The Injurious Burden of Poverty: Analysis of Socio-Economic Disparities in Injury Rates

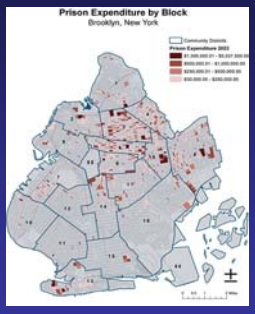
Eric Fleegler, MD, MPH
Division of Emergency Medicine,
Children's Hospital Boston
November 13, 2008
Harvard School of Public Health

Million-Dollar Blocks: The neighborhood costs of America's prison boom

The Village Voice
by Jennifer Gonnerman
November 16th, 2004

The Remeeder Houses make up one of the poorest blocks in Brooklyn…More than 50 percent of the project's residents live below the poverty line. Unemployment is rampant. Run-down, overcrowded apartments are the norm.

By another measure, though, this block is one of the priciest in the city. Last year, five residents were sent to state prison, at an annual cost of about $30,000 a person. The total price tag for their incarceration will exceed $1million.



Courtesy of Eric Cadora and Charles Schwartz. Source: NYS Division of Criminal Justice Services, 2003 prison sentences

Objectives

- Objective 1: Evaluate the spatial distribution of injuries
- Objective 2: Determine the impact of poverty and race/ethnicity on injury rates

Hypotheses

- Injuries concentrate in specific neighborhoods
- Significant injury rate disparities exist among:
  - neighborhoods with concentrated poverty
  - racial/ethnic groups

Background

Poverty affects:

- Preterm birth rates[1]
- Infectious diseases[2]
- Cancer mortality[3]
- Overall mortality[4]

[1]Smith. Arch Dis Childhood 2007;92:F11-F14
[2]Krieger. Am J Pub Health 2005;95:312-23
[3]Thomas. Am J Epidemiology 2006;164:586-590
[4]Pappas. NEJM. 1993;329:103-109

Methods: Design

A retrospective, population-based cohort study of 748,280 injuries in Massachusetts

Population

All individuals in Massachusetts
Total population: 6,349,097

Methods: Data (1)

Injury Data:

- Fiscal year 2004
- Emergency department, observation, and inpatient datasets
- Comprehensive and non-redundant
- ICD-9 codes identify injuries, E-codes identify injury mechanism

Methods: Data (2)

Zip Code operationalized as the unit of measure for a neighborhood

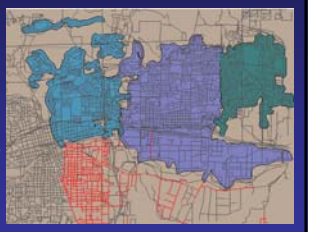
U.S. Census 2000 population and poverty data at the Zip Code Tabulation Area (ZCTA) level

Patient's home zip code matched to ZCTA (98.2% match rate)

Eric Fleegler, MD MPH

ZCTAs vs. Zip Codes

- Zip codes are *not* polygons – they are linear features associated with roads
- Zip Code Tabulation Areas (ZCTAs) were defined in 1990 to account for residential zip codes
- Business or post-office box-only zip codes excluded (~25% of total zip codes)

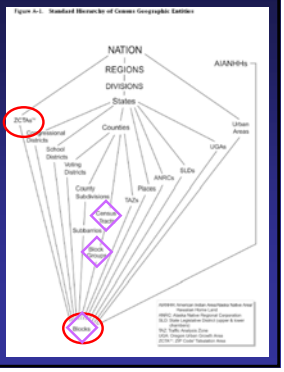


Reno, Nevada

Eric Fleegler, MD MPH

ZCTAs vs. Zip Codes

- ZCTAs are hierarchically composed of census 'blocks'
- Massachusetts has 693 zip codes, but only 503 ZCTAs
- Within the DPH dataset, 11,504 / 749,434 injuries (1.5%), are discarded when converting zip codes → ZCTAs

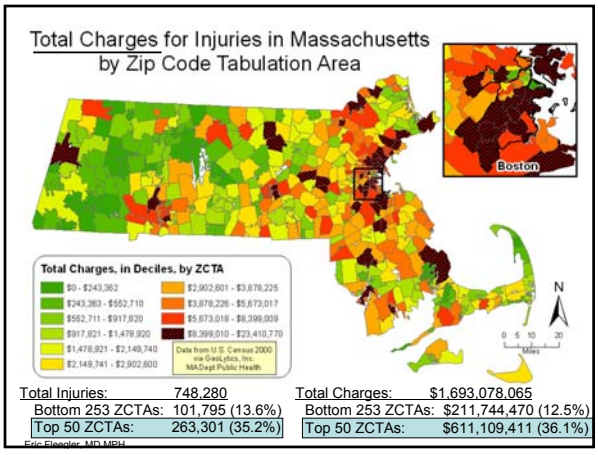


Eric Fleegler, MD MPH

Objectives

- Objective 1: Evaluate the spatial distribution of injuries
- Objective 2: Determine the impact of poverty and race/ethnicity on injury rates

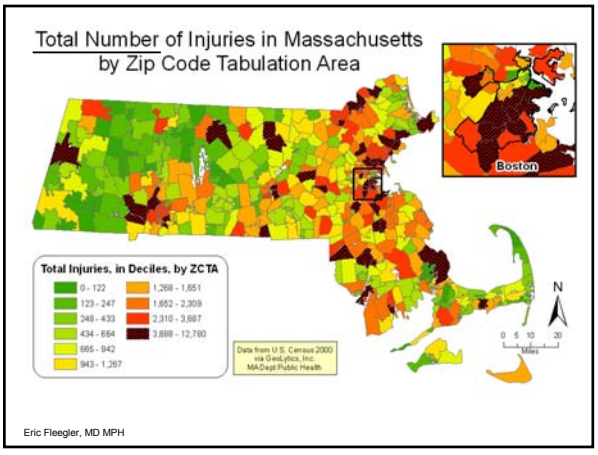
Eric Fleegler, MD MPH



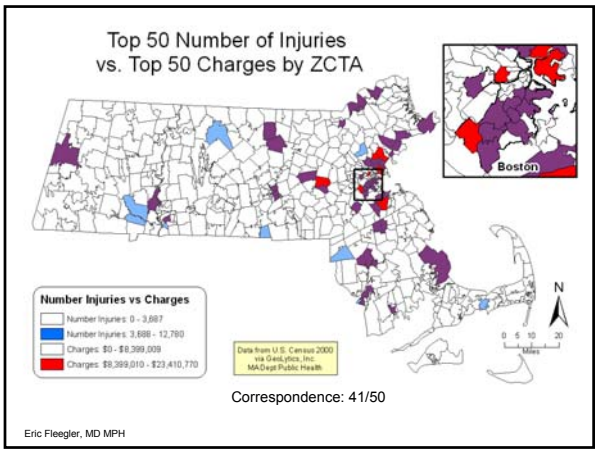
Total Injuries: 748,280
Bottom 253 ZCTAs: 101,795 (13.6%)
Top 50 ZCTAs: 263,301 (35.2%)

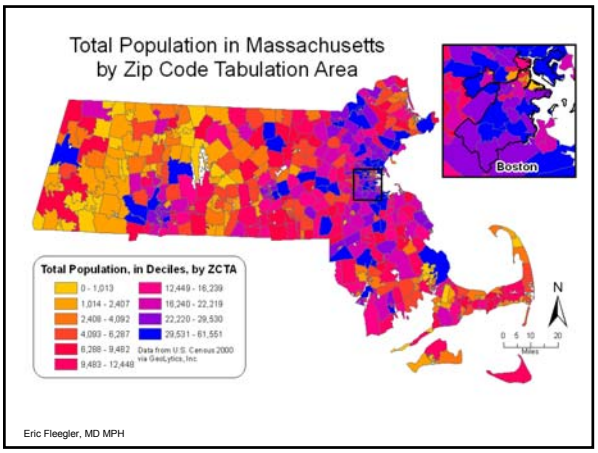
Total Charges: $1,693,078,065
Bottom 253 ZCTAs: $211,744,470 (12.5%)
Top 50 ZCTAs: $611,109,411 (36.1%)

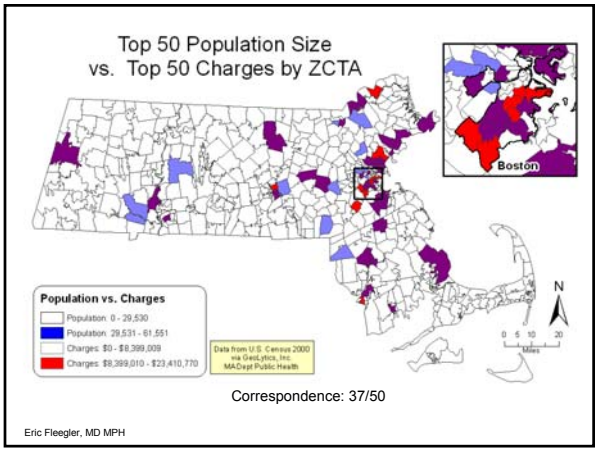
Eric Fleegler, MD MPH

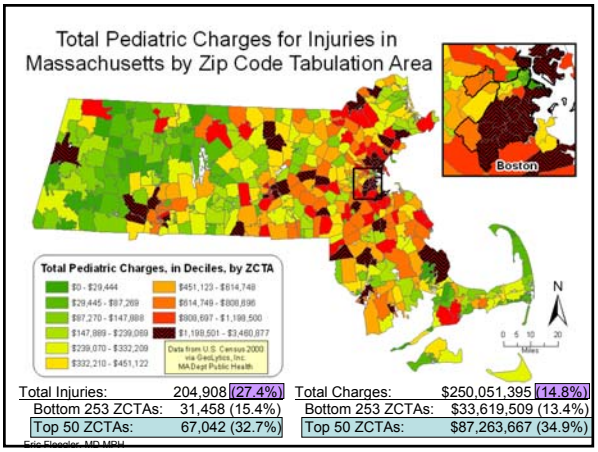


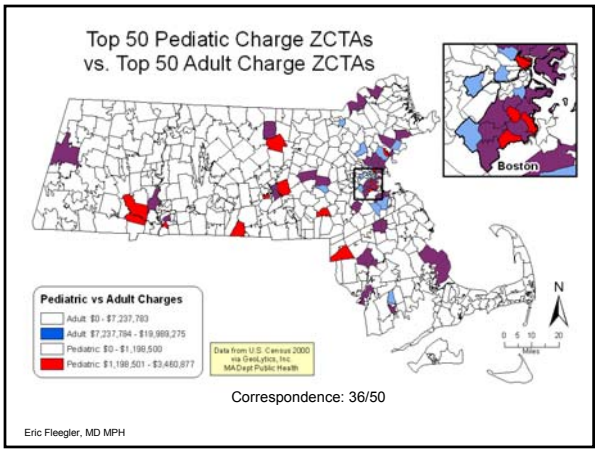
Eric Fleegler, MD MPH


Top 50 Number of Injuries
vs. Top 50 Charges by ZCTA
Boston
Number Injuries vs Charges
Number Injuries: 0 - 3,687
Number Injuries: 3,688 - 12,780
Charges: $0 - $8,399,009
Charges: $8,399,010 - $23,410,770
Data from U.S. Census 2000 via GeoLytics, Inc
MA Dept Public Health
N
0 5 10 20
Miles
Correspondence: 41/50
Eric Fleegler, MD MPH


Total Population in Massachusetts
by Zip Code Tabulation Area
Boston
Total Population, in Deciles, by ZCTA
0 - 1,013
1,014 - 2,407
2,408 - 4,092
4,093 - 6,287
6,288 - 9,482
9,483 - 12,448
12,449 - 16,239
16,240 - 22,219
22,220 - 29,530
29,531 - 61,551
Data from U.S. Census 2000 via GeoLytics, Inc
N
0 5 10 20
Eric Fleegler, MD MPH


Top 50 Population Size
vs. Top 50 Charges by ZCTA
Boston
Population vs. Charges
Population: 0 - 29,530
Population: 29,531 - 61,551
Charges: $0 - $8,399,009
Charges: $8,399,010 - $23,410,770
Data from U.S. Census 2000 via GeoLytics, Inc
MA Dept Public Health
N
0 5 10 20
Miles
Correspondence: 37/50
Eric Fleegler, MD MPH


Total Pediatric Charges for Injuries in
Massachusetts by Zip Code Tabulation Area
Boston
Total Pediatric Charges, in Deciles, by ZCTA
$0 - $29,444
$29,445 - $87,269
$87,270 - $147,888
$147,889 - $239,069
$239,070 - $332,209
$332,210 - $451,122
$451,123 - $614,748
$614,749 - $808,896
$808,697 - $1,199,500
$1,199,501 - $3,460,877
Data from U.S. Census 2000 via GeoLytics, Inc
MA Dept Public Health
N
0 5 10 20
Miles
Total Injuries: 204,908 (27.4%)
Bottom 253 ZCTAs: 31,458 (15.4%)
Top 50 ZCTAs: 67,042 (32.7%)
Total Charges: $250,051,395 (14.8%)
Bottom 253 ZCTAs: $33,619,509 (13.4%)
Top 50 ZCTAs: $87,263,667 (34.9%)
Eric Fleegler, MD MPH


Top 50 Pediatric Charge ZCTAs
vs. Top 50 Adult Charge ZCTAs
Boston
Pediatric vs Adult Charges
Adult: $0 - $7,237,793
Adult: $7,237,794 - $19,989,275
Pediatric: $0 - $1,198,500
Pediatric: $1,198,501 - $3,460,877
Data from U.S. Census 2000 via GeoLytics, Inc
MA Dept Public Health
N
0 5 10 20
Miles
Correspondence: 36/50
Eric Fleegler, MD MPH

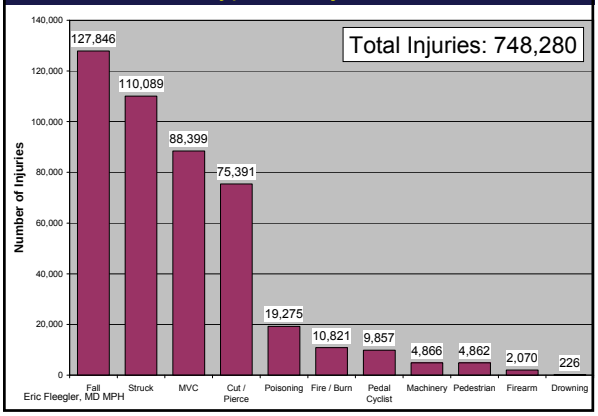
What type of injuries?
Eric Fleegler, MD MPH

Injury Mechanisms

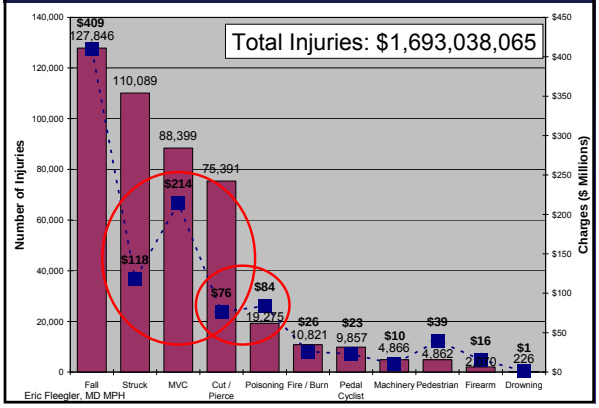
- Struck by / Against
- Fall
- Cut / Pierce
- Motor Vehicle
- Pedal Cyclist
- Poisoning
- Fire / Burn
- Pedestrian
- Firearm
- Machinery
- Drowning

Eric Fleegler, MD MPH

Types of Injuries



Number of Injuries vs. Charges

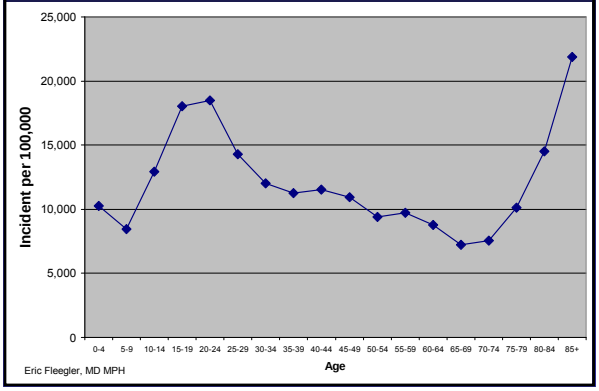


Who is being injured?

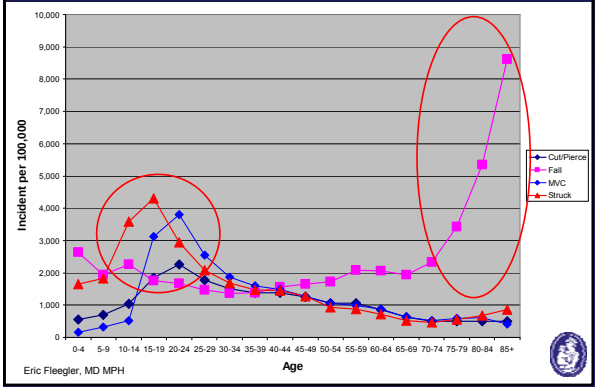
Variations in injury patterns by age, gender, and race

Eric Fleegler, MD MPH

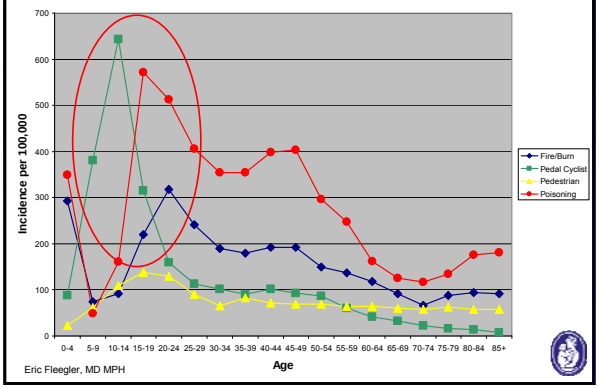
Total Injuries Incident Rate by Age



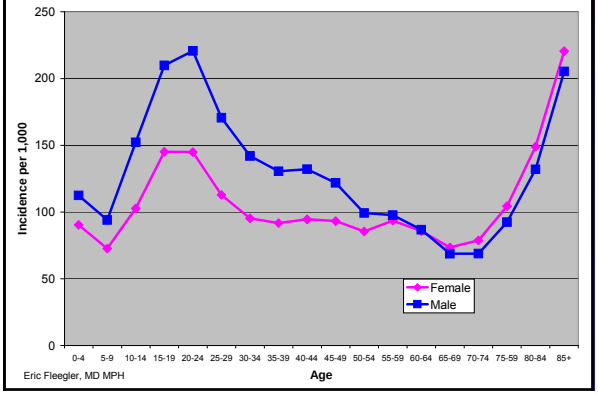
Common Injuries Incident Rate



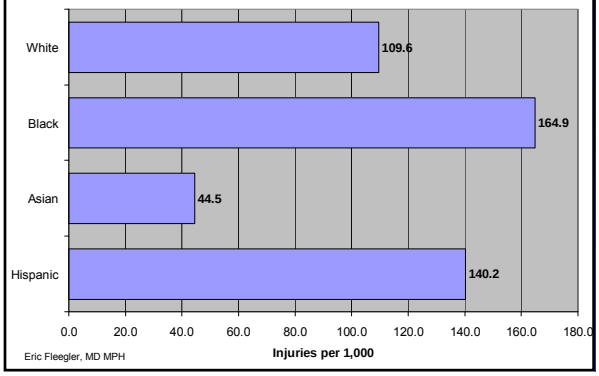
Less Common Injuries Incident Rate



Total Injuries Incident Rate by Gender



Injury Incident Rate by Race



Objectives

- Objective 1: Evaluate the spatial distribution of injuries
- Objective 2: Determine the impact of poverty and race/ethnicity on injury rates

Eric Fleegler, MD MPH

Methods: Analysis

Area-based measure of socioeconomic inequality: Poverty rate

ZCTA poverty rate calculation:

$$\left[\frac{\text{Population below the federal poverty line}}{\text{Total population of ZCTA}}\right]$$

Federal poverty line for a family of four: $17,603

Eric Fleegler, MD MPH

Methods: Analysis

Poverty levels:

(1) 0.0 - 4.9% (Least impoverished)
(2) 5.0 - 9.9%
(3) 10.0 - 19.9%
(4) 20.0 - 100% (Most impoverished)

Areas with poverty rate ≥20% are federally defined "poverty areas"[1]

[1]Bishaw A. Areas with Concentrated Poverty: 1999. *Census 2000 Special Reports*. Vol CENSR-16; 2005:1-11. Eric Fleegler, MD MPH

Methods: Outcome Measures

Incident Rate

Overall and by poverty level

Incident Rate Ratio

Compared to least impoverished

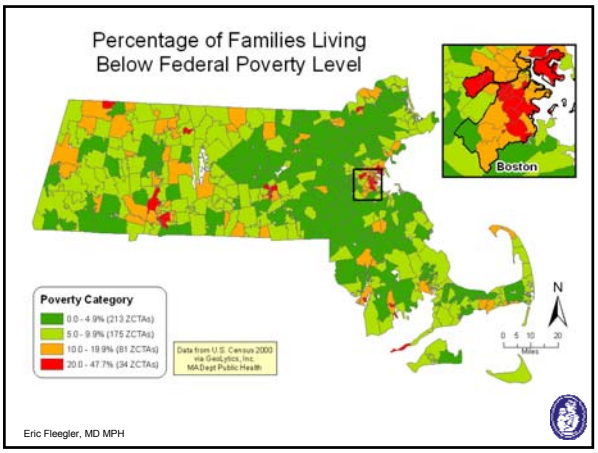
Relative Risk

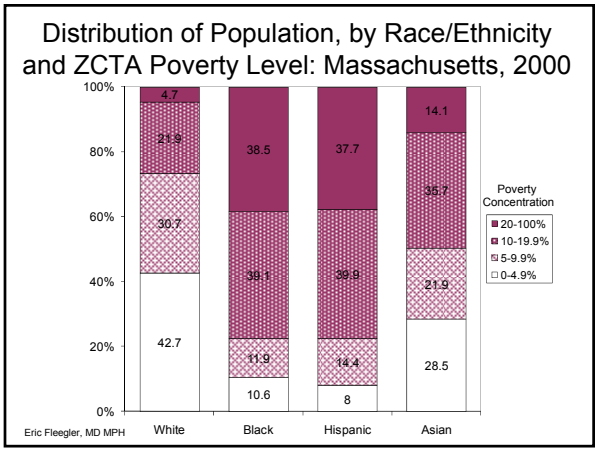
Compared to White, Non-Hispanic

Population Attributable Fraction

Injuries that would not have occurred if the risk of injury for all groups equaled that of least impoverished regions

Eric Fleegler, MD MPH

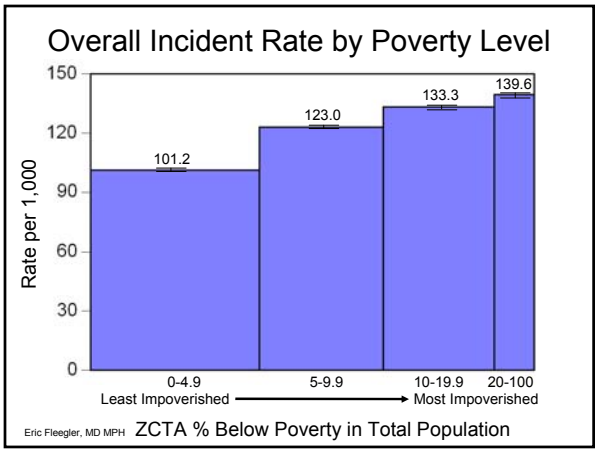


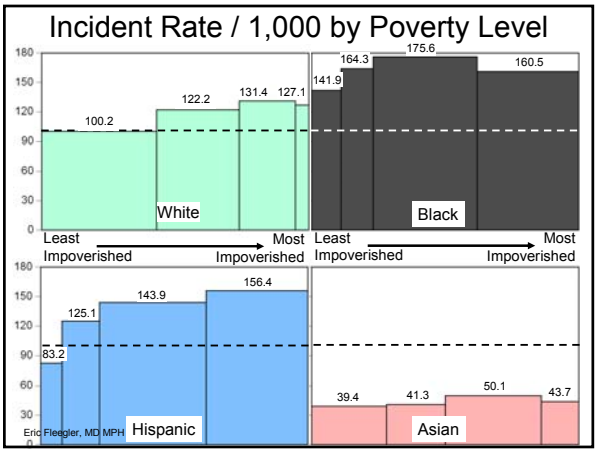


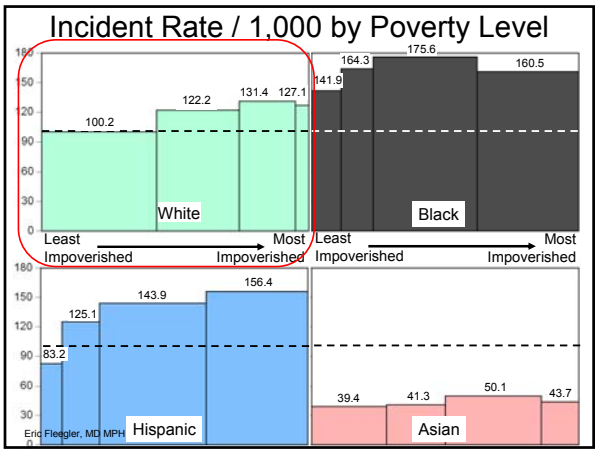
Results: Number of Injuries

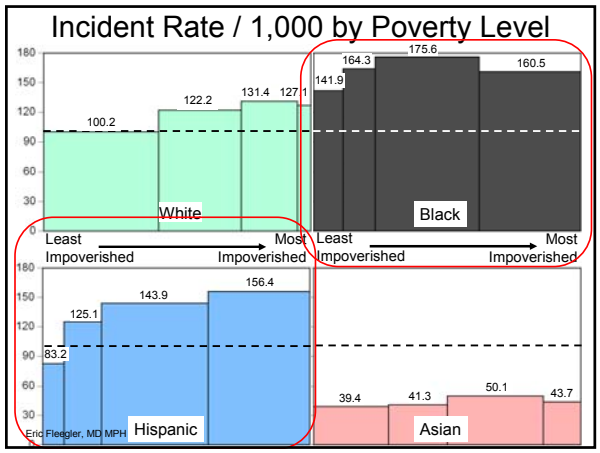
	Population (% Total)	Injuries (% Total)
Total	6,349,097 (100)	748,280 (100)
White	5,197,124 (82)	584,553 (78)
Black	337,157 (5)	57,200 (8)
Hispanic	427,340 (7)	61,940 (8)
Asian	238,246 (4)	10,185 (1)

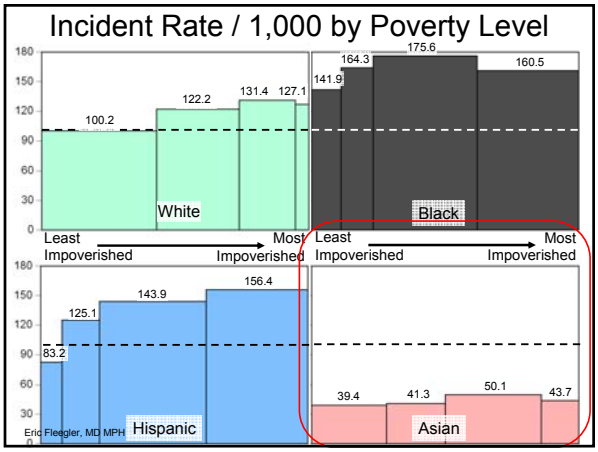
Eric Fleegler, MD MPH











Results: Incidence Rate Ratio

	Incidence Rate		
	Poverty 0-4.9%	Poverty 20-100%	Incidence Rate Ratio
Total	101.2	139.6	1.38
White	100.2	127.1	1.27
Black	141.9	162.7	1.15
Hispanic	83.2	156.4	1.88
Asian	39.4	43.7	1.11

Eric Fleegler, MD MPH

Results: Relative Risks

	Unadjusted	Adjusted for Age & Gender	Adjusted for Age, Gender & Poverty
Black:White	1.43	1.29	1.15 (1.12, 1.19)
Hispanic:White	1.26	0.97	0.87 (0.84, 0.90)
Asian:White	0.35	0.34	0.31 (0.30, 0.33)

Eric Fleegler, MD MPH

Results: Relative Risks

	Unadjusted	Adjusted for Age & Gender	Adjusted for Age, Gender & Poverty
Black:White	1.43	1.29	1.15 (1.12, 1.19)
Hispanic:White	1.26	0.97	0.87 (0.84, 0.90)
Asian:White	0.35	0.34	0.31 (0.30, 0.33)

Eric Fleegler, MD MPH

Results: Relative Risks

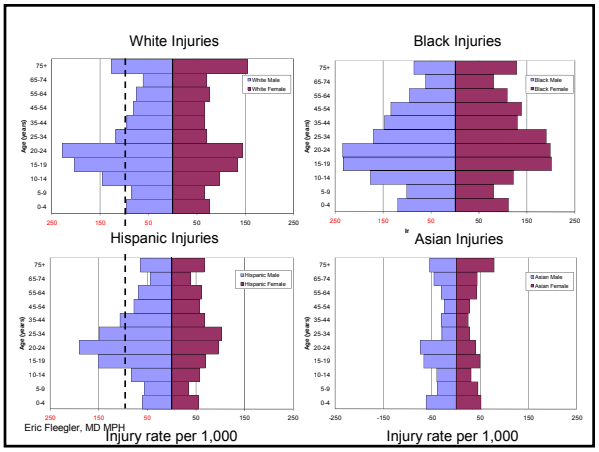
	Unadjusted	Adjusted for Age & Gender	Adjusted for Age, Gender & Poverty
Black:White	1.43	1.29	1.15 (1.12, 1.19)
Hispanic:White	1.26	0.97	0.87 (0.84, 0.90)
Asian:White	0.35	0.34	0.31 (0.30, 0.33)

Eric Fleegler, MD MPH

Results: Relative Risks

	Unadjusted	Adjusted for Age & Gender	Adjusted for Age, Gender & Poverty
Black:White	1.43	1.29	1.15 (1.12, 1.19)
Hispanic:White	1.26	0.97	0.87 (0.84, 0.90)
Asian:White	0.35	0.34	0.31 (0.30, 0.33)

Eric Fleegler, MD MPH



Population Attributable Fraction

	PAF (%)	Excess Injuries
Total	14.5	108,757
White	12.3	71,907
Black	13.3	7,612
Hispanic	37.7	23,343
Asian	10.9	1,106

Eric Fleegler, MD MPH

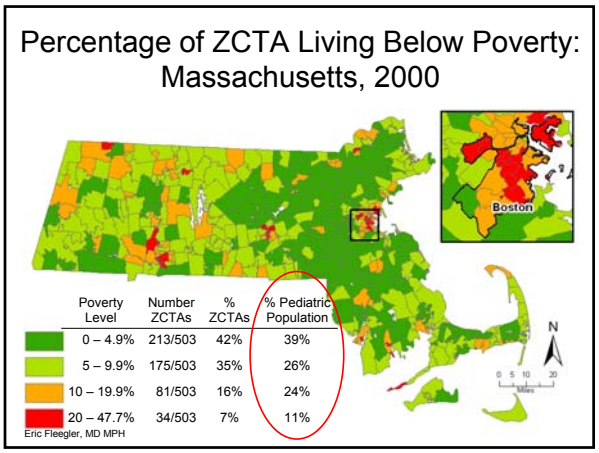
Population Attributable Fraction

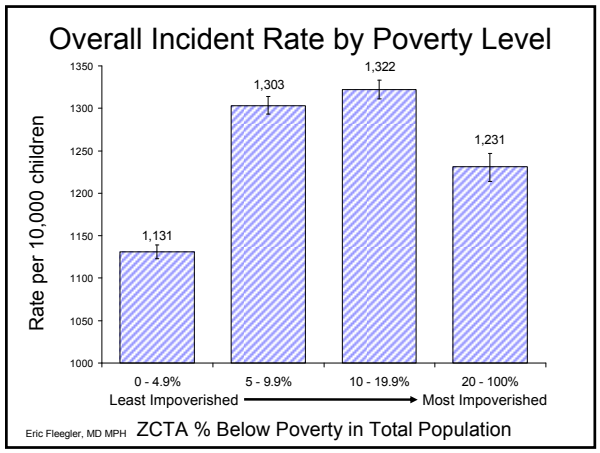
	PAF (%)	Excess Injuries
Total	14.5	108,757
White	12.3	71,907
Black	13.3	7,612
Hispanic	37.7	23,343
Asian	10.9	1,106

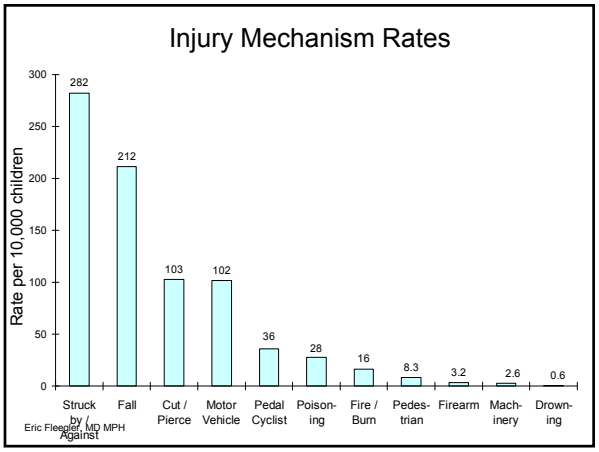
Eric Fleegler, MD MPH

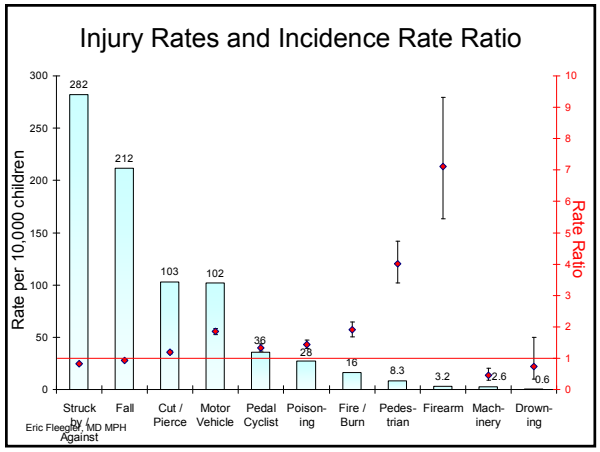
Impact of Socioeconomic Inequalities on Childhood Injury Mechanisms

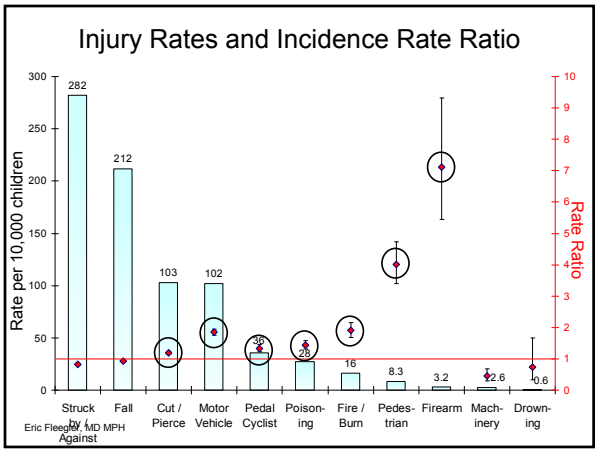
Eric Fleegler, MD MPH

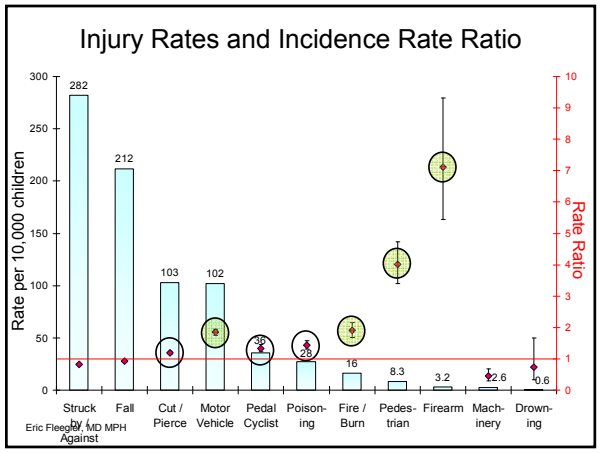

Percentage of ZCTA Living Below Poverty: Massachusetts, 2000
Boston
Poverty Level | Number ZCTAs | % ZCTAs | % Pediatric Population
0 – 4.9% | 213/503 | 42% | 39%
5 – 9.9% | 175/503 | 35% | 26%
10 – 19.9% | 81/503 | 16% | 24%
20 – 47.7% | 34/503 | 7% | 11%
N
Eric Fleegler, MD MPH

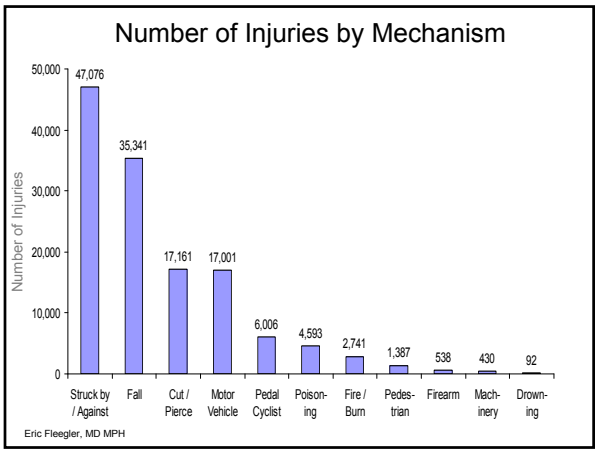

Overall Incident Rate by Poverty Level
Rate per 10,000 children
1,131
1,303
1,322
1,231
0 - 4.9%
5 - 9.9%
10 - 19.9%
20 - 100%
Least Impoverished
Most Impoverished
ZCTA % Below Poverty in Total Population
Eric Fleegler, MD MPH

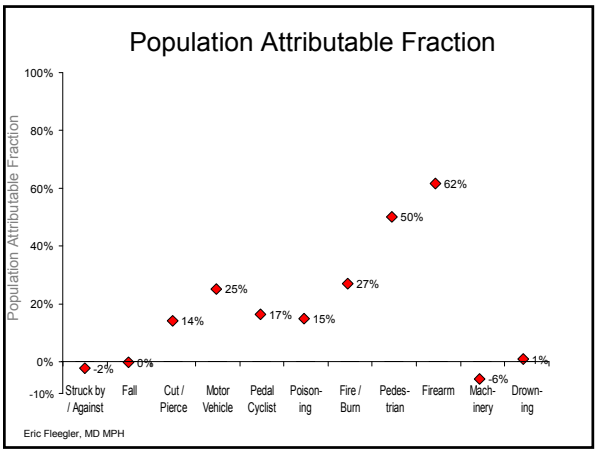

Injury Mechanism Rates
Rate per 10,000 children
282
212
103
102
36
28
16
8.3
3.2
2.6
0.6
Struck by / Against
Fall
Cut / Pierce
Motor Vehicle
Pedal Cyclist
Poison-ing
Fire / Burn
Pedes-trian
Firearm
Mach-inery
Drown-ing
Eric Fleegler, MD MPH

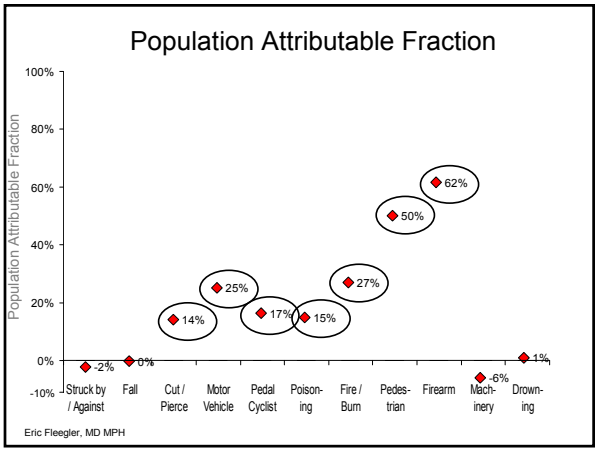

Injury Rates and Incidence Rate Ratio
Rate per 10,000 children
Rate Ratio
282
212
103
102
36
28
16
8.3
3.2
2.6
0.6
Struck by / Against
Fall
Cut / Pierce
Motor Vehicle
Pedal Cyclist
Poison-ing
Fire / Burn
Pedes-trian
Firearm
Mach-inery
Drown-ing
Eric Fleegler, MD MPH

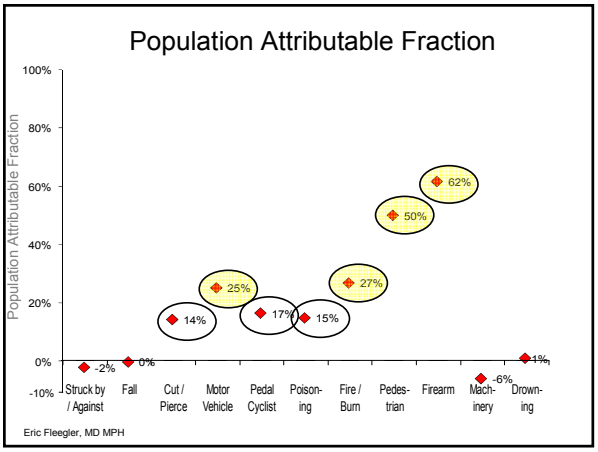

Injury Rates and Incidence Rate Ratio
Rate per 10,000 children
Rate Ratio
282
212
103
102
36
28
16
8.3
3.2
2.6
0.6
Struck by / Against
Fall
Cut / Pierce
Motor Vehicle
Pedal Cyclist
Poison-ing
Fire / Burn
Pedes-trian
Firearm
Mach-inery
Drown-ing
Eric Fleegler, MD MPH

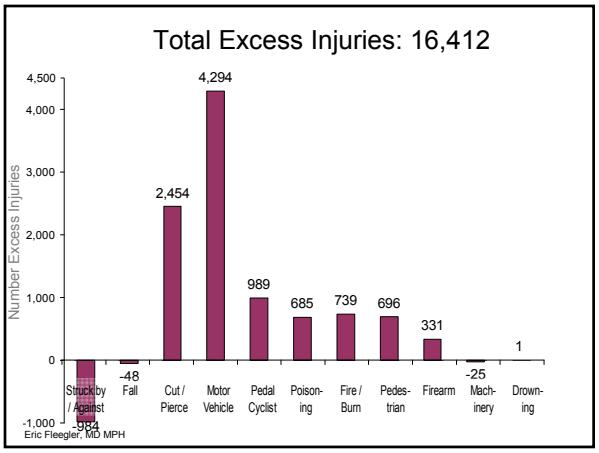

Injury Rates and Incidence Rate Ratio
Rate per 10,000 children
Rate Ratio
282
212
103
102
36
28
16
8.3
3.2
2.6
0.6
Struck by / Against
Fall
Cut / Pierce
Motor Vehicle
Pedal Cyclist
Poison-ing
Fire / Burn
Pedes-trian
Firearm
Mach-inery
Drown-ing
Eric Fleegler, MD MPH

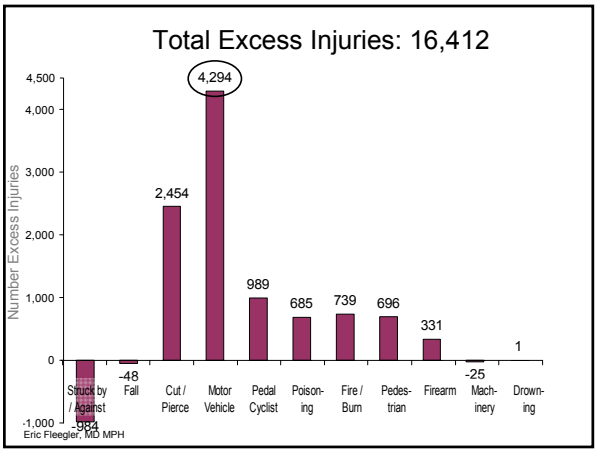

Number of Injuries by Mechanism
Number of Injuries
50,000
40,000
30,000
20,000
10,000
0
47,076
35,341
17,161
17,001
6,006
4,593
2,741
1,387
538
430
92
Struck by / Against
Fall
Cut / Pierce
Motor Vehicle
Pedal Cyclist
Poison-ing
Fire / Burn
Pedes-trian
Firearm
Mach-inery
Drown-ing
Eric Fleegler, MD MPH


Population Attributable Fraction
Population Attributable Fraction
100%
80%
60%
40%
20%
0%
-10%
-2%
0%
14%
25%
17%
15%
27%
50%
62%
1%
-6%
Struck by / Against
Fall
Cut / Pierce
Motor Vehicle
Pedal Cyclist
Poison-ing
Fire / Burn
Pedes-trian
Firearm
Mach-inery
Drown-ing
Eric Fleegler, MD MPH


Population Attributable Fraction
Population Attributable Fraction
100%
80%
60%
40%
20%
0%
-10%
-2%
0%
14%
25%
17%
15%
27%
50%
62%
1%
-6%
Struck by / Against
Fall
Cut / Pierce
Motor Vehicle
Pedal Cyclist
Poison-ing
Fire / Burn
Pedes-trian
Firearm
Mach-inery
Drown-ing
Eric Fleegler, MD MPH


Population Attributable Fraction
Population Attributable Fraction
100%
80%
60%
40%
20%
0%
-10%
-2%
0%
14%
25%
17%
15%
27%
50%
62%
1%
-6%
Struck by / Against
Fall
Cut / Pierce
Motor Vehicle
Pedal Cyclist
Poison-ing
Fire / Burn
Pedes-trian
Firearm
Mach-inery
Drown-ing
Eric Fleegler, MD MPH


Total Excess Injuries: 16,412
Number Excess Injuries
4,500
4,000
3,000
2,000
1,000
0
-1,000
-984
-48
2,454
4,294
989
685
739
696
331
-25
1
Struck by / Against
Fall
Cut / Pierce
Motor Vehicle
Pedal Cyclist
Poison-ing
Fire / Burn
Pedes-trian
Firearm
Mach-inery
Drown-ing
Eric Fleegler, MD MPH


Total Excess Injuries: 16,412
Number Excess Injuries
4,500
4,000
3,000
2,000
1,000
0
-1,000
-984
-48
2,454
4,294
989
685
739
696
331
-25
1
Struck by / Against
Fall
Cut / Pierce
Motor Vehicle
Pedal Cyclist
Poison-ing
Fire / Burn
Pedes-trian
Firearm
Mach-inery
Drown-ing
Eric Fleegler, MD MPH

Strengths & Limitations

- Population based study
  - Injuries presenting to hospitals
  - Accuracy of zip codes
- ZCTA poverty measure
  - Heterogeneous and relatively large
- Distribution of population by poverty concentration
  - High proportion live in least impoverished regions

Eric Fleegler, MD MPH

Summary

- 748,280 injuries in 2004
- Top 10% of zip codes account for 36% of injury charges
- Higher injury rates among most impoverished ZCTAs
- Variation in injury rates among different race/ethnicities
- Overall, 14.5% Population Attributable Fraction and 108,757 excess injuries

Eric Fleegler, MD MPH

Implications

- Socioeconomic inequalities adversely effect all injuries across a spectrum of mechanisms
- Need to address neighborhood-level poverty as a risk factor for injuries
- Need to monitor socioeconomic inequalities to set health objectives and track progress

Eric Fleegler, MD MPH

Implications

- Socioeconomic inequalities adversely effect all injuries across a spectrum of mechanisms
- Need to address neighborhood-level poverty as a risk factor for injuries
- Need to monitor socioeconomic inequalities to set health objectives and track progress

Eric Fleegler, MD MPH

Implications

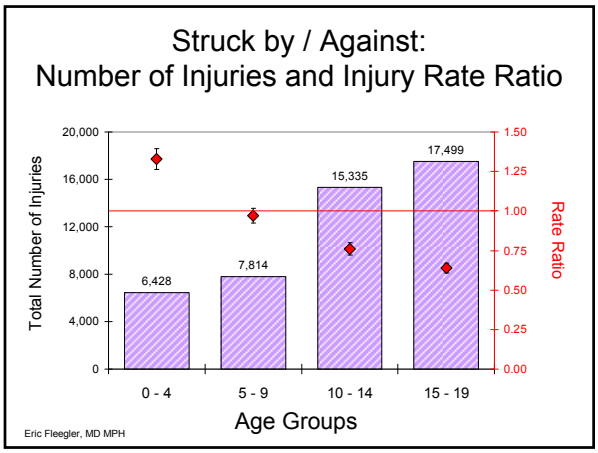
- Socioeconomic inequalities adversely effect all injuries across a spectrum of mechanisms
- Need to address neighborhood-level poverty as a risk factor for injuries
- Need to monitor socioeconomic inequalities to set health objectives and track progress

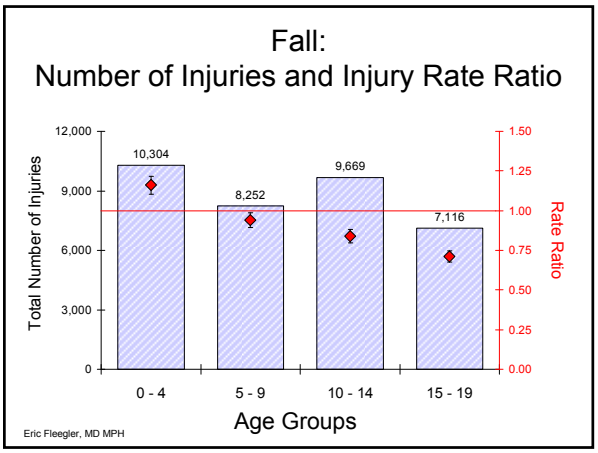
Eric Fleegler, MD MPH

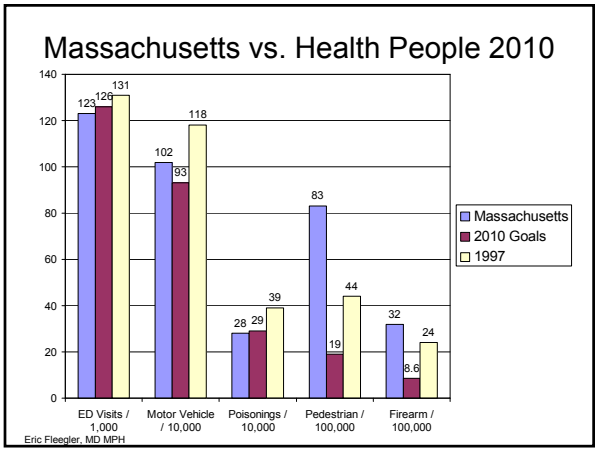
Thank you

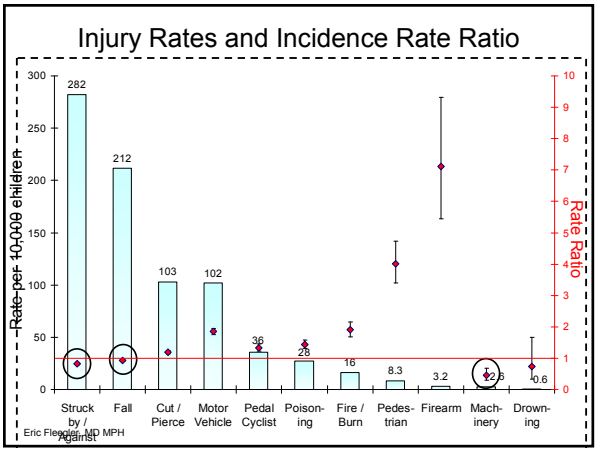
Eric Fleegler, MD MPH
Peter Forbes, MA
Lois Lee, MD MPH
Karen Olson, PhD
S.V. Subramanian, PhD
David Mooney, MD MPH

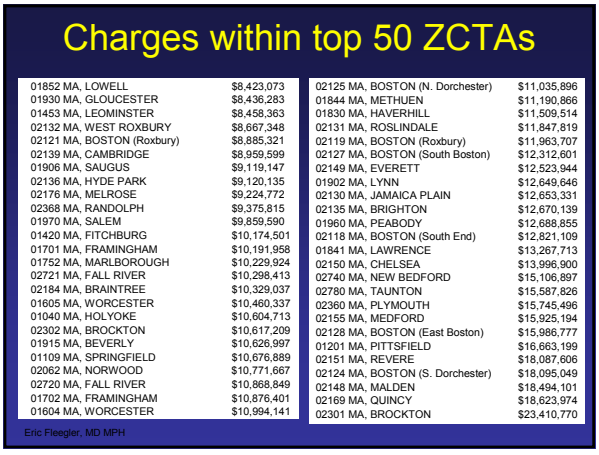
Eric Fleegler, MD MPH

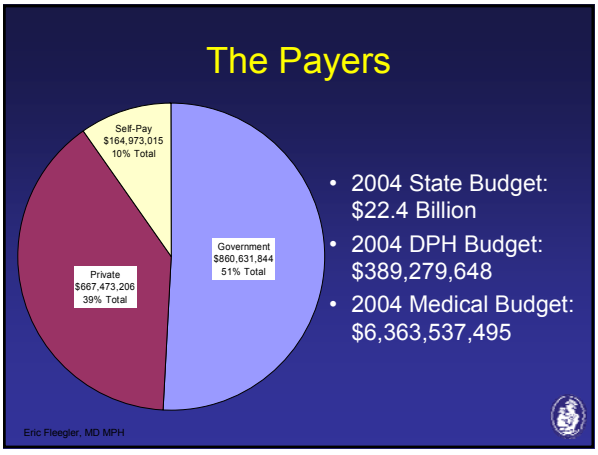

Struck by / Against:
Number of Injuries and Injury Rate Ratio
Total Number of Injuries
Rate Ratio
20,000
16,000
12,000
8,000
4,000
0
1.50
1.25
1.00
0.75
0.50
0.25
0.00
6,428
7,814
15,335
17,499
0 - 4
5 - 9
10 - 14
15 - 19
Age Groups
Eric Fleegler, MD PHH


Fall:
Number of Injuries and Injury Rate Ratio
Total Number of Injuries
Rate Ratio
12,000
9,000
6,000
3,000
0
1.50
1.25
1.00
0.75
0.50
0.25
0.00
10,304
8,252
9,669
7,116
0 - 4
5 - 9
10 - 14
15 - 19
Age Groups
Eric Fleegler, MD PHH


Massachusetts vs. Health People 2010
140
120
100
80
60
40
20
0
123
126
131
102
93
118
28
29
39
83
19
44
32
8.6
24
Massachusetts
2010 Goals
1997
ED Visits / 1,000
Motor Vehicle / 10,000
Poisonings / 10,000
Pedestrian / 100,000
Firearm / 100,000
Eric Fleegler, MD PHH


Injury Rates and Incidence Rate Ratio
Rate per 10,000 children
Rate Ratio
300
250
200
150
100
50
0
10
9
8
7
6
5
4
3
2
1
0
282
212
103
102
36
28
16
8.3
3.2
2.6
0.6
Struck by / Against
Fall
Cut / Pierce
Motor Vehicle
Pedal Cyclist
Poison-ing
Fire / Burn
Pedes-trian
Firearm
Mach-inery
Drown-ing
Eric Fleegler, MD PHH


Charges within top 50 ZCTAs
01852 MA, LOWELL $8,423,073
01930 MA, GLOUCESTER $8,436,283
01453 MA, LEOMINSTER $8,458,363
02132 MA, WEST ROXBURY $8,667,348
02121 MA, BOSTON (Roxbury) $8,885,321
02139 MA, CAMBRIDGE $8,959,599
01906 MA, SAUGUS $9,119,147
02136 MA, HYDE PARK $9,120,135
02176 MA, MELROSE $9,224,772
02368 MA, RANDOLPH $9,375,815
01970 MA, SALEM $9,859,590
01420 MA, FITCHBURG $10,174,501
01701 MA, FRAMINGHAM $10,191,958
01752 MA, MARLBOROUGH $10,229,924
02721 MA, FALL RIVER $10,298,413
02184 MA, BRAINTREE $10,329,037
01605 MA, WORCESTER $10,460,337
01040 MA, HOLYOKE $10,604,713
02302 MA, BROCKTON $10,617,209
01915 MA, BEVERLY $10,626,997
01109 MA, SPRINGFIELD $10,676,889
02062 MA, NORWOOD $10,771,667
02720 MA, FALL RIVER $10,868,849
01702 MA, FRAMINGHAM $10,876,401
01604 MA, WORCESTER $10,994,141
02125 MA, BOSTON (N. Dorchester) $11,035,896
01844 MA, METHUEN $11,190,866
01830 MA, HAVERHILL $11,509,514
02131 MA, ROSLINDALE $11,847,819
02119 MA, BOSTON (Roxbury) $11,963,707
02127 MA, BOSTON (South Boston) $12,312,601
02149 MA, EVERETT $12,523,944
01902 MA, LYNN $12,649,646
02130 MA, JAMAICA PLAIN $12,653,331
02135 MA, BRIGHTON $12,670,139
01960 MA, PEABODY $12,688,855
02118 MA, BOSTON (South End) $12,821,109
01841 MA, LAWRENCE $13,267,713
02150 MA, CHELSEA $13,996,900
02740 MA, NEW BEDFORD $15,106,897
02780 MA, TAUNTON $15,587,826
02360 MA, PLYMOUTH $15,745,496
02155 MA, MEDFORD $15,925,194
02128 MA, BOSTON (East Boston) $15,986,777
01201 MA, PITTSFIELD $16,663,199
02151 MA, REVERE $18,087,606
02124 MA, BOSTON (S. Dorchester) $18,095,049
02148 MA, MALDEN $18,494,101
02169 MA, QUINCY $18,623,974
02301 MA, BROCKTON $23,410,770
Eric Fleegler, MD PHH


The Payers
Self-Pay
$164,973,015
10% Total
Government
$860,631,844
51% Total
Private
$667,473,206
39% Total
• 2004 State Budget: $22.4 Billion
• 2004 DPH Budget: $389,279,648
• 2004 Medical Budget: $6,363,537,495
Eric Fleegler, MD PHH