Pedestrian injuries in San Francisco: distribution, causes, and solutions

Presentation to the San Francisco Health Commission

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National Burden of Traffic Injuries and Fatalities

- 2009 National Traffic Safety Facts
  - 33,808 deaths
  - 2,217,000 injuries
  - 4,092 pedestrian deaths
  - 49,000 pedestrian injuries

- For youth and children
  - Leading cause of death
  - 900 pedestrians deaths
  - 51,000 children injuries 5,300 hospitalizations

- Vulnerable users (walkers, bikers) with higher per trip risks than drivers or transit users

- Estimated $230 billion in economic costs

San Francisco Burden of Pedestrian Injuries and Fatalities

- ~ 800 injury collisions
- ~100 people killed or seriously injured annually
- Per resident rate of injuries (97 /100,000) five times national public health target
- Trends stable ~ 10 years

Pedestrian Injuries under-reporting in San Francisco

- State injury data (SWITRS) is based on local police reports
- Police reports have under-estimated pedestrian collisions based on comparison with hospital data
- Under-reporting is less likely for severe & fatal injuries

Causes of pedestrian injuries and fatalities

- Traffic flow
- Pedestrian activity
- Vehicle speed
- Vehicle type (e.g. trucks)
- Road layout, geometry, lighting, and crossing facilities
- Driver experience, attitudes, and behaviors
- Pedestrian age & ability
Pedestrian injury rates are higher than national public health objectives in all San Francisco age groups

- Children, the poor, the elderly, and non-auto owners are more vulnerable to traffic hazards
  - higher number of walking trips
  - physical and cognitive limits
  - more injury complications in the elderly

- Rate of pedestrian deaths in elderly San Franciscans are 4 X that of adults and 12 X that of children

### Rate of Pedestrian Fatalities and Injuries (2004-2008), San Francisco, California

<table>
<thead>
<tr>
<th>Age</th>
<th>Fatality Rate per 100,000</th>
<th>Injury Rate per 100,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under 18</td>
<td>0.5</td>
<td>73.1</td>
</tr>
<tr>
<td>18 - 64</td>
<td>1.5</td>
<td>101.7</td>
</tr>
<tr>
<td>65 and over</td>
<td>6.0</td>
<td>97.2</td>
</tr>
<tr>
<td>All ages</td>
<td>2.5</td>
<td>98.1</td>
</tr>
<tr>
<td><strong>Healthy People 2020 Targets</strong></td>
<td><strong>1.3</strong></td>
<td><strong>20.3</strong></td>
</tr>
</tbody>
</table>

More walking does not fully explain San Francisco’s high pedestrian injury rates

- On a per-walking-trip basis, pedestrian collisions rates are 30% higher in San Francisco than the U.S.
- Walking carries 4 times the risk of death relative to driving for San Franciscans
- Cycling is the most hazardous mode of travel
- Drivers fare much better in San Francisco than the rest of the U.S.

### Injury and fatality rates per 100 million trips by travel mode: San Francisco compared to the U.S.

<table>
<thead>
<tr>
<th>Travel Mode</th>
<th>Injury Rate</th>
<th>Fatality Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>United States (1999-2003)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walkers</td>
<td>216</td>
<td>14</td>
</tr>
<tr>
<td>Car Drivers/Passengers</td>
<td>803</td>
<td>9</td>
</tr>
<tr>
<td>Cyclists</td>
<td>1461</td>
<td>21</td>
</tr>
<tr>
<td><strong>San Francisco (2004-2008)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walkers</td>
<td>281</td>
<td>8</td>
</tr>
<tr>
<td>Car Drivers/Passengers</td>
<td>297</td>
<td>2</td>
</tr>
<tr>
<td>Cyclists</td>
<td>1170</td>
<td>6</td>
</tr>
</tbody>
</table>

Majority of police identified primary collision factors are driver violations

- Police assign a “primary collision factor” to each collision based on their investigation
  - Environmental and engineering factors are not considered as collision factors in police accident investigations in SF
- Driver violations represent the majority of primary collision factor in SF
  - Pedestrian Right of Way – 39%
  - Unsafe Speed – 6%
  - Fail to observe traffic signals and signs – 5%
  - Unsafe starting or backing (up) – 5%
- Driving under the influence is the primary collision factor in ~1% of collisions

Data Sources: SWITRS (Statewide Integrated Traffic Records System) Data from the California Highway Patrol, 2004-2008.
Injuries are highly concentrated in San Francisco

- ~50% of injuries occur in 20% of census tracts and in 8% of San Francisco surface area

- Injury rates highest in lower-income neighborhoods

Several San Francisco neighborhoods and corridors have very high pedestrian injury densities

### Table 4. Seven final zones showing boundaries, percent of pedestrian-injury collisions represented, and efficiency ratios

<table>
<thead>
<tr>
<th>Zone</th>
<th>Boundaries</th>
<th>Efficiency Ratio (Injury Density Ratio)</th>
<th>Percent of Pedestrian-Injury Collisions in the City</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Area Zones</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chinatown/North Beach</td>
<td>Kearney to Filbert, to Stockton, to Bay, to Columbus, to Mason, to Sacramento, to Kearney</td>
<td>5.6</td>
<td>4.1</td>
</tr>
<tr>
<td>SOMA (South of Market) West</td>
<td>4th, 10th, Mission, Harrison</td>
<td>6.2</td>
<td>5.7</td>
</tr>
<tr>
<td>North Mission</td>
<td>Guerrero, 13th, 17th, Potrero, Divis Joan</td>
<td>4.5</td>
<td>3.7</td>
</tr>
<tr>
<td><strong>Linear Zones</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Geary Richmond</td>
<td>Geary from Parker to 28th Avenue</td>
<td>9.9</td>
<td>1.8</td>
</tr>
<tr>
<td>Upper Market</td>
<td>Market from Van Ness to Castro</td>
<td>8.9</td>
<td>1.1</td>
</tr>
<tr>
<td>Outer Mission</td>
<td>Mission from I-280 to Geneva</td>
<td>7.5</td>
<td>0.9</td>
</tr>
<tr>
<td>Geary/Cathedral Hill</td>
<td>Geary from Van Ness to Baker</td>
<td>10.4</td>
<td>1.3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td>18.6</td>
</tr>
</tbody>
</table>

Pedestrian injury collision models can identify modifiable causes at the city level

Predictors of differences in injury rates among census tracts in San Francisco

- Traffic volume (+++)
- Arterial streets (++)
  - w/o surface transit
- Neighborhood commercial zoning (++)
- Employees (++)
- Residents (++)
- Land area (--)
- Below poverty level (+)
- Age 65 and over (-)

Source: California Highway Patrol, Statewide Integrated Traffic Records System

High proportions of drivers exceed the speed limit

<table>
<thead>
<tr>
<th>Posted speed limit</th>
<th>Observations</th>
<th>Estimated mean speed</th>
<th>Percent exceeding speed limit</th>
<th>Estimated mean speed of those exceeding limit</th>
<th>Percent 5 mph or more over speed limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 mph</td>
<td>152,640</td>
<td>25 mph</td>
<td>56%</td>
<td>30 mph</td>
<td>23%</td>
</tr>
<tr>
<td>30 mph</td>
<td>61,388</td>
<td>26 mph</td>
<td>31%</td>
<td>34 mph</td>
<td>10%</td>
</tr>
<tr>
<td>35 mph</td>
<td>29,626</td>
<td>31 mph</td>
<td>26%</td>
<td>39 mph</td>
<td>8%</td>
</tr>
</tbody>
</table>

Source: SFDPH analysis based on sample of San Francisco Municipal Transportation Authority speed survey data from 2004-2009
Travel speeds are a fundamental cause of collisions

- **Speeds affects**
  - awareness of pedestrians
  - Control of vehicle
  - Stopping distance

- On urban roads, reducing mean speed by 1 mph reduces injury collisions by 2 – 7%

Speeds determine pedestrian injury severity

- Collision force increases with vehicle mass and speed (Force = mass X velocity^2)
- Small increases in impact speed translate into large increases in fatality risks
- Seniors highly vulnerable to speed

Risk of pedestrian fatality by impact speed and age group

Annual hospital costs for severe pedestrian injury = Approx. $15 million/annually

76% of the total cost was paid for by public funding (Medicare, MediCal, patients)

Obstacles to a pedestrian safety culture in the United States

- Transportation system relies on the individual to protect themselves—“Mistakes” result in fatal consequences,
- System does not account the vulnerability of walkers or the limited abilities of children and elderly
- System often privileges motor vehicle needs over walking, bicycling, and public transit (e.g. maximizes flow and speed)
- Collision analysis does not investigate physical and engineering factors (e.g. design speed)
- Proven protective engineering and enforcement measures are not being utilized
Many proven effective strategies for reducing injury frequency and severity

- **Speed reductions:**
  - 20 mph Home Zones
  - Traffic Calming
  - Automated Speed Enforcement

- **Engineering counter-measures**
  - Median Refuge Islands
  - Signalized Cross-walks
  - Pedestrian crossing phase
  - Lighting
Proven Safety Engineering Countermeasures

- Advance limit lines with high visibility crosswalks
- Center Median improvements
- Sidewalk “bulb-outs”
- Improved Lighting
- Raised Crosswalks
- Pedestrian Countdown Signals (PCS)

Source: San Francisco Municipal Transportation Agency
Altering roadway dimensions and geometry

- Reducing lanes (road diets) can lower traffic flow and pedestrian risks
- Narrowing lanes may reduce speed
- Widening sidewalks, parking, and bicycle lanes buffer pedestrians from traffic

Source: San Francisco Municipal Transportation Agency
Citywide Traffic Calming Planning Studies (MTA)

Source: San Francisco Municipal Transportation Agency
Research also challenges some conventional wisdom: No protection from crosswalks at uncontrolled intersections

- Marked crosswalks do not offer a safety benefit on low traffic volume streets and increase hazards on high traffic volume streets.

- Signalization, traffic calming or other safety measures warranted for crosswalks at uncontrolled locations.
20 mph or less “home zones” can significantly reduce road injuries in residential areas

- Researchers analyzed longitudinal changes in road injuries from 1986 to 2006 within ~120,000 road segments in London to examine effect of engineered 20 mph “home zones”
- Observed ~42% reduction in road casualties, adjusting for time trends
- Greater reductions for younger children and for fatal and serious injuries
- No evidence of migration of injuries to adjacent areas

Source: Grundy et al. BMJ 2009;339:b4469
The international *Vision Zero* movement argues for greater responsibility for transportation system designers

- System designers bear the ultimate responsibility for transportation safety.
- The system should be designed to prevent levels of violence intolerable to the human body (excessive forces) for all users.
- Systems designers can and must account for the expected behaviors of road users.
December 20th 2010 Executive Directive on Pedestrian Safety –

- Establishes new medium (25% by 2016) and long range (50% by 2021) reduction targets for serious and fatal injuries

- Requires (1 year) actions
  - 15 mph school zone speed limits
  - 20 mph home zones
  - High risk corridor engineering program
  - Enhance Pedestrian Injury Prediction Model (SFDPH)
  - Develop Pedestrian Environmental Quality Index (SFDPH)
  - Best practices research (All)

- Inter-agency workgroup
- Pedestrian Safety Plan
Opportunities Generated by the Executive Directive

- Elevates the importance of safety for walkers as a priority need for a sustainable 21st century city.

- Establishes the City’s first official performance measure and long range target for pedestrian safety.

- Recognizes the need for and creates the opportunity for collaboration among multiple City agencies and external stakeholders.

- Can leverage resources for successful practices.

- Identifies the importance of citywide design and policy solutions.
Improvements to the San Francisco Pedestrian Injury Prediction Model (SFDPH)

- Builds on recently published area-level model
- Will analyze causes at the intersection-level
- Adapts lessons from FHWA best practices and other research
- Limited pedestrian activity data is an important model gap
Development of the Pedestrian Environmental Quality Index

SFDPH Pedestrian Environmental Quality Index:

- Quantitative, observational survey instrument based on street segment and intersection level indicators
- Will be validated against pedestrian flow and injury frequency
- Potential uses to focus safety investments in land use and transportation planning

More info at: www.sfphes.org/HIA_Tools_PEQI.htm
Walk First Project: A inter-agency partnership for walking

- **Objectives:**
  - citywide map of key pedestrian streets and zones;
  - method and criteria for prioritizing pedestrian improvements;
  - five case study and concept designs;
  - capital project list of recommended pedestrian improvements for those case studies;
  - draft General Plan policies relating to walking and the pedestrian environment; and
  - strategies for safe and active walking to be included into the San Francisco Transportation Plan.

- **Partners:**
  - San Francisco Municipal Transportation Agency
  - San Francisco County Transportation Authority
  - San Francisco Planning Department

- **Funding Source:**
  - California Office of Traffic Safety

- **DPH Staff Lead:**
  - Ana Validzic
Potential future local policy alternatives

- Reduce urban traffic speeds
  - Speed limits higher than those recommended by WHO
  - Increase resources for traffic calming infrastructure
  - Enable automated speed enforcement
- More robust injury data collection and analysis
  - Include environmental factors
- Develop a minimum standard of safety countermeasures for future development
- Require integration of safety countermeasures whenever roadways are renovated
Some considerations for the Health Commission

- Schedule for updates on implementation of Executive Directive

- Specific Roles For SFDPH staff
  - Facts research / assessment
  - Education/ awareness
  - Support of community led activities
  - Support of planning and design activities
  - Implementation of Executive Directive

- Updates on research

- Departmental policy and positions on safety issues