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Maternal and child health after injuries: a two-year follow-up of a nationally representative sample

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Abstract

Objective: The objective of this study was to examine the association between childhood injury and health outcomes among survivors and their mothers using a national survey in the United States (US).

Study design: This was a longitudinal analysis of a nationally representative sample.

Methods: Secondary analysis of the 1997–2013 Medical Expenditure Panel Survey (MEPS) was performed. Children (aged 2–18 years) with or without injuries were followed up for two years. Injuries captured in the study were those associated with at least one hospitalization, emergency department visit, or office-based visit. Outcome measures were child and maternal general and mental health status. Multiple mixed-logistic regressions were used with suboptimal health defined as the response of poor or fair health versus good, very good, or excellent health.

Results: Of the 63,422 children analyzed, 3251 (4.9%) were injured, representing 3.6 million US children. Injured children were more likely to be male, white, and older than those without injuries ($P < 0.01$). About a fifth of injured children suffered head injuries. Injuries were strongly associated with suboptimal general and mental health status in children (adjusted odds ratios [AORs], 1.35 and 1.36, respectively, $P < 0.05$). Mothers of children with injuries were also more likely to report suboptimal mental health (AOR, 1.30, $P < 0.05$).

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Ethical approval

This study was granted an exemption status by the School of Public Health Institutional Review Board at Johns Hopkins University as it only used de-identified information from the Household Component of the MEPS.

Competing interests

None declared.

Conclusion: Injuries among children are associated with lasting adverse effects in general and mental health. To improve health outcomes of pediatric injuries, further follow-up care may be needed to ensure that they return to pre-injury health levels. These results highlight the importance of primary prevention and the long-term impact of injuries on the health of children and their mothers.

Keywords

Injuries; Child; Maternal health; Prevention; Self-reported health; MEPS

Introduction

Injuries remain the leading cause of death among children in the United States (US).[1] In addition, they are a significant source of morbidity, as nine million children are treated for injuries in emergency departments (EDs) each year.[2] Consequently, injuries lead to short- and long-term disabilities and drain healthcare resources.[3] These preventable morbidities, as a result, have negative implications for children's future well-being and pose a significant threat to population health.

Reduction in quality of life after injuries is one of the indicators of the burden on population health.[4] Among children, long-term health after injury is a particularly important area of research to identify the prevalence of residual health issues and magnitude of recovery.[5] Failure to achieve complete recovery may affect children for the rest of their lives, leading to severe and possibly permanent disabilities. In addition, injuries may affect children's caregivers (i.e. mothers), compounding the impact of the original trauma. Unfortunately, limited research exists on the impact of traumatic injuries among children and their mothers. Therefore, investigating this area may help quantify the negative impact of injuries not only to children's health but also to the health of their care-givers. This, in turn, may facilitate communicating the burden to researchers, policymakers, and the public to support prevention programs.

Although areas of injury mortality among children have been explored previously,[1,6] little is known about the implications of non-fatal injuries on health outcomes. Many previous studies suffered the limitation of a short follow-up time,[7] not including a comparison population,[8,9] or the use of non-representative samples.[10–12] Furthermore, many studies are retrospective analyses incorporating a cross-sectional analytic approach.[13,14] For cohort studies with multiple follow-up points, longitudinal analysis methods need to be incorporated appropriately to handle the correlation between observations from the same subject. Finally, we are not aware of any previous study that investigated the impact of children's injuries on their health and on the self-reported health of their mothers.

To address this gap, we used a national household survey that follows up families for approximately two years to examine the perceived health status of injured children and their mothers relative to those without injuries beyond the first follow-up year. We hypothesize that injured children and their mothers will have lower levels of health relative to non-injured counterparts beyond the acute stage of injury recovery.

Methods

Analysis of sixteen panels (2–17) from the Medical Expenditure Panel Survey (MEPS) was performed. The MEPS, which is conducted by the Agency of Healthcare Research and Quality (AHRQ), is a nationally representative household survey.[15] These panels span between the years 1997 and 2013. The survey is conducted using a stratified and clustered sampling design and incorporates weights to adjust for inclusion probability, oversampling, and survey non-response. Details on comprehensive information on healthcare use, sources of payment, and insurance coverage are collected in the survey. In addition, the MEPS also surveys respondents regarding their health status and medical conditions.

Every year, a new panel is selected and followed up for about two years. During follow-up, participants complete five rounds of in-person interviews spaced 4–5 months apart. For example, panel five was enrolled in the year 2000, and the last follow-up interview occurred in 2002 (Fig. 1). Two data files from the MEPS were used in the analysis: the medical conditions file and the individual characteristics file. A single respondent from the family is designated to answer the survey questionnaire for all members of the household, including children. The MEPS guidelines recommend the respondent be the family member most familiar with health status and healthcare use in the household.[16]

Participants

Children aged 2–18 years with and without injuries were included in the analysis. Injured children were defined to be those whose parents reported an injury that was associated with at least one hospitalization, ED visit, or office-based visit. To avoid bias due to differences in baseline health, only those injuries occurring on the second or third rounds of the survey were included (Fig. 1). Children without any reported injury throughout follow-up were used as the comparison group.

Outcomes

The primary outcome measures were parent-reported general and mental health status of the child. Using a Likert scale, parents answered the question ‘Would you rate this child’s health as excellent, very good, good, fair, or poor?’ This was also asked for mental health. Outcome measures obtained at the end of rounds three and five (last round) were included in the analysis. Suboptimal health was defined as the binary response of poor/fair health versus good/very good/excellent health. This definition was based on previous literature.[17] A different definition of suboptimal health (poor/fair/good versus very good/excellent) was evaluated to assess if this would affect the results, but they remained consistent. The two outcome measures were also investigated in a subgroup analysis among mothers’ self-reported general and mental health.

Statistical analysis

Because the MEPS is a complex survey, which includes survey weights, strata, and clustering of individuals, all analyses and survey procedures are performed using STATA, version 14 (STATA Corp LP, College Station, TX) to provide nationally representative results of US non-institutionalized populations.[15] Bivariate differences between children

with and without injuries were investigated using a chi-square test, whereas the difference in the mean of age was assessed using a student's t-test, accounting for the complex design of the survey.

The frequency of injury types was queried to identify the most common injuries among children. In addition, long-term general and mental health of injured children, measured at the end of follow-up (round 5), were also evaluated. Once injuries are reported during the survey as verbatim text, professional coders from the AHRQ convert those conditions into International Classification of Disease (ICD)-9 codes. Codes are then reduced to the first three digits for confidentiality reasons. Then, similar ICD-9 codes are grouped into 261 unique clinical classification codes (CCCs), which represent groupings of clinically similar medical conditions.[18] Based on the CCCs reported in the MEPS, the following injury types were created: 1) head; 2) spinal cord; 3) upper extremities fractures; 4) lower extremities fractures; 5) other fractures (i.e. vertebral, ribs, and pelvis); 6) head, neck, or trunk wounds; 7) extremities wounds; 8) dislocations; 9) sprains; 10) contusion or superficial injuries; 11) burns; 12) poisoning; and 13) other injuries due to external causes.

Using 'generalized linear latent and mixed models', we examined the association between injuries and suboptimal health while adjusting for potential confounders.[19] This approach was used to accommodate the longitudinal nature of the measures while incorporating weights and clusters into the estimation.[20] Weights were rescaled using the approach recommended by Rabe-Hesketh.[21] Multiple mixed-logistic regression models were used while adjusting for age, sex, race, family income, insurance status, baseline health status, and the survey year. Age was treated as a continuous variable, whereas sex and baseline health (poor/fair vs. excellent/very good/good) as binary variables, in the regression analyses. The following variables were treated as categorical: family income (defined as a percentage of the Federal Poverty Level: poor as the reference group [<100%], near poor [100 to <125%], low income [125 to < 200%], middle income [200 to <400%], and high income [≥400%]); insurance status (private insurance as reference, public insurance, and no insurance); and race (white as the reference, blacks, Hispanic, and others). The 'other' race category included those reporting being Asians, American Indians, native Hawaiian, and those reporting multiple races.

Using the same covariates, multiple mixed-logistic regression models were constructed in the subgroup analyses to examine the association between children's injuries and mothers' general and mental health. The same covariates and classification of suboptimal health were used as in the previous analysis among children.

This study was granted an exemption from the Bloomberg School of Public Health at Johns Hopkins University as it only used de-identified information from the household component of the MEPS.

Results

Of the 63,422 children included in this study, 3251 (4.9%) reported injuries. The weighted estimate indicates that this sample is nationally representative of more than 63 million US

children per panel and that 3.6 million were injured at either round two or three of the study follow-up (Table 1). Injured children were more likely to be male, white, and slightly older than those without injuries ($P < 0.01$). Baseline pre-injury general health was marginally better among non-injured children than among those who sustained injuries, whereas mental health was not statistically different between the two groups ($P < 0.08$).

Weighted frequencies showed head injuries to be the most common injury type, affecting about a fifth of all injured children (Table 2), whereas, not surprisingly, the least common injury types among children were burns (1.3%) or poisoning (1.4%). Fractures of upper extremities were more common than those of lower extremities (17.1% vs. 6.0%). Children with 'other' fractures showed the worst long-term outcomes with 9.1% and 16.5% of those injured reporting suboptimal general and mental health, respectively.

Regression analyses showed injury status to be associated with both general and mental health (Table 3). Relative to non-injured children, the results showed that injured children were 35% (odds ratio [OR]: 1.35; 95% confidence interval [CI]: 1.12–1.75) more likely to be in suboptimal health status after adjusting for age, gender, income, race, insurance, baseline health, and the survey year. Similarly, injured children were 36% (OR: 1.36; 95% CI: 1.03–1.80) more likely to have suboptimal mental health than those children without reported injuries adjusting for other covariates.

Of the children included in the survey, 29,014 mothers had health status information documented in the survey. The subgroup analysis showed that children's injuries were associated with maternal mental, but not with general health (Table 4). Mothers of injured children were 1.30 (95% CI: 1.04–1.60) times more likely to report suboptimal health than those of non-injured children adjusting for other covariates.

Discussion

The present study provides evidence that injuries are strongly associated with long-term health status among a nationally representative sample of US children and their mothers. These results highlight the fact that the burden of injuries may not be limited to those injured but transcend to cast additional tolls on population health. Therefore, further investment in all preventative strategies (primary, secondary, and tertiary) aimed to reduce the burden of injuries cannot be overstated.

Our finding that children experience lasting health deficits after injury is consistent with that of previous literature in the US[8,11,22] and other developed countries.[7,14,23] None of the previous trauma outcomes studies used similar measures of health as those in our study, which affects our ability to draw a more specific comparison. Nevertheless, other studies of children's health have used parent-reported measures such as those in our study.[17,24]

An important finding is that about a fifth of those injured suffered head injuries. Among both children and adults,[25] traumatic brain injuries are among the most common causes of short- and long-term disabilities.[26] McCarthy et al.[22] followed up injured children longitudinally and found 40% of those with head injuries to have substantial impairments at 12 months. Another study by Batailler et al.[27] among children injured in traffic crashes

found that 32.3% of them had not fully recovered at 12 months. Health deficits among children with injuries were also documented in a study by Holbrook et al.[28] in which children were followed for 24 months. These estimates along with ours have significant implications for public health policy, practice, and planning. Primary prevention focusing on preventing head injuries should be a priority to reduce their incidence and associated sequelae.

The clinical implications of our findings suggest that vestment in secondary and tertiary prevention may be needed to support children's return to pre-injury health, as well support mothers of injured children. Supporting the recovery of a mother's mental health is also vital to reduce the chance of debilitating conditions, which may affect future maternal and child health. A previous study by Yamaoka et al.[29] examined unintentional injuries among infants and found postpartum depression among mothers to be a significant predictor. Future studies are warranted to quantify the association between mothers' mental status and injury incidence and recidivism among children.

Because this study was based on a nationally representative sample, it is possible that reported deficits are strongly influenced by those with severe injuries or permanent disabilities where prognosis is not likely to improve. A study Valadka et al.,[30] which evaluated long-term outcomes injured children, found that after one year of discharge, around half the patients suffered long-term and possibly permanent limitations. However, achieving further improvements in health status with access to needed evidence-based practices remains possible.

According to our findings, more than 3.6 million US children were injured during a period of about nine months and are at risk of future reduced health. This is lower than the estimated seven million children provided by the Center for Disease Control and Prevention (CDC) through the Web-based Injury Statistics Query and Reporting System (WISQAR) system.[31] This discrepancy may be due to the fact that injuries at rounds two or three cover a period of about eight to nine months rather than the entire year, as in the CDC figures. Another possibility is that parents were less inclined to report injuries because of fear of negligent labeling or, not unlikely, recall bias of mild injuries treated at EDs. A previous study of the adult population, using the MEPS, found ED visits to be underreported by about a third when compared to data from administrative records.[16] Although this potential limitation may affect the estimated number of injured children, it is unlikely that it changes our estimate of the association between injuries and health status unless only severe injuries ended up being captured.

Our study found that mothers of injured children report poorer mental health than those of uninjured children. Unlike adults, children are mostly dependent on their families to take care of them and to ensure they live a healthy life. Health conditions due to preventable injuries may put children's health on a different trajectory for the remainder of their lives. As a result, this may lead to temporary and sometimes permanent disabilities, making children more dependent on their caregivers. Meeting the new health needs of injured children could exert a toll on the parent's mental health, possibly through increased emotional stress or financial strain. A study of children, who suffered burns, observed stress

among parents due to a 'feeling of hopelessness.'[32] In addition, injuries of children may affect professional life, such as retaining employment. Consequently, this may explain the findings we observed. A study by Witt et al.[33] found child activity limitations to be strongly associated with parent's overall health, mental health, and lost workdays. The authors examined health status and workdays lost among parents of children with activity limitations, which can be a consequence of childhood injuries.[33] In summary, childhood injuries can have negative and lasting externalities beyond their effects on a child's health.

Large prospective studies, such as the MEPS, are instrumental in understanding the burden of injuries and guiding the development of interventions to maximize recovery after injuries. In addition, these data sets allow evaluating the impact of injury prevention programs by assessing the incidence of injury and associated disabilities after implementation. Other countries such as South Africa have recognized the importance of establishing prospective trauma data sets to plan for prevention strategies.[34] The UK Burden of Injury study is another example of a data source that provided evidence of long-term burden on trauma population health.[35] Finally, an additional advantage of these sources is the ability to conduct cross-national comparisons to understand the burden further and reduce the global burden of injuries.

Several limitations need to be considered in light of these findings. A significant limitation of our study is that we did not have data on the mechanisms of injuries. It is possible that intentional injuries (i.e. abuse or self-harm) are more strongly associated with poor outcomes than unintentional injuries. Unfortunately, we were unable to identify the mechanism because the data set does not include to reduce the likelihood of identifying a particular patient. Another limitation is the use of generic measures of general and mental health rather than other recommended Health-Related Quality of Life measures among children such as DISABKIDS, KIDSCREEN-52, or PedsQL, which are not collected in the MEPS.[36] Future studies should capture more detailed information about injury mechanisms, medical care use at the time of injury, and use pediatric-specific health measures.

A potential source of confounding in our study is differences in pre-injury health levels between the two groups. However, this is unlikely to have affected our findings because baseline health was not substantially different across the two groups and our results remained consistent even after adjusting for baseline health.

Another potential limitation is that we included parent-reported health measures rather than those reported by both parents and children. Although many previous studies have used parent-reported health as means to measure children's health,[37,38] this was dictated by the nature of the MEPS design, which assigns one household member to answer on behalf of all family members. This may introduce bias if the family member was not familiar with the child true health status. A proxy report, nevertheless, has been found to be a valid measure of a child's health.[17,39] It is also important to acknowledge that some children are too young to provide valid measures of health.[5]

Despite limitations, this is the first nationally representative study investigating the long-term implications of injuries among US children and the impact of their injuries on maternal

health. We used a longitudinal analysis approach to better model the association between injuries and long-term health outcomes and adjusted for many important confounders, such as pre-injury health status. Furthermore, unlike hospital-based studies, we used a population-based sample, which captures conditions from a breadth of injury types and severity, which is more representative of the underlying population. Finally, we included a large sample, which improved the power of the study.

In conclusion, we have shown that injuries were significantly associated with lower general and mental health among children and their mothers beyond the first year after follow-up. To improve health outcomes of children with injuries, further follow-up care may be needed to ensure they return to pre-injury health levels. These results stress the necessity for all levels of preventative strategies to reduce the burden of injuries on population health.

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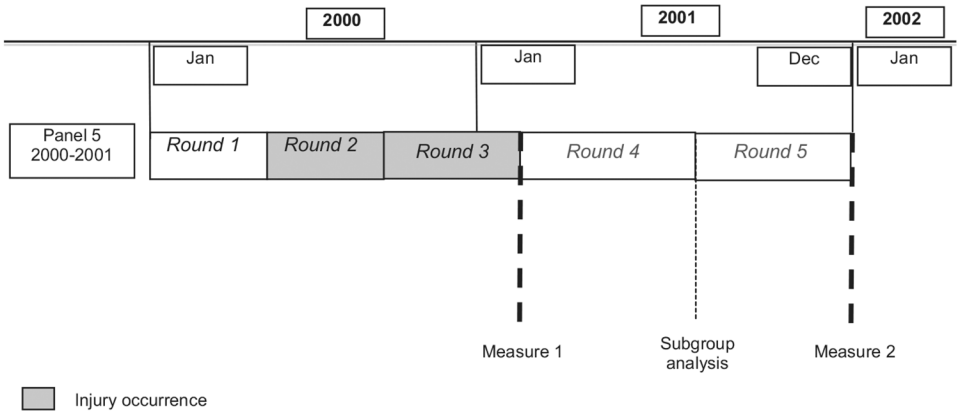

Fig. 1 –.

Survey administration in the Medical Expenditure Panel Survey (MEPS).

Table 1 –

Weighted baseline characteristics of the child population stratified by injury status (N = 66,673).

Characteristic	Injury free	Injured	*P*-value
Unweighted, *N* (%)	63,422 (95.1)	3251 (4.9)	
Weighted *N* %	63,253,599	3,670,197	
	(94.5)	(5.4)	
Age, years, mean	10.4	10.9	<0.01[a]
Gender %			
Male	50.0	59.4	<0.01[b]
Family income %[c]			
Poor (<100%)	17.2	16.1	<0.01[b]
Near poor (100 to <125%)	12.2	11.1	
Low (125 to <200%)	14.6	12.8	
Middle (200 to <400%)	30.3	31.3	
High (≥400%)	25.8	28.7	
Race %			
White	35.8	41.9	<0.01[b]
Black	13.4	12.6	
Hispanic	19.5	11.8	
Other	31.3	33.6	
Insurance status %			
Private	64.5	67.5	<0.01[b]
Public	26.2	26.2	
Uninsured	9.3	6.4	
Baseline physical health %			
Poor/fair	3.2	4.0	0.02
Baseline mental health %			
Poor/fair	2.7	3.4	0.08

[a] *t*-test.

[b] Chi-squared test.

[c] Federal Poverty Level.

Table 2 –

Types, locations, and end of follow-up health outcomes among injured children in the sample (N = 3232).

Type of injury	Weighted %	Fair/poor general health[a]%	Fair/poor mental health[a]%
Head	19.3	1.8	2.3
Spinal	0.0	*b*	*b*
Fracture			
Upper	17.1	3.0	3.1
Lower	6.0	2.7	3.1
Other	1.0	9.1	16.5
Dislocation	2.6	0	0.2
Crush, contusion or superficial injury	8.9	1.8	2.9
Open wound			
Head, neck, and trunk	14.1	3.7	2.5
Extremities	10.6	3.4	5.1
Sprain	15.1	1.8	2.1
Burn	1.3	0	3.6
Poison	1.4	3.2	8.9
Other injuries due to external causes	15.0	4.6	3.8

[a]At round 5 (end of follow-up).

[b]Subsample is too small to provide reliable estimates.

Table 3 –

Mixed-logistic regressions of the association between injury and children's health status (N = 66,673).

Variable	Poor/fair general health, OR (95% CI)	Poor/fair mental health, OR (95% CI)
Injury status (unadjusted)		
Not injured	Reference	Reference
Injured	1.43[a] (1.12–1.84)	1.55[a] (1.20–1.99)
Injury status (adjusted)		
Not injured	Reference	Reference
Injured	1.35[a] (1.12–1.75)	1.36[a] (1.03–1.80)

CI, confidence interval; OR, odds ratio.

[a]Significant at $P < 0.05$ level; model covariates: age, sex, race, income, baseline health status, and survey year.

Table 4 –

Mixed-logistic regressions of the association between children's injury and maternal health (N = 29,014).

Variable	Poor/fair general health, OR (95% CI)	Poor/fair mental health, OR (95% CI)
Injury status (unadjusted)		
Not injured	Reference	Reference
Injured	1.20 (0.98–1.48)	1.47[a] (1.18–1.85)
Injury status (adjusted)		
Not injured	Reference	Reference
Injured	1.10 (0.91–1.33)	1.30[a](1.04–1.60)

CI, confidence interval; OR, odds ratio.

[a]Significant at $P < 0.05$ level; model covariates: age, sex, race, income, baseline health status, and survey year.

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