CHARACTERISTICS OF NEIGHBORHOODS WHERE EMERGENCY MEDICAL SERVICES ENCOUNTER CHILDREN AT RISK FOR MALTREATMENT

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ABSTRACT

Objective: The objective of this study was to determine if neighborhood rates of pediatric Emergency Medical Services (EMS) encounters correlate with rates of child maltreatment reporting and if there are neighborhood-level risk factors for EMS encountering children with maltreatment reports. Methods: We conducted a retrospective cohort study using the electronic medical records of children ages <18 years who had Columbus Division of Fire EMS encounters between 2011 and 2015. We used Nationwide Children’s Hospital electronic medical records to identify child maltreatment reports. The EMS scene addresses and home addresses associated with maltreatment reports were geocoded independently and rates for each Census tract were calculated. The maltreatment reports were matched to the EMS encounters using name, gender, and date of birth. Rates of EMS encounters with children that had a maltreatment report were calculated for each Census tract. Census tract demographic information was obtained from the American Community Survey. Bayesian conditional autoregressive Poisson models were used to calculate rate ratios for census tract variables to determine their relationship to EMS encountering children with maltreatment reports. Results: A total of 44,002 EMS encounters and 4,298 maltreatment reports were included in the study. The Spearman correlation coefficient relating rates of EMS encounters to rates of maltreatment reports within census tracts was 0.72 (95% confidence interval, 0.65-0.77). Within the study period, a total of 1,134 EMS encounters were linked to 578 children with maltreatment reports. Poverty was the only independent risk factor for EMS encountering children with maltreatment reports. The multivariate analysis also identified protective factors, which included neighborhoods with higher proportions of residents who had bachelor’s degrees, spoke a language other than English, and had the same residence the previous year. Conclusion: This study showed that in Franklin County, Ohio, neighborhoods with high EMS utilization had a strong positive correlation with areas that had high rates of child maltreatment reports. We also identified four neighborhood characteristics that were independently associated with EMS encountering children at risk for maltreatment (risk factor: poverty; protective factors: residents with college educations, non-English speaking households, and residents maintaining the same residence as the previous year). Key words: emergency medical services; child abuse; child maltreatment; risk factors; protective factors; poverty

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BACKGROUND

In 2016, child protective services in the United States received reports on an estimated 2.3 million children, of whom 676,000 were identified as child maltreatment victims (1). The true incidence of child maltreatment is unknown as child maltreatment, if identified, is often underreported. A study of pediatricians showed that only 24% of injuries in which abuse was suspected were reported (2). Preventing child maltreatment is contingent on recognizing and reporting children at risk for maltreatment, which is the responsibility of healthcare providers among others (3).

Emergency Medicine Services (EMS) providers, like other healthcare professionals, underreport
child maltreatment. The reasons that were cited for underreporting include being primarily focused on the child’s medical complaint, thinking someone else will report, needing absolute certainty of child maltreatment, or being unsure of what constitutes child maltreatment (4, 5). Prehospital personnel are in a unique position to identify maltreatment because they observe children in the environments in which they live and are among the only healthcare providers who can observe environmental maltreatment risk factors (5). Despite this position, a minimal amount is known about EMS encounters with maltreated children including the frequency of these encounters.

While the frequency of EMS encounters with maltreated children is unknown, there are studies investigating how maltreatment victims access health care. One study found that child maltreatment victims were more likely to change primary care providers in the year prior to maltreatment but that there was no difference in the frequency of emergency department presentations (6). Another study evaluated EMS utilization among pediatric homicide victims, a population more likely to have a maltreatment history (7, 8). These pediatric homicide victims were twice as likely to use EMS than children who died of natural causes, and approximately one third of these victims utilized EMS services on the day of death (9). EMS utilization among non-fatal child maltreatment victims has not been well studied.

Children who use EMS and child maltreatment victims have been described as separate populations. Children who used EMS were more likely to be nonwhite, have an urban residence, seek injury or poisoning treatment, and lack insurance (10). Previously identified child maltreatment risk factors included low-income households, ethnicity, large family size, young maternal age, low maternal education, and single parent households (11). This literature suggests that there may be shared sociodemographic characteristics between the neighborhoods of children who encounter EMS and those who experience child maltreatment.

The objective of this study was to determine if neighborhood rates of children utilizing EMS correlate with child maltreatment reporting rates and to determine if there are neighborhood-level risk factors for EMS encountering children with maltreatment reports. We hypothesized that neighborhood rates of EMS pediatric encounters correlated with child maltreatment reporting rates and that there were neighborhood-level risk factors associated with rates of EMS encountering children with maltreatment reports.

### Methods

#### Study Design

We conducted a retrospective cohort study of children ages 0–17 years, with a Columbus Division of Fire EMS encounter and/or children with a maltreatment report filed by Nationwide Children’s Hospital from January 1, 2011 through December 31, 2015. To determine the correlation between EMS pediatric encounters and child maltreatment reports at the neighborhood-level, we compared the cohort of children with EMS encounters to the cohort of children with maltreatment reports. To examine neighborhood-level rates of EMS encounters involving children with maltreatment reports and to identify neighborhood-level factors related to EMS encountering these children, we limited the analytic cohort to only children with an EMS encounter and within that cohort, identified children with a maltreatment report. We used maltreatment reports as a proxy for maltreatment risk.

#### Setting

Nationwide Children’s Hospital is a large, free-standing pediatric quaternary medical center within Franklin County, Ohio, which provides care to over 90% of the children within its primary catchment area. Columbus Division of Fire is the largest EMS provider of the 26 providers that service Franklin County, Ohio with over 10,000 pediatric encounters annually. Columbus Division of Fire provides 30% of total transports to Nationwide Children’s Hospital. All of Columbus Division of Fire’s providers are paramedics with Advanced Life Support training and can run independent of a fire response.

#### Eligibility Criteria

We included children ages 0–17 years who had an EMS encounter or a maltreatment report filed at the hospital. Children who had more than one maltreatment report for the same encounter were included once. However, if a child with a maltreatment report had multiple EMS encounters over the study period, each encounter was included. We excluded encounters where the address could not be mapped and EMS encounters and child maltreatment reports from census tracts not covered by Columbus Division of Fire. We also excluded children who had maltreatment reports for dependency, a classification used when a family requires child protective services involvement deemed to be of no fault to the parent or caregiver (12).
Data Sources

We queried hospital electronic medical records (EMRs) for children ages 0–17 years that had a completed ‘child maltreatment report’, the hospital-based form used when a maltreatment report is made to a child protective services agency. EMR data elements included medical record number, patient name, date of birth, race, sex, address of patient, date of medical evaluation, and type of maltreatment reported. Type of maltreatment report is categorized as physical assault, physical abuse, sexual assault, sexual abuse, child welfare concerns, dependency, emotional abuse, neglect, and other. For ease of analysis, we combined physical abuse and physical assault, as well as sexual abuse and sexual assault, because the categorical differences are typically due to injury timing. Similarly, the analysis combined emotional abuse and neglect as they both are identified as a pattern over time. Using a modified Delphi approach, two child abuse experts re-classified “other” maltreatment report types into one of the remaining categories: physical abuse/assault, sexual abuse/assault, neglect, or child welfare concerns.

EMR data from all pediatric encounters during the study period were obtained from Columbus Division of Fire and included patient name, date of birth, age, gender, race, address of encounter, time of encounter, patient’s address, scene address, incident type, disposition, and destination. These records are completed by the paramedics after the encounter.

Data Analysis

We independently geocoded EMS encounter scene addresses and maltreatment report home addresses and mapped them as rates for each census tract to determine the correlation between rates of pediatric EMS encounters and maltreatment reports within neighborhoods. There are 284 census tracts in Franklin County; however, Columbus Division of Fire does not provide EMS coverage for the entirety of Franklin County. If Columbus Division of Fire provided service within any part of a census tract, the analysis included the information from that census tract. The census tract also had to have at least 100 children who reside in the tract to be included. Thus, the comparison of the two larger groups of EMS encounters and child maltreatment reports included 249 of 284 Franklin County census tracts. We calculated the rates of pediatric EMS encounters and maltreatment reports per 1000 residents ages 0–17 years using the 2011–2015 five-year population estimates from the U.S. Census Bureau’s American Community Survey. Rates grouped into quartiles for both pediatric EMS encounters and maltreatment reports had descriptive spatial patterns and Spearman correlation coefficient calculated relating Census tract rates for EMS encounters to Census tract rates for maltreatment reports.

To identify neighborhood-level factors associated with EMS encountering children with maltreatment reports, we limited the analysis to the EMS encounters and within this cohort, identified children with a maltreatment report. For this analysis, we include census tracts in the catchment area with EMS encounters. An excluded tract contained the airport because of lack of covariate information. Therefore, this analysis included 258 of 284 Franklin County census tracts included was 258 of 284.

We matched EMS encounters to maltreatment reports using name, gender, and date of birth. Probabilistic record linkage implemented in the RecordLinkage R package completed the matching (13). Records were grouped by gender with a phonetic comparison applied to names and a string comparison to date of birth. EpiWeights provided a weight for each match and determined a priori weights greater or equal to 0.95 to be an appropriate match (14). Research staff reviewed a random sample of 20% of appropriate matches to confirm that the records were matched appropriately. Every record in the random sample was appropriately matched, determined by date of birth, if a hospital encounter occurred on the same day as the EMS encounter, or address of EMS encounter.

Possible matches included records with a weight of 0.80 to 0.95. Research staff systematically reviewed these possible matches by comparing the EMS data to the hospital EMR. The first step compared the date of birth between the EMS records and hospital EMR. If the patient of the maltreatment report was born after the EMS encounter date, we excluded the match. The next step determined if the patient had a hospital encounter on the same day as the EMS encounter date. If an encounter existed, the match was included. If no hospital encounter occurred on the day of the EMS encounter, the third step compared the EMS encounter address with the hospital EMR address. If the address from the child’s EMS encounter could be found in the hospital EMR demographics or on a patient consent form, the match was included.

We used neighborhood-level characteristics from the 2011–2015 five-year estimates from American Community Survey for census tracts in the Columbus Division of Fire catchment area. We fit Bayesian Poisson generalized linear mixed effects models to assess the association between neighborhood-level characteristics and EMS encounter rates.
of children with maltreatment reports (15). We modeled the count of EMS encounters with children with maltreatment reports at each address with an EMS run. We used an offset to adjust for the number of EMS runs at each address. We included two random effects to account for sources of correlation. The first was a spatial random effect for each census tract that follows a conditional autoregressive model where the neighborhood structure was defined by an adjacency matrix (16). The second random effect was to capture uncorrelated heterogeneity specific to an address and was independent and identically distributed. We specified weakly informative prior distributions for all parameters in the model. The full model details are included in a supplement. The INLA package in R estimated posterior distributions for the parameters using integrated nested Laplace approximations (17).

First, we fit models to assess univariable associations for each covariate considered. The list of covariates and definitions are presented in Table 1. Using a forward selection-like approach, we fit a multivariable model retaining the most important covariates while considering model fit using the deviance information criterion and collinearity (18). We calculated posterior summaries and 95% credible intervals to estimate rate ratios associated with each covariate.

### Study Design

#### Human Subjects Review

The Nationwide Children’s Hospital Institutional Review Board approved this study with a waiver of informed consent and a HIPAA waiver.

#### Results

##### Cohort Eligibility

There were 45,694 EMS pediatric encounters over the 5-year study period (Figure 1). We excluded

| Term                          | Definition according to Census Bureau Glossary |
|-------------------------------|-----------------------------------------------|
| Median Age                    | Refers to the median age of each tract        |
| White                         | A person having origins in any of the original peoples of Europe, Middle East, or North Africa |
| Latino                        | Hispanic or Latino refers to a person of Cuban, Mexican, Puerto Rican, South or Central American, or other Spanish culture or origin regardless of race |
| Language spoken at home:      | The language currently used by respondents at home, either a non-English language which is used in addition to English or in place of English |
| Married                       | Adults are generally classified by marital status as being married, never married, separated, divorced, or widowed |
| High School Degree            | Refers to the highest level of education complete in terms of the highest degree or highest level of schooling completed |
| Average Family Size           | Refers to the number of people in a family |
| Owning a Home                 | Provides current information on characteristic of housing units available for occupancy, as well as on homeownership (Housing Vacancies and Homeownership) |
| Bachelor’s Degree             | Refers to the highest level of education complete in terms of the highest degree or highest level of schooling completed |
| Households with Children      | The proportion of households with one or more people under age 18 |
| Over 18 years old             | The proportion of the population that has the age of 18 years or greater when answering the length of time in completed years that a person has lived as of April 1 of that Census year (Age) |
| Poverty Rate                  | A set of money income thresholds set by the Office of Management and Budget that vary by family size and composition to determine who is in poverty. If the total income for a family falls below the relevant poverty threshold, then they are considered in poverty (Poverty) |
| Disability Rate               | A long-lasting physical, mental, or emotional condition. This condition can impede a person from being able to go outside the home alone or to work at a job or business |
| Health Insurance              | Classified as private, public, or uninsured. Public includes federal programs such as Medicare, Medicaid, VA Health Care, and the Children Health Insurance Program. TRICARE was considered private insurance |
| Unemployment Rate             | Represents the number of unemployed people as a percentage of civilian labor force |
| Labor Force Participation Rate| Represents the proportion of the population that is in the labor force |
| Foreign Born                  | Refers to people who are not U.S. citizens at birth. Includes naturalized U.S. citizens, lawful permanent residents (immigrants), temporary migrants, humanitarian migrants, and persons illegally present in the U.S. |
| Same Residence Last Year      | Indicates the place of residence in the reference year for those who reported that they lived in a different housing unit or group quarter at time |
| Occupied Housing Units        | The proportion of the homeowner housing inventory that is vacant for sale (Homeowner vacancy rate) |
1,691 encounters due to occurrence outside of the primary catchment area. Twenty encounters had reported address inaccuracies; however, when mapped using Google Maps, 19 were valid Franklin County addresses. We excluded 1 address that could not be found. The study included a total of 44,002 EMS pediatric encounters.

During this period, there were 7,183 maltreatment reports filed at the hospital, of which 41 were excluded for patients 18 years or older (Figure 1). Missing data or a dependency classification excluded 385 hospital maltreatment reports. Out of the 102 maltreatment reports classified as “other”; two were patients 18 years or older (included in the previously stated 41); and the remaining 100 were reclassified into the remaining categories. The child’s home address occurring outside of Franklin County excluded an additional 2,459 reports. The study included a total of 4,298 children with maltreatment reports.

Probabilistic record linkage matched the 44,002 EMS pediatric encounters and the 4,298 children with maltreatment reports. A total of 1,134 EMS pediatric encounters were linked to 578 children with maltreatment reports.

For the children who had an EMS encounter and a child maltreatment report, all EMS encounters during the study period were included. Of these 578 children, 245 children had multiple EMS encounters. The median number of encounters for those 245 children was 2 and the third quartile was 3, indicating that most children with multiple encounters only had one or two additional encounters. However, the maximum number of encounters was a total of 58 EMS encounters during the 5-year period.

Description of Cohorts

Table 2 presents demographic characteristics of children included in the study. The median ages of children in the child maltreatment (5.0 years) and EMS groups (6.0 years) were older than children in the EMS subgroup that had maltreatment reports (3.0 years). Children in the EMS group were more likely to be male (52.2%) compared to children in the child maltreatment group (40.4%) and children in the EMS subgroup that had maltreatment reports (40.7%). Children in all groups: the EMS group, child maltreatment group and the children in the EMS subgroup that had maltreatment reports were more likely to be black (43.2%, 45.4%, and 48.5%) than Caucasian (24.2%, 37.5%, and 23.6%). However, for the EMS group and the children in the EMS subgroup that had maltreatment reports, race data was missing in almost one in four cases (23.1% and 23.4%). Children in the EMS subgroup that had maltreatment reports were more likely than the overall
EMS group to be transported to Nationwide Children’s Hospital (49.3% vs. 34.6%). However, 58.2% of children in the EMS group were not transported to a hospital, which included 45.8% of the EMS subgroup that had maltreatment reports. Sexual abuse/assault was slightly more common than physical abuse/assault in the child maltreatment group (35.9% and 33.6%); but, the EMS subgroup that had maltreatment reports sexual abuse/assault and physical abuse/assault were no different (both at 29.8%). Children that were in the EMS subgroup that had maltreatment reports had a higher proportion of neglect than the overall child maltreatment group (16.6% and 11.0%).

**Neighborhood Characteristics**

The calculated rates of both EMS encounters and maltreatment reports were grouped into quartiles and mapped by census tract (Figure 2). The range for census tract rates for EMS pediatric encounters in tracts with at least 100 children was 0–726 per 1,000 child person years of residents aged 0–17 years. The rate quartiles for EMS pediatric encounters were as follows:

- **Rate Quartile**
  - 0-8
  - 8-28
  - 28-72
  - Over 72

And for child maltreatment reports:

- **Rate Quartile**
  - 0-1
  - 1-3
  - 3-6
  - Over 6

**TABLE 2. Characteristics of children with emergency medical services (EMS) encounters, children with maltreatment reports, and the subgroup of children that had both EMS encounters and child maltreatment reports**

|                          | Children with EMS encounters (N = 44,002) | Children with maltreatment reports (N = 4,298) | Children with both EMS encounters and child maltreatment reports (N = 920) |
|--------------------------|--------------------------------------------|-------------------------------------------------|---------------------------------------------------------------------------|
| Age (median years (interquartile range)) | 6.0 (1.0, 13.0)                           | 5.0 (2.0, 12.0)                                 | 3.0 (1.0, 11.0)                                                           |
| Sex (n, column%)          |                                            |                                                 |                                                                           |
| Male                     | 22,982 (52.2%)                             | 1,736 (40.4%)                                  | 462 (40.7%)                                                               |
| Female                   | 20,841 (47.4%)                             | 2,561 (59.6%)                                  | 672 (59.3%)                                                               |
| Missing                  | 179 (0.4%)                                 | 1 (0.02%)                                      | 0                                                                         |
| Race (n, column%)         |                                            |                                                 |                                                                           |
| Black                    | 19,011 (43.2%)                             | 1,953 (45.4%)                                  | 550 (48.5%)                                                               |
| Caucasian                | 10,668 (24.2%)                             | 1,611 (37.5%)                                  | 268 (23.6%)                                                               |
| Other                    | 4,166 (9.5%)                               | 716 (16.7%)                                    | 51 (4.5%)                                                                 |
| Missing                  | 10,157 (23.1%)                             | 18 (0.4%)                                      | 265 (23.4%)                                                               |
| Destination (n, column%) |                                            |                                                 |                                                                           |
| NCH                      | 15,230 (34.6%)                             | N/A                                            | 559 (49.3%)                                                               |
| Other                    | 3,185 (7.2%)                               | N/A                                            | 56 (4.9%)                                                                 |
| None                     | 25,587 (58.2%)                             | N/A                                            | 519 (45.8%)                                                               |
| Report Type (n, column%)  |                                            |                                                 |                                                                           |
| Physical abuse/assault    | N/A                                        | 1,443 (33.6%)                                  | 338 (29.8%)                                                               |
| Sexual abuse/assault      | N/A                                        | 1,541 (35.9%)                                  | 338 (29.8%)                                                               |
| Neglect                  | N/A                                        | 472 (11.0%)                                    | 188 (16.6%)                                                               |
| Child welfare concerns    | N/A                                        | 842 (19.6%)                                    | 270 (23.8%)                                                               |

N/A = not applicable.
encounters were 0–8 encounters per 1,000 child person years in the first quartile, 8–28 in the second quartile, 28–72 in the third quartile and over 72 encounters in the fourth quartile.

The range for census tract rates of maltreatment reports per 1,000 child person years was 0–41. The rate quartiles for maltreatment reports were 0–1 reports per 1,000 child person years in the first quartile, 1–3 reports in the second quartile, 3–6 reports in the third quartile and over 6 reports in the last quartile. The Spearman correlation coefficient relating EMS encounter rates to maltreatment report rates within census tracts was 0.72 (95% confidence interval, 0.65–0.77).

Neighborhood-level factors associated with EMS encountering children with maltreatment reports

Figure 3 presents the univariable estimates of census tract characteristics associated with EMS encountering children with maltreatment reports. Census tract variables that had positive associations with EMS encountering children with maltreatment reports included average family size, poverty rate, disability rate, and unemployment rate. Census tract variables that had negative associations with EMS encountering children with maltreatment reports included neighborhoods with a higher proportion of people who were Caucasian, spoke a language other than English, were married, had a high school education, owned their home, had a bachelor’s degree, had more household members over the age of 18, had private health insurance, contributed to the labor force, had foreign born members, had more occupied housing units within a building, and had lived in the same residence the prior year.

A multivariable analysis (Figure 4) found that the census tract’s poverty rate was an independent risk factor for EMS encountering children with maltreatment reports (rate ratio of 1.03, 95% credible interval of 1.01–1.06). A 5% increase in poverty rate was associated with a 3% increase in EMS encounters involving a child with a maltreatment report. The multivariable analysis also identified 3 independent protective factors including the proportions of households with bachelor’s degrees (rate ratio of 0.94, 95% credible interval of 0.91–0.97), households that spoke a language other than English (0.91, credible interval of 0.88–0.95), and households that had the same residence the previous year (0.94, credible interval of 0.90–0.97). Thus, a 5% increase in residents with bachelor’s degrees was associated with a 6% decrease in EMS encounters involving a child with a maltreatment report; a 5% increase in households that spoke a language other than English was associated with an 9% decrease in encounters, and a 5% increase in households that had the same residence the previous year was associated with a 6% decrease in encounters.

Relative rates map

Figure 5 illustrates log standardized rate ratios for each census tract estimated from the multivariate model. The ratios are standardized by the estimated county rate of 5.9 reports per 1,000 EMS runs. The red scales reflect above average rates and the blue scales reflect below
average rates. The more southern, central, and eastern census tracts of the county tended to have above average rates. The more western and northern census tracts of the county tended to have below average rates.

**DISCUSSION**

In Franklin County, Ohio, census tract rates for pediatric EMS encounters showed a strong positive correlation with census tracts rates of maltreatment reports, demonstrating that EMS providers respond to areas where children are at risk for maltreatment. The analysis of neighborhood-level risk factors found that 3 factors were independently protective of EMS encountering children at risk for maltreatment: neighborhoods with a higher proportion of residents who earned bachelor’s degrees, spoke a language other than English, and lived in the same residence during the previous year. Poverty rate was the only independent risk factor for EMS encountering children with maltreatment reports.
This study also showed that in our community, EMS stations in the southern, central, and eastern part of the county encountered children at risk for maltreatment at higher rates than those in the northern or western part of the county.

We found that it is not only common for EMS to encounter children at risk for maltreatment, but sometimes EMS comes in contact with those children multiple times. This is consistent with a recent study that showed that young homicide victims used EMS more often prior to their death than those who died of natural causes (9). This finding supports the need for EMS provider education and training to help them better identify maltreatment. One study developed a checklist for EMS providers to help identify children with maltreatment, however only 50% of users were able to identify the abuse (19). In our community, there are areas with higher rates of EMS contact with children at risk for maltreatment. Knowing this information allows us to focus efforts on areas where interventions will be most beneficial.

Poverty as a neighborhood-level risk factor for EMS encountering children with maltreatment reports is consistent with previous literature investigating the relationship between community sociodemographic characteristics, EMS use, and child maltreatment. One study revealed that children who live in urban areas and lack insurance (often used as a proxy for low income or poverty) used EMS more often (10). Other studies showed poverty as a neighborhood-level factor associated with child maltreatment (20–24). Recent population-based studies in Ohio demonstrated that poverty and living in areas with high unemployment rates contribute to children’s health disparities (25).

Few studies have investigated possible community protective factors for child maltreatment. Density of child welfare services, Asian race, and higher population age have been associated with lower community child maltreatment rates (20, 26–28). We found that within Franklin County, Ohio, EMS was less likely to encounter children at risk for maltreatment in neighborhoods with higher proportions of residents who had bachelor’s degrees, spoke a language other than English, or lived in the same residence the previous year. Lower education has been cited as a risk factor for child maltreatment (11). Interestingly, living in neighborhoods with a higher proportion of residents who spoke a language other than English was a protective factor in our study. It is unclear if this finding is reflective of higher education or professional status, consistent with the associations for poverty and education, or cultural differences.

Alternatively, it may indicate that child maltreatment is more difficult to identify in a population that does not speak English as a first language and, therefore, reported maltreatment is lower.

An additional neighborhood-level protective factor for EMS encountering children at risk for maltreatment was the proportion of households that lived in the same residence the previous year. The Centers for Disease Control and Prevention has identified concentrated community disadvantage, specifically residential instability, as a child maltreatment risk factor (11). This is also consistent with literature showing that vacant housing, and residential instability were factors associated with higher rates of child maltreatment (20, 29). It is interesting that residential stability, not home ownership, was protective, possibly suggesting that the chaos of living in a neighborhood with transient housing contributes more to maltreatment than socioeconomic status.

Our study determined the protective factors and risk factors based on maltreatment reports as a proxy for being at risk for child maltreatment. Many studies have demonstrated child maltreatment reporting bias (30–32). Previous studies showed that children of lower socioeconomic background and minorities are more often evaluated and reported for maltreatment (30, 32). Consistent with this bias and previous studies, we found children with child maltreatment reports, those who encountered EMS, and the subgroup of children who encountered EMS and had maltreatment reports were more likely to be black (Table 2) (9–10). In multivariable analysis, race was not an independent predictor of EMS encountering children with child maltreatment reports after accounting for other variables in the model.

A large portion of children in Franklin County who were at risk for maltreatment were not transported to the hospital after EMS evaluation (approximately 45.6%). This is significantly more than a recent study that had a 12.7% refusal rate of their pediatric EMS encounters (33). This same study did not see a correlation between suspected maltreatment and refusal of EMS transport; however, the refusal of transport of a patient could be problematic (33). In young infants who are not transported to the hospital, a minor injury could be a missed opportunity to identify a sentinel injury and to intervene. Additionally, parent’s refusal for transport presents a unique problem of having a possible perpetrator limiting the identification of maltreatment, which would be a missed opportunity to protect a vulnerable child.
Limitations

This was a retrospective study; therefore, data was not collected for research purposes and variables may be missing. Child maltreatment reports are only a proxy for maltreatment. We did not have child protective services outcomes data regarding which cases were opened for investigation and the case dispositions (i.e., substantiated, indicated, or unsubstantiated). This is a reasonable proxy; a recent study determined that up to 80% of initially unsubstantiated reports were re-reported and the re-reports were substantiated almost 63% of the time (34). The child maltreatment records included were only those made by the hospital, which is an underestimate of total maltreatment reports made to child protective services for the county. Only maltreatment reports during the study period were included, which could be an underestimate if reports were made outside the study period.

As described in previous literature, there are unique obstacles in performing high-quality out of hospital research (35). We may have made errors linking reports to EMS runs, as there was not a unique identifier common to both data sources. Since the EMS catchment area is not defined by census tracts, we are also limited by spatial misalignment, particularly on the catchment area boundaries. By including tracts that are partly served by EMS, we may have inflated contact rates since we would have failed to capture EMS runs by other providers that service those tracts.

All covariates used in our modeling are estimated at the census tract level, so conclusions related to effects must be interpreted at this level. We cannot make conclusions about individual and household level risk factors from this analysis (36). Instead, we focus on characterizing the socio-demographic environment of neighborhoods with differing rates of EMS contact with children at risk of maltreatment. In addition, census tract characteristics are estimated with error, which we did not account for in our analysis. To minimize the estimation error in the covariates, we used five-year Census estimates.

Conclusion

This study showed that in Franklin County, Ohio neighborhoods with high EMS utilization had a strong positive correlation with neighborhoods that had high child maltreatment report rates. Neighborhood poverty was the only independent risk factor for EMS encountering children at risk for maltreatment. The multivariable analysis also identified protective factors, including neighborhoods with higher proportions of residents who had earned bachelor’s degrees, spoke a language other than English, and had lived in the same residence the previous year. Future studies are needed to identify patient-level risk factors for EMS encounters with children at risk for maltreatment and to evaluate if the relationships observed in this study are present in other communities. These findings will guide future EMS-based interventions aimed at identifying and preventing child maltreatment.

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