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Evaluating the association between obesity and discharge functional status after pediatric injury

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Abstract

Background: Children with obesity frequently have functional impairment after critical illness. Although obesity increases morbidity risk after trauma, the association with functional outcomes in children is unknown.

Objective: To evaluate the association of weight with functional impairment at hospital discharge in children with serious injuries.

Methods: This secondary analysis of a multicenter prospective study included children <15 years old with a serious injury. Four weight groups, underweight, healthy weight, overweight, and obesity/severe obesity were defined by body mass index z-scores. The functional status scale (FSS) measured impairment across six functional domains before injury and at hospital discharge.

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New domain morbidity was defined as a change ≥2 points. The association between weight and functional impairment was determined using logistic regression adjusting for demographics, physiological measures, injury details, presence of a severe head injury, and physical abuse.

Results: Although most patients discharged with good/unchanged functional status, new domain morbidity occurred in 74 patients (17%). New FSS domain morbidity occurred in 13% of underweight, 14% of healthy weight, 15% of overweight, and 26% of obese/severe obese patients. Compared to healthy weight patients, those with obesity had more frequent new domain morbidity ($p = 0.01$), while the other weight groups had similar morbidity. However, after adjustment for confounders, weight was not associated with new functional morbidity at discharge.

Conclusion: Patients with obesity have greater frequency of new domain morbidity after a serious injury; however, after accounting for injury characteristics, weight group is not independently associated with new functional morbidity at hospital discharge after injury in children.

Level of Evidence: III

Keywords

Trauma; Injury; Childhood obesity; Functional outcomes

1. Introduction

Obesity is an ever-increasing epidemic, with a current prevalence of 18% in children and adolescents in the United States [1]. Individuals with obesity are at greater risk of chronic comorbidities such as asthma, diabetes mellitus type 2, and cardiovascular disease [2]. Obesity is prevalent in approximately 20% of hospitalized children, [3]. with this morbidity negatively impacting hospital and post-hospitalization outcomes. Children with obesity have a higher risk of postoperative complications, including infections, venous thrombosis, and airway obstruction [4–6]. When critically ill, children with obesity require longer durations of mechanical ventilation and longer intensive care unit (ICU) and hospital stays [7,8]. Functional outcomes and lower quality of life have also been reported in children with obesity when compared to those at a healthy weight, showing its impact in both physical and psychosocial domains [9,10].

Trauma is a major cause of acquired disability in children, sometimes extending to lifelong impairment [11]. With the continued rise of childhood obesity and its known impact on health outcomes, several studies have evaluated the association of obesity with outcomes after pediatric injury. Among children with long bone fractures, those with obesity are more likely to require surgical treatment, develop a wound infection, or experience refracture [12,13]. Higher sepsis rates and more frequent postoperative fistulae formation, decubitus ulcers, and deep vein thrombosis occur in children with obesity hospitalized after injury compared to those of healthy weight [13–15]. Children with obesity who sustain an injury more frequently require ICU level care and have longer ICU and hospital lengths of stay [13–16].

The impact of obesity on functional outcomes after pediatric injury has not been reported. In adults, the association between obesity and functional outcomes after injury has not been consistently observed. Injured adults with obesity had a slower recovery towards functional independence during their hospitalization [17]. Those with obesity more frequently required home health nursing after discharge to achieve the same functional independence as their healthy weight peers [17]. In contrast to these findings, an association between obesity and functional independence was not observed in a cohort of adults with traumatic brain injury admitted to an inpatient rehabilitation facility [18].

The objective of this study was to evaluate the previously not evaluated association between weight and functional status in a cohort of children with serious injuries. Determining the impact of childhood obesity on functional status after injury will both reinforce the urgent need to focus medical efforts on reducing the incidence of childhood obesity, as well as guide patient management to achieve functional recovery and speedy transition back into the community and school. This study is a secondary analysis of the “Assessment of Functional Outcomes and Health-Related Quality of Life after Pediatric Trauma” study that evaluated non-mortality outcomes in a prospective cohort of injured children [19]. We hypothesized that weight group (underweight, healthy weight, overweight, obese/morbidly obese) is independently associated with functional impairment at discharge, controlling for other patient and injury-related characteristics.

2. Materials and methods

2.1. Study design, setting, and patients

This report is a planned secondary analysis of the “Assessment of Functional Outcomes and Health-Related Quality of Life after Pediatric Trauma” prospective observational cohort study. Patients were recruited to the parent study at the seven participating sites of the Collaborative Pediatric Critical Care Research Network (CPC-CRN) from March 2018 to September 2020. Each site is a designated level 1 pediatric trauma center. The trauma census at each institution was screened daily. Patients meeting inclusion criteria with no exclusion criteria were approached for participation in the study. This study enrolled children (<15 years old) who were treated for serious (Abbreviated Injury Scale [AIS] severity ≥ 3) injuries in one or more major body regions (head, thorax, abdomen, spine, or extremity). Enrollment was limited to patients who survived to allow assessment of discharge status. Patients with burn injuries were excluded because of their unique functional outcomes [20]. Children with parents or guardians who did not speak English or Spanish were excluded to ensure the applicability of surveys and evaluation instruments. The Institutional Review Board at the University of Utah approved this study through a central mechanism. Written consent was attained from the parents or guardians of subjects and assent based on patient age. All patients enrolled in the primary study were included in this secondary analysis.

2.2. Measurements and data collection

Weight-for-height (age <2 years old) or body mass index (BMI, age 2 to 15 years old) z-scores were calculated using hospital admission height and weight and corrected for age and gender based on the Center for Disease Control (CDC) growth charts [21]. We defined four weight groups using the 2006 CDC definitions that align with current practice within the nutrition and obesity disciplines. These weight groups included children with underweight (<5th percentile), healthy weight (≥5th and <85th percentile), overweight (≥85th and <95th percentile), and obesity/severe obesity (≥ 95th percentile) [22].

We used the Functional Status Scale (FSS) to quantify functional impairment. The FSS is a validated and age-independent scale comprised of six domains of the activities of daily living [23]. The six domains of the FSS are mental status, sensory function, communication, motor function, feeding, and respiratory status. Each domain is scored on a five-point ordinal scale with a score of ‘1′ considered normal and a score of ‘5′ assigned ‘very severe dysfunction.’ The six domain scores are aggregated into a total FSS score that ranges from 6 to 30. An FSS of less than 8 defines a child with ‘normal’ functional capacity, while 8 or 9 shows ‘mild’ impairment, 9 to 15 shows ‘moderate’ impairment, and >15 shows ‘severe’ impairment. Preinjury and discharge FSS scores were acquired using chart review. When information was not found within the electronic health record, parent/guardian or clinical care team were queried.

Clinical and injury data collected were obtained from the trauma registry at each site or from the electronic health record. Demographic information was self-reported via surveys completed by the primary caregiver. The analyses included the following variables: age, sex, race, ethnicity, pre-injury chronic medical conditions, injury type (blunt versus penetrating), injured body region, number of body regions injured, mechanism of injury, and suspicion of child physical abuse. Injury body regions were classified into six categories: (1) multiple body regions, (2) isolated head injury, (3) isolated thoracic injury, (4) isolated abdominal injury, (5) isolated spinal injury, and (6) isolated extremity injury. Severe head injury was defined as a GCS total <9 or GCS motor score <5. Because of the association of missingness with severity, a missing GCS was also categorized as severe [24]. Clinical data collected included initial systolic blood pressure and heart rate, initial GCS, and hospital length of stay. To address the variability in blood pressure and heart rate with age, we standardized these data to a z-score, using age-based means and standard deviations [25,26].

2.3. Statistical analysis

Our pre-specified primary outcome was ‘new domain morbidity,’ defined as a change of ≥2 in any FSS domain between preinjury and hospital discharge status. This level of change in any FSS domain (‘new domain morbidity’) shows significant functional changes and has been previously used as an outcome in large scale studies [27]. Demographic characteristics, underlying medical conditions, baseline FSS score, injury category, number of body regions injured, injury type, mechanism of injury, presence of severe head injury, duration of hospitalization, need for post-discharge rehabilitation services, and development of new domain morbidity were compared among the four weight groups using likelihood ratio test and Jonckheere-Terpstra test. To determine the association of weight group with new domain morbidity at discharge, logistic regression was performed and adjusted for a priori determined variables, including demographic characteristics (age and race/ethnicity), physiological measures (systolic blood pressure, heart rate), the six injury categories, injury type, the presence of a severe head injury, and child physical abuse. We used inverse probability weights in this regression to allow inferences for the population of children reported in the trauma registry.

The cohort had missing height in 28.6% and missing weight in 2.8% of patients (Appendix Table 1). A similar level of missingness has been observed in other pediatric and adult obesity focused studies [15,28]. Complete case analysis to address missing weight, height, and BMI values can lead to biased inferences in critically ill adults [29,30]. Missing BMI is associated with several sociodemographic characteristics in adolescents and adults, including age, primary language, and education level, [28,31]. supporting the use of multiple imputation when these associated variables are observed. To address missing data, we imputed 10 datasets using chained regressions under the assumption of a missing at random pattern, combining results using standard techniques [32,33]. All variables included in the study manuscript, in addition to the categorical weight group, were included in the imputation model. Model discrimination was determined using the c-statistic estimate averaged over the imputations and calibration using the Hosmer-Lemeshow goodness of fit test. We defined statistical significance at $p<0.05$.

3. Results

The cohort had 427 patients with a median age of 7.2 years old (IQR 2.5 to 11.7 years old). The proportion of patients in each weight group were 13% with underweight, 47% with healthy weight, 12% with overweight, and 27% with obesity/severe obesity. Most patients ($n = 271$, 63%) were male. Most patients (85%) had no chronic medical diagnoses before injury. Patients with underweight were most often less than five years old, while the age distribution in the remaining weight groups was similar. No differences were observed among the weight groups based on sex, race, or ethnicity (Table 1).

The distribution of injury categories was similar across weight groups. Compared to patients with healthy weight, children with obesity/severe obesity more frequently had more than one body region injured ($p = 0.02$). No differences in number of body regions injured was noted when comparing the three other weight groups to each other. Weight groups had similar distributions of injury category, injury mechanism, and the occurrence of a severe head injury (Table 1). The median hospital length of stay was similar among the weight groups. Among the 21% of patients requiring post-hospitalization rehabilitation services, the proportion among the weight groups was similar.

Although most patients returned to or remained with good functional status at discharge ($n = 353$, 83%), new domain morbidity occurred in 74 patients (17%) (Table 2). New FSS domain morbidity was found in 13% of patients with underweight, 14% of patients with healthy weight, 15% of patients with overweight, and 26% of patients with obesity/severe obesity. Motor function was the most affected domain overall and in each weight group (Table 3). Compared to patients with healthy weight, those with obesity/severe obesity had more frequent new domain morbidity ($p = 0.01$), while those in other weight groups had similar new domain morbidity. The predominant factors associated with new functional domain morbidity were related to the injury characteristics. Injury mechanism, injury category, and the presence of a severe head injury were all associated with new functional domain morbidity.

In a multivariate model, no association between new domain morbidity and weight group was observed (Table 4). Younger children had a higher risk of new functional morbidity. Race/ethnicity groups were associated with new domain morbidity, with non-Hispanic Whites being at higher risk of poor outcome than Hispanic/Latino, non-Hispanic Black, and non-Hispanic other races. Injury category was associated with new domain morbidity. While all other categories had greater odds of new functional domain morbidity than isolated head injuries, the presence of a severe head injury was associated with more frequent new domain morbidity. The model discrimination c-statistic averaged over the imputations was 0.86 (95% CI 0.82, 0.92) with a p-value of 0.16 for calibration.

4. Discussion

In the United States, more than 9000 children and adolescents die each year from injuries, and another 225,000 are hospitalized [34]. Although several studies have evaluated the in-hospital morbidities and the mortality risk associated with pediatric trauma, few studies have evaluated functional status after hospitalization for injury. Given its impact with functional status in other critically ill children, [10,35–37] we evaluated the association of weight group as a predictor of discharge status. Univariate analysis found that children with obesity/severe obesity are more likely to have new domain morbidity compared to their healthy weight peers. However, after adjusting for variables known to greatly affect functional status including injury mechanisms and characteristics, we found no association with weight group and new functional morbidity at discharge.

Studies evaluating the impact of obesity on hospital outcomes after pediatric trauma have had mixed conclusions. A retrospective study of almost 150,000 children from the National Trauma Data Bank found that obesity was associated with adjusted odds of higher mortality and rates of complications, including deep vein thrombosis. Among those with critical injuries, those with obesity required longer mechanical ventilation and hospital stays [15]. Two single-center studies had similar findings [14,38]. Other studies found no difference in length of stay, ventilator duration, or mortality comparing pediatric trauma patients with and without obesity by univariate analysis [12,39]. Similar to the latter studies, we found no association of weight group with need for ICU care or ICU or hospital length of stay. Our study differed from these studies by evaluating functional status at hospital discharge rather than hospital complications and mortality. We also evaluated weight as four different categories instead of a dichotomous with and without obesity. Using multiple weight groups is more statistically sound and aligns with research standards in the obesity and nutrition fields. Dichotomization of weight, as done in previous pediatric and adult trauma studies, increases the risk of a false positive association with obesity [40]. and may underestimate variations in outcome between weight groups [41].

The effect of obesity on functional outcomes after injury has not been consistently observed in adults. In a prospective single center study of adults with blunt trauma, functional status was measured at admission, at hospital discharge, and at 6 months after discharge. During the hospitalization, functional recovery was 30% slower in those who are overweight, 37% slower in those with obesity and 48% slower in those with morbid obesity compared to those of healthy weight. Patients with overweight or obesity were more likely to be discharged with home health nursing services, but no differences in functional status among the weight groups at the six month assessment were observed in multivariable analyses [17]. In contrast, no association between obesity and long-term functional independence was observed in adults with traumatic brain injury after adjusting for age and sex [18]. This study, however, included only patients admitted to an inpatient rehabilitation facility after initial hospitalization, leading to potential selection bias. We observed no difference among the weight groups based on the need for inpatient or outpatient rehabilitation services after discharge.

We found that only 17% of children admitted after serious or severe injury were discharged with new functional morbidity. Young age, race/ethnicity, injury category, and presence of a severe head injury were the predominant characteristics associated with new domain morbidity. While patients with obesity/severe obesity more often had more than one body region with injury when compared to those of healthy weight, the injury categories were not different among the weight groups. Other studies have found differences in injury category between patients with and without obesity, with more frequent extremity injuries in those with obesity [12,15]. Some studies have also noted lower frequency of abdominal injury [12,15]. and head injury in those with obesity [12,14,38,42].

While our univariate analysis found greater occurrence of new domain morbidity in the patients with obesity/severe obesity compared to the healthy weight, this association was no longer found after adjustment for covariates, including injury mechanism and severity. Our findings contrast with a previous study in which FSS was used to evaluate the association of weight on functional outcomes after pediatric critical illness. In a cohort of 432 children admitted to the ICU, high weight had a higher adjusted odds of new functional impairment at hospital discharge, with high BMI being associated with a 4 fold higher likelihood of impairment [10]. Our study differs in that our population of interest is restricted to traumatic injury and includes patients admitted to both the ICU (42% of cohort) and the general wards (58% of cohort). Although weight may contribute to functional impairment after pediatric injury, the impact of injury characteristics, such as the severity of head injury or number or type of injured body region, may have a greater impact on functional outcomes than obesity and other factors.

Evaluating the impact of obesity in childhood is challenging in part because of lack of uniformity classifying weight. BMI z-scores are dependent on height measurements, which are frequently missing in the medical record. We addressed this limitation by imputing missing values of height. Second, uniform BMI or weight-for-length cutoff points do not exist for defining weight classes. The CDC and the World Health Organization (WHO) have categorized weight status groups but use different percentile cutoff points for these groupings. In the current study, we used CDC definitions that divide weight status into underweight, health weight, overweight, obesity and severe obesity. Because of the available sample size, we chose to combine the obesity and severe obesity subgroups for our analyses. Combining these groups may have prevented us from observing difference in impairment between these groups. Future studies will require sufficient enrollment of patients with severe obesity to evaluate association.

The main strength of our study is that is it a prospective analysis that measured functional status using a validated metric that is independent of age and developmental stage. By collecting preinjury FSS scores and FSS scores at hospital discharge, we evaluated the change in status related to the injury and subsequent hospital course without the confounding effects of previous functional disabilities.

This study has several limitations. First, patients in this study were treated at academic hospitals with level 1 trauma capabilities. Establishing generalizability to other populations requires additional study. Second, our findings are based on a single functional status metric, the FSS. Although FSS has been validated against the Adaptive Behavior Assessment System II, other outcome assessments may identify differences by weight group. Third, we did not consider the causation of new domain morbidity. Functional morbidity at hospital discharge is likely due to the primary injury as well as associated complications. Fourth, we observed wide 95% CIs for several odds ratios in the multivariate model. Although these wide intervals may have arisen from small sample sizes within categories or from infrequent new domain morbidity, it is also possible that this finding suggests high variability in the observed associations. Because our study cohort included few patients with moderately or severely abnormal FSS scores, we were unable to make inferences about the association of weight group within these morbidity categories. With childhood obesity at epidemic proportions, further evaluation of the impact of obesity and obesity-associated comorbidities and hospital complications on long term functional status and health related quality of life are necessary.

In conclusion, only 17% of pediatric trauma patients had a new functional morbidity at time of hospital discharge. Obesity is associated with decline in functional status after critical illness in both children and adults, affecting length of hospital stay and mortality [10,14,15,35,37]. This association is likely related to obesity-related comorbidities as well as higher rates of injury and hospital acquired complications resulting from obesity. Obesity likely impairs functional outcomes after injury in children, but this impact may be less than injury-related features. The weight may also have less impact on children with minimal injury. Future studies should include focused enrollment of patients with severe obesity to better address the role of weight on functional outcomes.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Abbreviations:

AIS	Abbreviated Injury Score
BMI	Body Mass Index
CDC	Center for Disease Control
CPCCRN	Collaborative Pediatric Critical Care Research Network
FSS	Functional Status Scale
GCS	Glasgow Coma Scale
ICU	Intensive Care Unit

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Table 1

Demographics, injury and hospitalization information among the weight groups.

	Weight Group of Patient					
	Overall (*N* = 427)	**With Underweight (*N* = 57)**	**With Healthy Weight (*N* = 200)**	**With Overweight (*N* = 53)**	**With Obesity/ Morbid Obesity (*N* = 117)**	**P-value**
Age category (%)						0.01[1]
0–4 years	38.9	63.5	31.7	36.2	40.4	
5–9 years	26.0	26.2	28.7	26.5	21.0	
10–14 years	35.1	10.3	39.6	37.3	38.6	
Sex (%)						0.92[1]
Male	63.5	63.8	61.9	65.7	65.0	
Female	36.5	36.2	38.1	34.3	35.0	
Race (%)						0.94[1]
White	65.1	60.7	67.1	64.8	63.9	
Black	22.2	25.9	20.1	25.2	22.9	
Other	12.7	13.5	12.8	10.0	13.2	
Ethnicity (%)						0.81[1]
Hispanic or Latino	11.6	15.0	10.1	11.2	12.9	
Not Hispanic or Latino	88.4	85.0	89.9	88.8	87.1	
Injury category (%)						0.20[1]
Isolated head	25.1	46.5	25.0	16.5	18.5	
Isolated thorax	7.0	3.0	8.0	8.9	6.4	
Isolated abdomen	19.0	10.8	22.5	30.1	11.8	
Isolated spine	4.9	0.0	6.1	6.3	4.6	
Isolated extremity	26.9	27.4	22.5	26.9	34.4	
Multiple regions	17.1	12.2	15.8	11.4	24.3	
Number of body regions injured (%)						0.10[1]
One body region	82.9	87.8	84.2	88.6	75.7	
Two body regions	10.8	7.3	12.1	7.8	11.6	
Three or more body regions	6.3	4.9	3.7	3.6	12.7	

	Weight Group of Patient					
	Overall (*N* = 427)	**With Underweight (*N* = 57)**	**With Healthy Weight (*N* = 200)**	**With Overweight (*N* = 53)**	**With Obesity/ Morbid Obesity (*N* = 117)**	**P-value**
Injury type (%)						0.37[1]
Blunt	94.9	94.9	96.3	90.2	94.8	
Penetrating	5.1	5.1	3.7	9.8	5.2	
Mechanism of injury (%)						0.81[1]
Child abuse	14.3	20.6	12.8	8.0	16.5	
Penetrating	4.9	2.1	3.8	10.6	5.5	
Fall	30.3	34.8	30.6	40.0	23.1	
Motor vehicle collision occupant	20.4	11.9	19.5	20.6	26.0	
Pedestrian	8.4	13.1	7.6	2.8	9.9	
Transport other/motorcycle	5.1	2.8	5.5	4.4	5.9	
Cyclist	5.4	3.3	7.1	4.2	4.2	
Struck by/against	7.7	6.5	10.7	6.8	3.3	
Other	3.6	4.9	2.4	2.7	5.5	
Severe head injury (%)						0.74[1]
No	89.0	88.6	89.2	93.2	87.0	
Yes	11.0	11.4	10.8	6.8	13.0	
Underlying medical conditions (%)						0.64[1]
None	84.5	86.9	84.6	86.6	82.3	
Asthma	3.0	0.0	4.0	2.8	3.0	
Cardiovascular disease (arrhythmias/congenital)	0.7	0.0	0.5	0.0	1.7	
Neurological (seizure disorders/other)	1.4	0.5	1.8	0.2	1.7	
Other	10.3	12.6	9.1	10.4	11.2	
FSS at baseline (%)						0.59[1]
Normal (score of 6–7)	97.0	96.5	96.8	99.6	96.3	
Not Normal (score of ≥8)	3.0	3.5	3.2	0.4	3.7	
FSS at discharge (%)						0.65[1]
6–7 (good)	75.9	78.7	77.7	80.3	69.3	
8–9 (mildly abnormal)	15.7	15.0	14.7	13.1	18.9	

	Weight Group of Patient					
	Overall (*N* = 427)	**With Underweight (*N* = 57)**	**With Healthy Weight (*N* = 200)**	**With Overweight (*N* = 53)**	**With Obesity/ Morbid Obesity (*N* = 117)**	**P-value**
10–15 (moderately abnormal)	6.6	2.8	5.9	6.4	9.6	
≥ 16 (severely to very severely abnormal)	1.9	3.5	1.6	0.2	2.2	
ICU length of stay if admitted to the ICU (days)	3.9 [2.0, 7.5]	3.0 [2.0, 4.2]	3.1 [2.0, 6.8]	3.3 [2.0, 9.6]	4.0 [2.1, 13.0]	0.1[2]
Hospital length of stay (days)	3.0 [2.0,8.0]	2.8 [1.0,7.4]	3.0 [2.0,8.1]	3.0 [1.4,7.4]	4.0 [2.0,9.0]	0.17[2]
Post-discharge rehabilitation (%)						0.33[1]
Does not require rehabilitation program	78.9	79.5	82.2	82.8	71.3	
Outpatient rehabilitation program	9.0	12.9	6.8	10.8	9.9	
Skilled nursing care	0.7	0.0	0.5	0.0	1.8	
Inpatient rehabilitation	11.4	7.5	10.5	6.4	17.0	

[1] Likelihood ratio test.

[2] Jonckheere-Terpstra test.

Table 2

Relationship of new FSS domain morbidity with demographics and injury patterns.

	New Domain Morbidity at Discharge		
	No (*N* = 353)	Yes (*N* = 74)	P-value
Age category (%)			0.67[1]
0–4 years	38.0	43.2	
5–9 years	26.6	23.0	
10–14 years	35.4	33.8	
Sex (%)			0.43[1]
Male	64.3	59.5	
Female	35.7	40.5	
Race/Ethnicity (%)			0.40[1]
Hispanic/Latino	11.3	12.2	
Non-Hispanic White	58.1	51.4	
Non-Hispanic Black	19.8	28.4	
Non-Hispanic Other	10.8	8.1	
Weight Group (%)			0.06[1]
With Underweight	14.1	10.1	
With Healthy weight	48.7	38.2	
With Overweight	12.7	10.8	
With Obesity/Severe obesity	24.5	40.8	
Injury type (%)			0.40[1]
Blunt	95.4	92.7	
Penetrating	4.6	7.3	
Injury mechanism (%)			<0.001[1]
Child abuse	14.2	14.5	
Penetrating	4.2	7.8	
Fall	34.2	11.6	
Motor vehicle collision occupant	16.9	37.3	
Pedestrian	6.9	15.1	

	New Domain Morbidity at Discharge		
	No (*N* = 353)	**Yes (*N* = 74)**	**P-value**
Transport other/motorcycle	5.2	4.7	
Cyclist	6.6	0.0	
Struck by/against	8.0	6.1	
Other	3.8	2.8	<0.001[1]
Injury category (%)			
Isolated head	28.0	10.8	
Isolated thorax	7.4	5.4	
Isolated abdomen	22.1	4.1	
Isolated spine	4.2	8.1	
Isolated extremity	27.2	25.7	
Multiple body regions	11.0	45.9	
Severe head injury (%)			<0.001[1]
No	94.3	63.5	
Yes	5.7	36.5	
Age adjusted systolic blood pressure category[2] (%)			0.74[1]
Normal	96.1	95.3	
Abnormal	3.9	4.7	
Age adjusted pulse rate category[2] (%)			0.17[1]
Normal	68.0	59.3	
Abnormal	32.0	40.7	

[1]Likelihood ratio test.

[2]Normal = z-score −1.96 to 1.96, not normal = <−1.96 or >1.96.

Table 3

New FSS domain morbidities among weight groups.

FSS Domain (%)		Weight Group of Patient			
	Overall (*N* = 427)	**Underweight (*N* = 57)**	**Healthy Weight (*N* = 200)**	**Overweight (*N* = 53)**	**Obese/Severely Obese (*N* = 117)**
Mental status	2.6	1.7	2.7	0.2	3.9
Sensory	2.3	4.5	2.2	0.6	2.2
Communication	2.1	2.3	1.9	0.2	3.3
Motor	14.1	11.5	12.0	12.3	19.6
Feeding	5.4	5.1	3.7	4.7	8.7
Respiratory	0.5	0.0	0.0	0.0	1.7

Table 4

Multivariate model predicting new FSS domain morbidity after injury.

	OR (95% CI)	p-value
Age	0.89 (0.8, 0.9)	<0.001
Race/ethnicity		0.01
Hispanic/Latino	0.44 (0.3, 0.8)	
Non-Hispanic White	Reference	
Non-Hispanic Black	0.65 (0.4, 1.0)	
Non-Hispanic Other	0.80 (0.5, 1.3)	
Weight Group		0.88
With Underweight	1.0 (0.5, 2.3)	
With Healthy weight	Reference	
With Overweight	1.4 (0.6, 3.4)	
With Obesity/Severe Obesity	1.2 (0.7, 2.2)	
Injury type		0.30
Blunt	Reference	
Penetrating	0.56 (0.2, 1.7)	
Injury Category		<0.001
Isolated head	Reference	
Isolated thorax	28.6 (13.0, 62.9)	
Isolated abdomen	5.4 (2.2, 13.3)	
Isolated spine	127.4 (54.5, 297.8)	
Isolated extremity	18.4 (10.7, 31.5)	
Multiple body regions	62.7 (33.9, 115.9)	
Severe head injury		<0.001
No	Reference	
Yes	32.9 (19.1, 56.7)	
Suspected child physical abuse		0.11
No	Reference	
Yes	0.68 (0.4, 1.1)	
Age adjusted systolic blood pressure category		0.73

	OR (95% CI)	p-value
Normal	Reference	
Abnormal	0.70 (0.1, 5.6)	
Age adjusted pulse rate category		0.91
Normal	Reference	
Abnormal	1.0 (0.7, 1.5)	

[1] normal=*z*-score 1.96 to 1.96, not normal=*z*-score 〈 −1.96 or 〉 1.96.