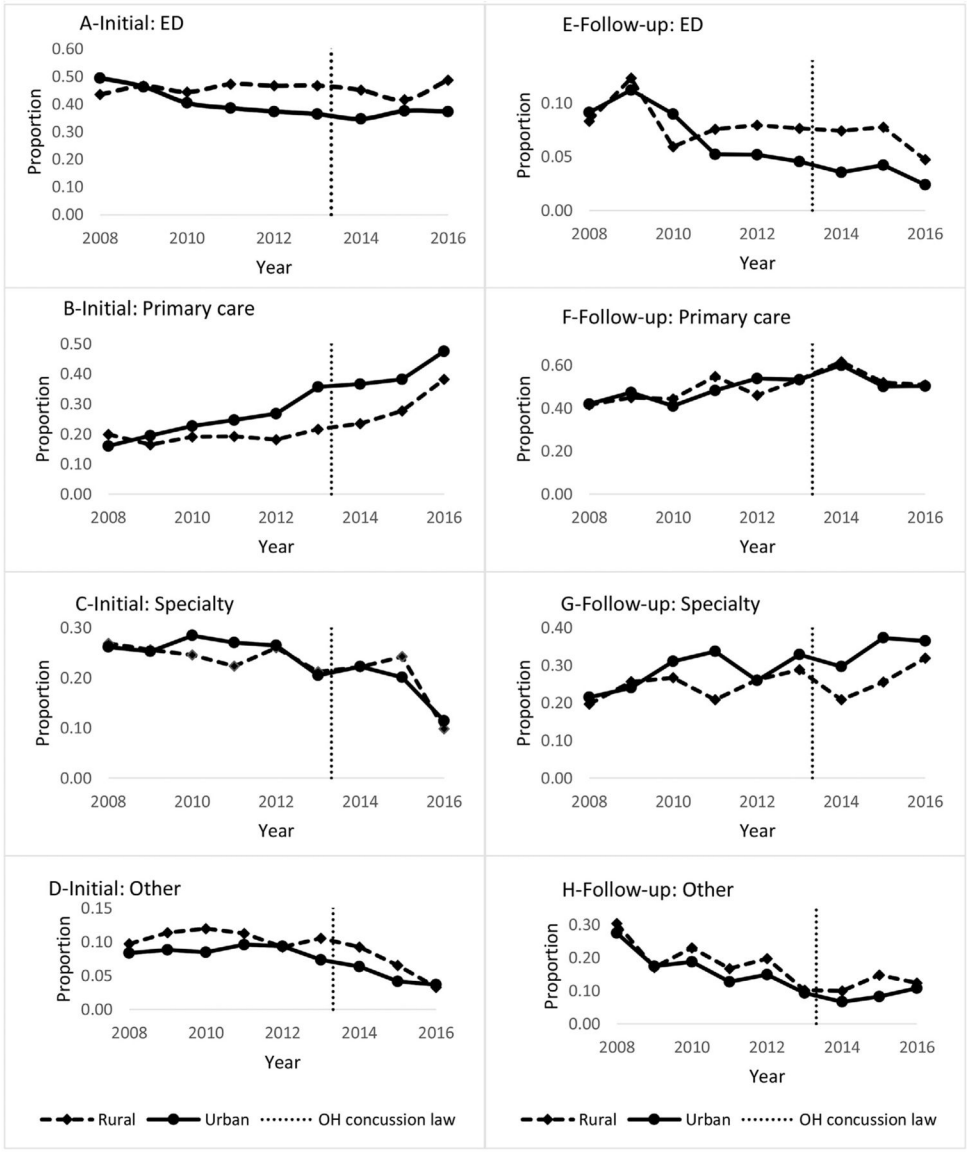

Figure 2. Type of Initial and Follow-Up Concussion-Related Health Care Utilization by Location of Residence.

Note: A, Initial medical care sought at the emergency department (ED); B, initial care sought through a primary care provider (PCP); C, initial care sought through a specialty care provider; D, initial care sought at other health care provider. E; follow-up care sought at ED; F, follow-up care sought at PCP; G, follow-up care sought at specialty care provider; H, follow-up care sought at other health care provider.

Table 1

Participant Demographics

Characteristics	Overalln (%)	Ruraln (%)	Urbann (%)	*P* Value[a]
Total	17,008	5,776 (34.0)	11,232 (66.0)	
Sex[b]				
Male	10,881 (64.0)	3,758 (65.1)	7,123 (63.4)	.0314
Female	6,084 (35.8)	2,002 (34.7)	4,082 (36.3)	
Age at first visit				
<5 years	2,004 (11.8)	743 (12.9)	1,261 (11.2)	< .0001
5–9 years	2,695 (15.8)	825 (14.3)	1,870 (16.6)	
10–14 years	6,100 (35.9)	2,027 (35.1)	4,073 (36.3)	
15–18 years	6,209 (36.5)	2,181 (37.8)	4,028 (35.9)	

[a] *P* values based on chi-square tests of the distributional difference between rural and urban.

[b] There were 43 injuries with a missing value on variable sex.