Segregating Suspected Child Maltreatment from Non-Child Maltreatment Injuries: A Population-Based Case-Control Study in Taiwan

Yo-Ting Jin, Chin-Mi Chen, Yao-Ching Huang, Chi-Hsiang Chung, Chien-An Sun, Shi-Hao Huang, Wu-Chien Chien, and Gwo-Jang Wu

Abstract: Objective: To identify the differential patient characteristics, injury types, and treatment outcomes between hospitalized child abuse and non-child abuse injuries in Taiwan. Methods: Using the data from the National Health Insurance Research Database, we selected a total of 1525 patients under the age of 18 that were diagnosed with child abuse, as well as an additional 6100 patients as a comparison group. Chi-square test, Fisher exact test, and independent samples t-test were used to compare the differences between the abused children and the non-abuse-related injured children. The multivariate conditional logistic regression was performed to measure the risk factor of child maltreatment in injured children. Results: Intracranial injury was more frequent in the child abuse group than it was in the non-child abuse group (35.0% vs. 8.2%; \( p < 0.001 \)). Children in the child abuse group tended to stay longer in the hospital and incur higher medical expenses (8.91 days vs. 4.41 days and USD 2564 vs. USD 880, respectively). In multivariate analysis, the Adjusted Odds Ratio (Adjusted OR) of abuse resulting in an injury for children in low-income families is 1.965 times higher than it was in the non-abuse-related injured children. The multivariate conditional logistic regression was performed to measure the risk factor of child maltreatment in injured children.

Keywords: child maltreatment; child abuse; injuries

1. Introduction

The Centers for Disease Control and Prevention (CDC) defined child maltreatment, also known as child abuse, as any act or series of acts of commission or omission by a parent or other caregiver that results in harm, potential for harm, or threat of harm to a child [1].
Four major categories of maltreatment are commonly recognized: neglect, physical abuse, sexual abuse, and emotional abuse [2]. Child neglect is the most common type of child maltreatment and physical abuse is second to neglect [3–5].

Injury is a common physical outcome of child maltreatment. Early detection of subtle injuries in the early stages of child abuse could potentially prevent many fatal or near-fatal abusive events [6–10]. Among non-fatal injuries, bruising injury is the most common injury due to abuse, and one that pediatric providers are often asked to comment on [11]. In comparison, traumatic brain injury is the most common fatal injury in physically abused children, second only to motor vehicle-related injuries in the pediatric age group [12,13].

According to Taiwan’s official data, in 2016 [14] 6031 children were documented as victims of maltreatment, including neglect, physical abuse, sexual abuse, and emotional abuse. Specifically, 37.76% of the victims were physically abused, 30.43% were sexually abused, 19.13% were emotionally abused, and 12.68% were neglected. However, this official statistic contradicts previous studies in that neglect was the most common form of child abuse [3,4]. Taiwan’s fertility rate has dropped sharply, and the population has shown negative growth. However, the number of child abuse cases will not decrease because of fewer children, as it is expected to increase instead of decrease in 2021; it is a national crisis [15].

Although numerous studies have reported on the characteristics of abuse-related injuries, the accuracies of these studies are called into question due to relatively small sample sizes [16].

So far, no studies have compared the characteristics of children admitted to the hospital with abuse-related and non-abuse-related injuries in Chinese societies. Therefore, the aim of this study is to identify the differential patient characteristics, injury types and treatment outcomes between hospitalized child abuse and non-child abuse injuries in Taiwan.

2. Materials and Methods

2.1. Data Source

The National Health Insurance Research Database (NHIRD) collects nationwide medical data including inpatient, outpatient, and emergency room services, and the law requires that all hospitals and clinics report all medical expenses to the Bureau of National Health Insurance on a monthly basis. Therefore, National Health Insurance (NHI) information can serve as representative empirical data in medical- and health-related research fields [17]. Researchers are required to pass a detailed review by a professional peer review committee before they can use the Taiwan’s NHIRD. The study is a case-control study, used reliable data from the NHIRD, and identified the differential impacts between child abuse and non-child abuse injuries in terms of patient characteristics such as household income, level of care, admission season, geographic region, urbanization level, length of hospital stays, surgical operation, prognosis, and medical costs, as well as the outcomes and injury types in Taiwan.

This study was conducted using the database without patient identifications, thereby conforming to the Declaration of Helsinki. (TSGHIRB number: C202105014).

2.2. Subjects

This was a matched case-control study. We selected patients under the age of 18 who were diagnosed with child abuse in accordance with the International Classification of Diseases, Ninth Revision (ICD-9) codes 995.5 Child maltreatment syndrome and E967 Perpetrator of child and adult abuse [18] between January 1997 and December 2013 from the NHIRD as the child abuse group for this study. Category 995.5 includes 995.50 Child abuse, unspecified, 995.51 Child emotional/psychological abuse, 995.52 Child neglect (nutritional), 995.53 Child sexual abuse, 995.54 Child physical abuse, 995.55 Shaken infant syndrome, and 995.59 Other child abuse and neglect; Category E967 Perpetrator of child and adult abuse includes E967.0 By father, stepfather, or boyfriend, E967.1 By other specified person, E967.2 By mother, stepmother, or girlfriend, E967.3 By spouse or partner, E967.4 By child,
E967.5 By sibling, E967.6 By grandparent, E967.7 By other relative, E967.8 By non-related caregiver, and E967.9 By unspecified person. The date of first diagnosed child abuse case was treated as the index date.

The control group was selected from the remaining patients in the NHIRD who were diagnosed with ICD-9-CM codes 800–949 unintentional injury, matched with the cases in terms of gender, age group (<1, 1–2, 3–5, 6–11, and 12–18), and year of the index date. Figure 1 illustrated the criteria of sampling the child abuse group and the control group.

![Figure 1. The flowchart of study sample selection from National Health Insurance Research Database in Taiwan.](image)

2.3. Variable Definitions

The following variables were included in the comparison: household income (USD) (two groups consisting of patients from low-income and non-low-income families), urbanization level of the patient’s residence (in order to correct for the difference in the degree of urbanization between the violent child abuse cases and the areas where the control group lives, the urbanization degree can be defined as the following: Four levels, with 1 being the “most urbanized”, and 4 the “least urbanized”), geographic location (Northern, Central, Eastern, Southern Taiwan, and Outlets islands), admission season, injury types, and outcomes.

Injury types were classified into 21 groups in accordance the ICD-9-CM: 800–804 Fracture of skull, 805–809 Fracture of neck and trunk, 810–819 Fracture of upper limb, 820–829 Fracture of lower limb, 830–839 Dislocation, 840–848 Sprains and strains of joints and adjacent muscles, 850–854 Intracranial injury, 860–869 Internal injury of chest, abdomen, and pelvis, 870–879 Open wound of head, neck, and trunk, 880–887 Open wound of upper limb, 890–897 Open wound of lower limb, 900–904 Injury to blood vessels, 905–909 Poisonings and toxic effects, 910–919 Superficial injury, 920–924 Contusion with intact skin surface, 925–929 Crushing injury, 930–939 Foreign body entering through orifice, 940–949 Burns, 950–957 Injury to nerves and spinal cord, 958–959 Traumatic complications, and 990–999 Others.

Outcomes were measured by level of care (three levels: medical center, regional hospital, and local hospital), catastrophic illness (two groups consisting of patients with/without catastrophic illness, such as cancers, Injury Severity Score ≥ 16, and rare diseases), Charlson Comorbidity Index (CCI), length of hospital stays (days), medical cost (USD), Surgery (with/without), and prognosis (survive/mortality). CCI selects the first five diagnostic codes (ICD-9-CM N-Code), weighs these 5 codes according to 19 disease scoring criteria defined by Charlson, and calculates the total score. The higher the score, the more complications or more severe diagnosis [19].
2.4. Statistical Analysis

The SPSS 20.0 statistical software was utilized in this research. Chi-square test, Fisher exact test, and independent samples t-test were used to compare the differences between the abused children and the non-abuse-related injured children in demographics, injury type, and outcomes. Furthermore, we calculated the Crude Odds Ratios (crude ORs) and the 95% confidence interval (CI) using the bivariate conditional logistic regression (conditioned on gender, age, and year of the index date) to assess the crude ORs of child abuse in injured children. The multivariate conditional logistic regression was performed to measure the risk factor of child maltreatment in injured children after adjustment for sociodemographic characteristics, outcomes, and injury types. A significance level of \( \alpha = 0.01 \) was established to determine the significance of the results.

3. Results

Table 1 shows the distribution of demographic characteristics in the child abuse group and the control group. In total 1525 children diagnosed with child abuse were identified and were matched to 6100 controls. Of the total of 7625 children, the mean age was 6.02 years (SD 6.37 years); 60.26% were males. After matching for age group, gender, and year of index date, the two groups were significantly different on household income (USD).

Table 1. Demographic characteristics of children with child abuse and controls (\( n = 7625 \)).

| Variables            | Children with Child Abuse | Controls       | \( p \) Value |
|----------------------|---------------------------|----------------|--------------|
|                      | \( n \) | % | \( n \) | % |             |
| Total                | 1525  | 20.00 | 6100 | 80.00 | 0.999 |
| Gender               |          |       |      |       |       |
| Male                 | 919   | 60.26 | 3676 | 60.26 | 0.999 |
| Female               | 606   | 39.74 | 2424 | 39.74 |       |
| Age (years)          |          |       |      |       | 0.999 |
| <1                   | 562   | 36.85 | 2248 | 36.85 |       |
| 1–2                  | 207   | 13.57 | 828  | 13.57 |       |
| 3–5                  | 186   | 12.20 | 744  | 12.20 |       |
| 6–11                 | 166   | 10.89 | 664  | 10.89 |       |
| 12–18                | 404   | 26.49 | 1616 | 26.49 |       |
| Household income (USD) |          |       |      |       | <0.001 |
| Without low-income   | 1446  | 94.82 | 5866 | 96.16 |       |
| With low-income      | 79    | 5.18  | 234  | 3.84  |       |
| Geographic region    |          |       |      |       | <0.001 |
| Northern             | 599   | 39.28 | 2110 | 34.59 |       |
| Middle               | 476   | 31.21 | 1974 | 32.36 |       |
| Southern             | 392   | 25.70 | 1535 | 25.16 |       |
| Eastern              | 56    | 3.67  | 448  | 7.34  |       |
| Outlets islands      | 2     | 0.13  | 33   | 0.54  |       |
| Urbanization level   |          |       |      |       | <0.001 |
| 1 (most urbanized)   | 570   | 37.38 | 1590 | 26.07 |       |
| 2                    | 688   | 45.11 | 2751 | 45.10 |       |
| 3                    | 79    | 5.18  | 603  | 9.89  |       |
Table 1. Cont.

| Variables            | Children with Child Abuse | Controls | \( p \) Value |
|----------------------|---------------------------|----------|---------------|
|                      | \( n \) | \%  | \( n \) | \%  |               |
| 4 (least urbanized)  | 188   | 12.33 | 1156 | 18.95 | \( <0.001 \) |
| Admission season     |         |      |      |      |               |
| Spring (March–May)   | 366   | 24.00 | 1685 | 27.62 |               |
| Summer (June–August) | 387   | 25.38 | 1444 | 23.67 |               |
| Autumn (September–November) | 420 | 27.54 | 1305 | 21.39 |               |
| Winter (December–February) | 352 | 23.08 | 1666 | 27.31 |               |

\( p \) value: Chi-square/Fisher exact test on category variables and \( t \)-test on continuous variables.

\( p \) < 0.001: 5.18% of children in the child abuse group were from low-income families as compared with 3.84% in the control group. More children in the child abuse group lived in northern Taiwan (39.28% vs. 34.29%) and in areas with the highest urbanization level (37.38% vs. 26.07%). Furthermore, children in the child abuse group were hospitalized more frequently in autumn (27.54% vs. 21.39%) and less frequently in winter (23.08% vs. 27.31%) than were their counterparts.

Table 2 shows the distribution of injury types in the child abuse group and the control group. Intracranial injury was more frequent in the child abuse group than it was in the control group (35.02% vs. 8.23%; \( p < 0.001 \)), whereas internal injury of chest, abdomen and pelvis were more frequent in the control group (2.75% vs. 30.26%; \( p < 0.001 \)). Moreover, the rate of the fracture of upper limb for the children in the control group was also significantly higher than that for the children abuse group (21.85% vs. 3.80%; \( p = 0.001 \)).

Table 2. Comparison of injury types between children with child abuse and controls.

| Injury Types                                   | Children with Child Abuse | Controls | \( p \) Value |
|------------------------------------------------|---------------------------|----------|---------------|
|                                                | \( n \) | \%  | \( n \) | \%  |               |
| Fracture of skull                              | 62   | 4.07 | 252 | 4.13 | 0.983 |
| Fracture of neck and trunk                     | 5   | 0.33 | 49 | 0.80 | 0.908 |
| Fracture of upper limb                         | 58 | 3.80 | 1333 | 21.85 | 0.001 |
| Fracture of lower limb                         | 41 | 2.69 | 506 | 8.30 | 0.199 |
| Dislocation                                    | 1 | 0.07 | 77 | 1.26 | 0.971 |
| Sprains and strains of joints and adjacent muscles | 2 | 0.13 | 153 | 2.51 | 0.830 |
| Intracranial injury                            | 534 | 35.02 | 502 | 8.23 | \( <0.001 \) |
| Internal injury of chest, abdomen and pelvis   | 42 | 2.75 | 1846 | 30.26 | \( <0.001 \) |
| Open wound of head, neck and trunk             | 31 | 2.03 | 216 | 3.54 | 0.622 |
| Open wound of upper limb                       | 9 | 0.59 | 128 | 2.10 | 0.755 |
| Open wound of lower limb                       | 9 | 0.59 | 139 | 2.28 | 0.736 |
| Injury to blood vessels                        | 0 | 0.00 | 8 | 0.13 | 0.594 |
| Poisonings and toxic effects                   | 4 | 0.26 | 168 | 2.75 | 0.761 |
| Superficial injury                             | 11 | 0.72 | 102 | 1.67 | 0.810 |
| Contusion with intact skin surface             | 79 | 5.18 | 114 | 1.87 | 0.201 |
| Crushing injury                                | 4 | 0.26 | 44 | 0.72 | 0.915 |
| Foreign body entering through orifice          | 4 | 0.26 | 86 | 1.41 | 0.846 |
Table 2. Cont.

| Injury Types                        | Children with Child Abuse | Controls | p Value |
|-------------------------------------|---------------------------|----------|---------|
|                                     | n  | %   | n   | %   |         |
| Burns                              | 19 | 1.25 | 237 | 3.89 | 0.557   |
| Injury to nerves and spinal cord    | 5  | 0.33 | 32  | 0.52 | 0.955   |
| Traumatic complications             | 36 | 2.36 | 55  | 0.90 | 0.573   |
| Others                             | 569| 37.31| 53  | 0.87 | <0.001  |

p: Chi-square/Fisher exact test on category variables and t-test on continuous variables.

Table 3 shows the distribution of treatment outcomes in the child abuse group and the control group. Children in the child abuse group were significantly more likely to receive medical attention in hospital centers (47.41% vs. 28.59%), while those in the control group were significantly more likely to receive medical attention in regional hospitals (53.30% vs. 34.16%). In the child abuse group, 3.02% of children had catastrophic illness compared with 1.79% in the control group. In comparing the CCI score, the abused children scored higher than the non-abused children (0.1 vs. 0.02), meaning the number or severity of injury was much higher for the child abuse group. Moreover, children in the child abuse group tended to stay longer in the hospital and incur higher medical expenses (8.91 days vs. 4.41 days and USD 2564 vs. USD 880, respectively). Although children in the child abuse group were less likely to receive surgical operations (23.02%) than those in the control group (42.21%), the mortality rate of children in the child abuse group was significantly higher than those in the control group (5.90% vs. 0.48%).

Table 3. Outcomes of children with child abuse and controls.

| Variables                | Children with Child Abuse | Controls | p Value |
|--------------------------|---------------------------|----------|---------|
| Total                    | 1525                      | 6100     | <0.001  |
| Level of care            |                           |          |         |
| Hospital center          | 723                       | 1744     | 28.59   |
| Regional hospital        | 521                       | 3251     | 53.30   |
| Local hospital           | 281                       | 1105     | 18.11   |
| Catastrophic illness     |                           |          | <0.001  |
| Without                  | 1479                      | 5991     | 98.21   |
| With                     | 46                        | 109      | 1.79    |
| Charlson comorbidity index (CCI) | 0.10 ± 0.40 | 0.02 ± 0.17 | <0.001 |
| length of hospital stays | 8.91 ± 10.96              | 4.41 ± 4.41 | <0.001 |
| Medical cost (USD)       | 2563.68 ± 4658.38         | 880.27 ± 1747.04 | <0.001 |
| Surgical operation       |                           |          | <0.001  |
| Without                  | 1174                      | 3525     | 57.79   |
| With                     | 351                       | 2575     | 42.21   |
| Prognosis                |                           |          | <0.001  |
| Survive                  | 1435                      | 6071     | 99.52   |
| Mortality                | 90                        | 29       | 0.48    |

p: Chi-square/Fisher exact test on category variables and t-test on continuous variables.
Table 4 shows the crude and adjusted OR for child abuse among the sampled subjects. The risk of abuse resulting in an injury for children in low-income families is 1.965 times higher than those in non-low-income families ($p < 0.001$). Additionally, a further look at the urbanization level revealed that children living in high urbanization areas had a significantly higher probability of being abused than those living in low urbanization areas (Adjusted OR = 1.560, $p < 0.001$). With respect to CCI score, the higher the score the children had, the higher the probability that they were abused (Adjusted OR = 2.099, $p < 0.001$). The risk of abuse resulting in an injury was significantly higher in autumn than it was in spring (Adjusted OR = 1.545, $p < 0.001$).

Table 4. Risk factors associated with child abuse based on conditional logistic regression.

| Variables               | Bivariate Model     | Multivariate Model    |
|-------------------------|---------------------|-----------------------|
|                         | Crude OR  | 95% CI   | p Value | Adjusted OR | 95% CI | p Value |
| Low-income              | 1.370     | [1.054–1.779] | 0.018   | 1.965       | [1.483–2.604] | <0.001  |
| Urbanization level      |          |          |         |             |        |         |
| 1 (most urbanized)      | 2.204     | [1.839–2.643] | <0.001 | 1.560       | [1.242–1.96]  | <0.001  |
| 2                       | 1.538     | [1.201–1.832] | <0.001 | 1.285       | [0.956–1.562] | 0.072   |
| 3                       | 0.806     | [0.608–1.067] | 0.131   | 0.767       | [0.57–1.032]  | 0.080   |
| 4 (least urbanized)     | Reference  | Reference  |         | Reference   | Reference  |         |
| Catastrophic illness    |          |          |         |             |        |         |
| Without                 | 1.708     | [1.206–2.472] | 0.003   | 1.385       | [0.922–2.079] | 0.117   |
| With                    | 3.002     | [2.385–3.780] | <0.001 | 2.099       | [1.65–2.672]  | <0.001  |
| CCI                     | Reference | Reference  |         | Reference   | Reference  |         |
| Level of care           |          |          |         |             |        |         |
| Hospital center         | 1.630     | [1.393–1.904] | <0.001 | 1.025       | [0.653–1.872] | 0.351   |
| Regional hospital       | 0.630     | [0.537–1.047] | 0.074   | 0.701       | [0.378–1.450] | 0.154   |
| Local hospital          | Reference | Reference  |         | Reference   | Reference  |         |
| Surgical operation      |          |          |         |             |        |         |
| Without                 | 0.680     | [0.364–0.912] | 0.005   | 0.761       | [0.196–1.356] | 0.297   |
| With                    | Reference | Reference  |         | Reference   | Reference  |         |
| Admission Season        |          |          |         |             |        |         |
| Spring                  | 1.234     | [1.052–1.447] | 0.010   | 1.279       | [0.972–1.524] | 0.067   |
| Summer                  | 1.482     | [1.266–1.725] | <0.001 | 1.545       | [1.296–1.84]  | <0.001  |
| Winter                  | 0.974     | [0.828–1.143] | 0.737   | 0.928       | [0.777–1.109] | 0.413   |

Adjusted OR = Adjusted odds ratio: Adjusted variables listed in the table, CI = confidence interval.

Furthermore, we analyzed the adjusted OR of child abuse with respect to injury types. Children with internal injury of chest, abdomen, and pelvis were less likely as a result of abuse (Adjusted OR = 0.121, $p = 0.001$) while children with intracranial injuries were more likely to be abuse victims (Adjusted OR = 1.234, $p < 0.001$) (Table 5).
Table 5. Crude and adjusted odd ratios of child abuse for injury types based on conditional logistic regression.

| Injury Types                              | Bivariate Model |          | Multivariate Model |          |
|-------------------------------------------|-----------------|----------|--------------------|----------|
|                                           | Crude OR        | 95% CI   | p Value            | Adjusted OR | 95% CI   | p Value |
| Fracture of skull                         | 0.256           | [0.121–1.597] | 0.982              | 0.298     | [0.121–1.597] | 0.982  |
| Fracture of neck and trunk                | 0.125           | [0.059–1.265] | 0.886              | 0.198     | [0.035–1.988] | 0.886  |
| Fracture of upper limb                    | 0.449           | <0.001   | 0.896              | 1.454     | [0.898–2.982] | 0.232  |
| Fracture of lower limb                    | 0.812           | [0.254–1.950] | 0.195              | 0.124     | [0.012–4.955] | 0.772  |
| Dislocation                               | 0.013           | [0.002–5.454] | 0.965              | 0.059     | [0.026–3.495] | 0.542  |
| Sprains and strains of joints and adjacent muscles | 0.019 | [0.003–3.454] | 0.565              | 1.234     | [1.025–1.670] | <0.001 |
| Intracranial injury                       | 1.067           | [1.011–1.564] | <0.001             | 1.234     | [1.025–1.670] | <0.001 |
| Contusion with intact skin surface        | 0.111           | [0.029–1.590] | 0.645              | 0.098     | [0.033–1.565] | 0.644  |
| Crush injury                              | 0.076           | [0.003–2.950] | 0.765              | 0.121     | [0.034–1.998] | 0.795  |
| Poisonings and toxic effects              | 0.065           | [0.012–1.986] | 0.798              | 0.055     | [0.011–1.749] | 0.897  |
| Superficial injury                        | 0.024           | [0.002–1.465] | 0.464              | 0.101     | [0.044–1.989] | 0.511  |
| Contusion with intact skin surface        | 0.178           | [0.022–1.596] | 0.765              | 0.199     | [0.102–2.995] | 0.564  |
| Crush injury                              | 0.693           | [0.465–3.454] | 0.295              | 0.795     | [0.345–3.495] | 0.265  |
| Foreign body entering through orifice     | 0.091           | [0.002–2.986] | 0.911              | 0.895     | [0.154–2.412] | 0.881  |
| Burns                                    | 0.047           | [0.014–4.562] | 0.842              | 0.124     | [0.022–4.431] | 0.701  |
| Crush injury                              | 0.081           | [0.025–1.113] | 0.541              | 0.894     | [0.131–1.234] | 0.454  |
| Injury to nerves and spinal cord          | 0.156           | [0.104–4.560] | 0.951              | 0.442     | [0.265–4.65] | 0.851  |
| Traumatic complications                   | 0.656           | [0.557–2.982] | 0.575              | 1.021     | [0.598–2.988] | 0.568  |

Adjusted OR = Adjusted odds ratio; Adjusted variables listed in the table, CI = confidence interval.

4. Discussion

The results of this study revealed that children with abuse-related injuries were more likely to be members of low-income families than those with non-abuse-related injuries (5.18% vs. 3.14%). Previous studies have also reported that low-income families may be at greater risk of child maltreatment, which was consistent with our results [20–22]. As household income impacts routine medical care and the quality of the caregiving environment, offering adequate economic resources or allowance for parents or caregivers to provide their children with appropriate care may help prevent more children from being abused [21,22].

In terms of urbanization, the percentages of children in the abuse group in the highest urbanized areas and in northern Taiwan were significantly higher than those in the controls group (37.38% vs. 26.07% and 39.28% vs. 34.59%, respectively). This could be because people living in urban areas, especially in developing countries, may experience more stress or depression, and may be associated with higher-risk behaviors (e.g., drug or alcohol abuse), which may increase the risk of child abuse [23–25]. Additionally, northern Taiwan is generally more urbanized than any other part of the country. Another observation was that most of the child maltreatment occurred during autumn in Taiwan. This could be linked with seasonal variations in the occurrence of depressive syndromes [26].

Our study has found that intracranial injury was significantly more frequent in the child abuse group than in the control group. Regarding injury types, previous research has indicated that children with abusive head injuries are more likely to die or become more severely incapacitated than children with unintentional head injuries [5]. Thus, it was reasonable to assume that children with abusive head injuries may be more likely to be diagnosed with child abuse. Moreover, we observed that children with internal injury of chest, abdomen, and pelvis were less likely to be diagnosed with child abuse. Although abdominal injury leads to a high risk of in-hospital mortality for children [27], diagnosis of abuse in children with internal abdominal injury was difficult [28]. In addition, the incidence of upper extremity fractures in children in the control group was also significantly
higher than that in the child abuse group. Several studies included a total of 154 children who sustained a fracture of the humerus, of whom 30 were classified as abused, 23 had suspected abuse, 100 had fractures resulting from non-abusive injury, and one was involved in a motor vehicle crash, which was similar to our findings [29].

Our study has also found that children in the child abuse group were significantly more likely to receive medical care at a hospital center, while children in the control group were significantly more likely to receive medical care at a regional hospital. Children in the child abuse group had more catastrophic illness than the control group. The number or severity of injuries was much higher in the child abuse group. Children in the child abuse group tended to have longer hospital stays and higher medical costs. Although children in the child abuse group were less likely to undergo surgery than the control group, the child abuse group had a significantly higher mortality rate than the control group.

Children from low-income households are at greater risk of injury from abuse than children from non-low-income households. Children living in highly urbanized areas are significantly more likely to be abused than children living in less urbanized areas. In autumn, children at the risk of injury from abuse is significantly higher than in spring, children with internal chest, abdominal, and pelvic injuries were less likely to be abused, while children with intracranial injuries were more likely to be victims of abuse. Regarding treatment outcomes, children in the abuse group required significantly longer hospital stays and suffered greater risk of fatality compared with those in the control group. In addition, abused children scored significantly higher on injury severity and experienced more catastrophic illness. Generally speaking, serious injuries require more comprehensive care at an advanced medical facility. Hence, nearly half of the abused children (47.41%) were treated at medical centers as opposed to regional and local hospitals in Taiwan. Therefore, the extended length of hospital stays, and the level of care were also associated with the severity of injury and medical costs. Our findings indicated that the average medical costs in the child abuse group were 2.91 times higher than those in the control group. Furthermore, while it appears that the more severe the injury, the higher the likelihood it would require surgical interventions, previous research has reported only one in five unconscious children suffering from head injury requires surgical operations [30]. Our study is consistent with this finding such that children in the child abuse group (23.02%) required fewer surgical interventions than those in the control group (42.21%). This is because while the rate of intracranial injury in the child abuse group was significantly higher than that of the control group (35.02% vs. 8.23%), the severity of the majority of these injuries did not warrant surgeries.

Finally, there were several limitations to this study. First, the study was limited to the data available in the health insurance database. We were unable to consider certain other factors that could also influence child maltreatment risk such as parent–child relationship, marital status, educational level, and religious beliefs. Second, the National Health Insurance database did not provide clinical biochemistry data, the Glasgow Coma Scale [31], or abbreviated injury severity scores [32]. Therefore, we used medical-related factors (e.g., length of hospital stays and medical costs) as indicators of the severity of injury. Third, we were unable to identify and interact with the patients directly to obtain additional information such as mental status due to privacy concerns and protocols. Finally, this study used inpatient data exclusively and we could not obtain sufficient information on cases where the injuries were minor and did not require care, or the patient received only outpatient/emergency care. Therefore, the results of this study were biased toward more severe cases of injury.

5. Conclusions

Our study found that children from low-income households, living in highly urbanized areas, and in autumn, are at greater risk of injury from abuse than children from non-low-income households. Children with internal chest, abdominal, and pelvic injuries are less likely to be abused, while children with intracranial injuries are more likely to be victims of
abuse. Moreover, our study identified and discussed numerous high-risk environmental factors observed in child abuse cases, including living in urban areas, families with low-income, and seasonality as child maltreatment cases occur more frequently in autumn. These findings will help develop new protocols and diagnostic criteria so that physicians are able to identify and report child abuse in a timelier manner.

This issue is of great significance and it is important to have the latest and most accurate information. Future studies should investigate if anything has changed during the observational period (e.g., comparing every ten years) from 2013 to 2022, including changes in awareness, relevant organizations, child support, etc.

Author Contributions: Conceptualization: Y.-T.J., W.-C.C., S.-H.H., Y.-C.H., G.-J.W. and C.-M.C.; Formal analysis: Y.-T.J., C.-A.S., G.-J.W. and W.-C.C.; Investigation: C.-H.C., C.-A.S., G.-J.W. and C.-M.C.; Methodology: W.-C.C., C.-H.C., C.-A.S., G.-J.W. and C.-M.C.; Project administration: W.-C.C., C.-H.C., G.-J.W. and C.-M.C.; Writing—original draft: Y.-T.J., S.-H.H., Y.-C.H., G.-J.W. and C.-M.C.; Writing—review and editing: Y.-T.J., W.-C.C., C.-A.S., G.-J.W. and C.-M.C. All authors have read and agreed to the published version of the manuscript.

Funding: This study was funded by the Medical Affairs Bureau, the Ministry of Defense of Taiwan (MND-MAB-D-111134), Tri-Service General Hospital, grant numbers TSGH-B-111018 and TSGH-A-111012.

Institutional Review Board Statement: This study was approved by Institutional Review Board of Tri-Service General Hospital. (TSGHIRB number: C202105014).

Informed Consent Statement: Not applicable.

Data Availability Statement: Data are available from the NHIRD published by the Taiwan NHI administration. Because of legal restrictions imposed by the government of Taiwan concerning the “Personal Information Protection Act”, data cannot be made publicly available. Requests for data can be sent as a formal proposal to the NHIRD (http://www.mohw.gov.tw/cht/DOS/DM1.aspx?f_list_no=8120 (accessed on 13 October 2021)).

Acknowledgments: This study was supported by Tri-Service General Hospital Foundation, grant number: TSGH-B-111018; MND-MAB-D-111134. We wish to thank Taiwan’s Health and Welfare Data Science Center and the Ministry of Health and Welfare (HWDC, MOHW) for providing the National Health Insurance Research Database (NHIRD).

Conflicts of Interest: The authors declare no conflict of interest.

References
1. Leeb, R.T.; Paulozzi, L.J.; Melanson, C.; Simon, T.R.; Arias, I. Child Maltreatment Surveillance: Uniform Definitions for Public Health and Recommended Data Elements. Version 1.0; Centers for Disease Control and Prevention: Atlanta, GA, USA, 2008. Available online: www.cdc.gov/violenceprevention/pdf/CM_Surveillance-a.pdf (accessed on 10 January 2013).
2. Giovannoni, J.M.; Becerra, R.M. Defining Child Abuse; Pp. xviii, 302; The Free Press: New York, NY, USA, 1979.
3. Allin, H.; Wathen, C.N.; MacMillan, H. Treatment of child neglect: A systematic review. Can. J. Psychiatry 2005, 50, 497–504. [CrossRef]
4. Jacobi, G.; Dettmeyer, R.; Banaschak, S.; Brosig, B.; Herrmann, B. Child abuse and neglect: Diagnosis and management. Dtsch. Arztebl. Int. 2010, 107, 231.
5. Kellogg, N.D. Evaluation of suspected child physical abuse. Pediatrics 2007, 119, 1232–1241. [CrossRef] [PubMed]
6. Jenny, C.; Hymel, K.P.; Ritzen, A.; Reinert, S.E.; Hay, T.C. Analysis of missed cases of abusive head trauma. JAMA 1999, 281, 621–626. [CrossRef]
7. King, W.K.; Kiesel, E.L.; Simon, H.K. Child abuse fatalities: Are we missing opportunities for intervention? Pediatric Emerg. Care 2006, 22, 211–214. [CrossRef] [PubMed]
8. Feldman, K.W. The bruised premobile infant: Should you evaluate further? Pediatric Emerg. Care 2009, 25, 37–39. [CrossRef] [PubMed]
9. Petska, H.W.; Sheets, L.K.; Knox, B.L. Facial bruising as a precursor to abusive head trauma. Clin. Pediatrics 2013, 52, 86–88. [CrossRef]
10. Pierce, M.C.; Kaczor, K.; Acker, D.; Webb, T.; Brenzel, A.; Lorenz, D.J.; Young Atkison, R. History, injury, and psychosocial risk factor commonalities among cases of fatal and near-fatal physical child abuse. Child Abus. Negl. 2017, 69, 263–277. [CrossRef]
11. Tenney-Soeiro, R.; Wilson, C. An update on child abuse and neglect. Curr. Opin. Pediatrics 2004, 16, 233–237. [CrossRef]
12. Duhaime, A.C.; Alario, A.J.; Lewander, W.J.; Schut, L.; Sutton, L.N.; Seidl, T.S.; Nudelman, S.; Budenz, D.; Hertle, R.; Tsiaras, W.; et al. Head injury in very young children: Mechanisms, injury types, and ophthalmologic findings in 100 hospitalized patients younger than 2 years of age. *Pediatrics* 1992, 90, 179–185. [CrossRef]

13. Reece, R.M.; Sege, R. Childhood head injuries: Accidental or inflicted? *Arch. Pediatrics Adolesc. Med.* 2000, 154, 11–15.

14. Ministry of Health and Welfare Department of Statistics. Child Abuse. 2016. Available online: https://dep.mohw.gov.tw/DOS/np-2985-113.html (accessed on 20 March 2020).

15. Ministry of Health and Welfare Department of Protection Services. Child and Adolescents Protection. 2021. Available online: https://dep.mohw.gov.tw/dops/np-1303-105-xCat-cat04.html (accessed on 15 March 2021).

16. Thombs, B.D. Patient and injury characteristics, mortality risk, and length of stay related to child abuse by burning evidence from a national sample of 15,802 pediatric admissions. *Ann. Surg.* 2008, 247, 519–523. [CrossRef]

17. National Health Research Institutes, ROC (Taiwan): National Health Insurance Research Database—Introduction of service. Available online: http://w3.nhri.org.tw/nhird/brief_01.htm (accessed on 15 March 2021).

18. Bullock, D.P.; Koval, K.J.; Moen, K.Y.; Carney, B.T.; Spratt, K.F. Hospitalized cases of child abuse in America: Who, what, when, and where. *J. Pediatric Orthop.* 2009, 29, 231–237. [CrossRef]

19. Charlson, M.E.; Pompei, P.; Ales, K.L.; MacKenzie, C.R. A new method of classifying prognostic comorbidity in longitudinal studies: Development and validation. *J. Chronic Dis.* 1987, 40, 373–383. [CrossRef]

20. Brown, J.; Cohen, P.; Johnson, J.G.; Salzinger, S. A longitudinal analysis of risk factors for child maltreatment: Findings of a 17-year prospective study of officially recorded and self-reported child abuse and neglect. *Child Abus. Negl.* 1998, 22, 1065–1078. [CrossRef]

21. Berger, L.M. Income, family structure, and child maltreatment risk. *Child. Youth Serv. Rev.* 2004, 26, 725–748. [CrossRef]

22. Eckenrode, J.; Smith, E.G.; McCarthy, M.E.; Dineen, M. Income inequality and child maltreatment in the United States. *Pediatrics* 2014, 133, 454–461. [CrossRef]

23. Park, M.S. The factors of child physical abuse in Korean immigrant families. *Child Abus. Negl.* 2001, 25, 945–958. [CrossRef]

24. Akmatov, M.K. Child abuse in 28 developing and transitional countries—results from the Multiple Indicator Cluster Surveys. *Int. J. Epidemiol.* 2010, 40, 219–227. [CrossRef]

25. Maes, M.; Meltzer, H.Y.; Suy, E.; Meyer, F. Seasonality in severity of depression: Relationships to suicide and homicide occurrence. *Acta Psychiatr. Scand.* 1993, 88, 156–161. [CrossRef] [PubMed]

26. Trokel, M.; DiScala, C.; Terrin, N.C.; Sege, R.D. Blunt abdominal injury in the young pediatric patient: Child abuse and patient outcomes. *Child Maltreat.* 2004, 9, 111–117. [CrossRef] [PubMed]

27. Barnes, P.M.; Norton, C.M.; Dunstan, F.D.; Kemp, A.M.; Yates, D.W.; Sibert, J.R. Abdominal injury due to child abuse. *Lancet* 2005, 366, 234–235. [CrossRef]

28. Kemp, A.M.; Dunstan, F.; Harrison, S.; Morris, S.; Mann, M.; Rolfe, K.; Maguire, S. Patterns of skeletal fractures in child abuse: Systematic review. *BMJ* 2008, 337, a1518. [CrossRef]

29. Bruce, D.A. Pathophysiological responses of the child’s brain following trauma. *Trauma. Head Inj. Child.* 1995, 40–51.

30. Chung, C.H.; Lai, C.H.; Chu, C.M.; Pai, L.; Kao, S.; Chien, W.C. A nationwide, population-based, long-term follow-up study of repeated self-harm in Taiwan. *BMC Public Health* 2012, 12, 744. [CrossRef]

31. Farst, K.; Ambadwar, P.B.; King, A.J.; Bird, T.M.; Robbins, J.M. Trends in hospitalization rates and severity of injuries from abuse in young children, 1997–2009. *Pediatrics* 2013, 131, e1796–e1802. [CrossRef]