Pedestrian and Bicyclist Behavior at Highway-Rail Grade Crossings: An Observational Study of Factors Associated with Violations, Distraction, and Crossing Speeds During Train Crossing Events

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Background – Pedestrian Safety

- Pedestrian fatalities on the rise nationwide.
- In 2016 there were 5,987 pedestrians killed in traffic crashes, a 9-percent increase from the 5,495 pedestrian fatalities in 2015.
- Highest number of pedestrians killed in one year since 1990.
- Pedestrian distraction identified as potential contributor.

Arizona has highest rate of pedestrian deaths in the U.S., report says

BrieAnna J Frank, The Republic | azcentral.com   Published 6:00 a.m. MT March 1, 2018 | Updated 9:17 a.m. MT March 1, 2018
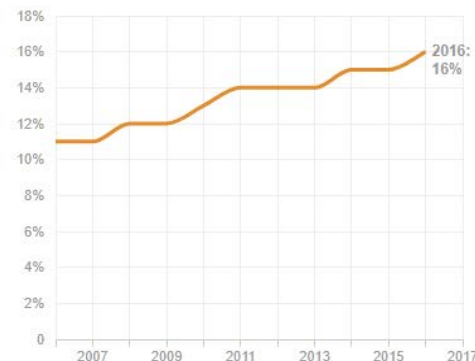
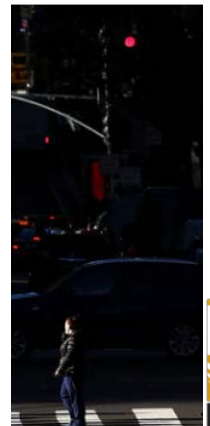**Pedestrian Fatalities Remain At 25-Year High For Second Year In A Row**

February 28, 2018 · 5:55 PM ET

Pedestrian Deaths Remain High And Rising

PEDESTRIAN DEATHS AS A PERCENT OF TOTAL TRAFFIC FATALITIES

2016: 16%

TOTAL NUMBER OF PEDESTRIAN DEATHS

2017: 5,984

Background – Highway-Rail Grade Crossing (HRCG) Safety

- In ten year period from 2008-2017, there were 1,470 reported pedestrian-train crashes.

- Resulted in 908 fatalities and 492 injuries.

- Pedestrian action in over 27% of these crashes was disregarding gates, and a significant proportion was coded as other/unknown.

U.S.News **BEST STATES**

HOME / CIVIC / BEST STATES / ARIZONA NEWS

Police: Flagstaff Man Killed After Being Run Over by a Train

Police in Flagstaff say a 21-year-old man is dead after being run over by a passing train.

Aug. 26, 2018, at 11:56 p.m.

AP

FLAGSTAFF, Ariz. (AP) — Police in Flagstaff say a 21-year-old man is dead after being run over by a passing train.

Denver police: Pedestrian killed at light rail crossing was distracted

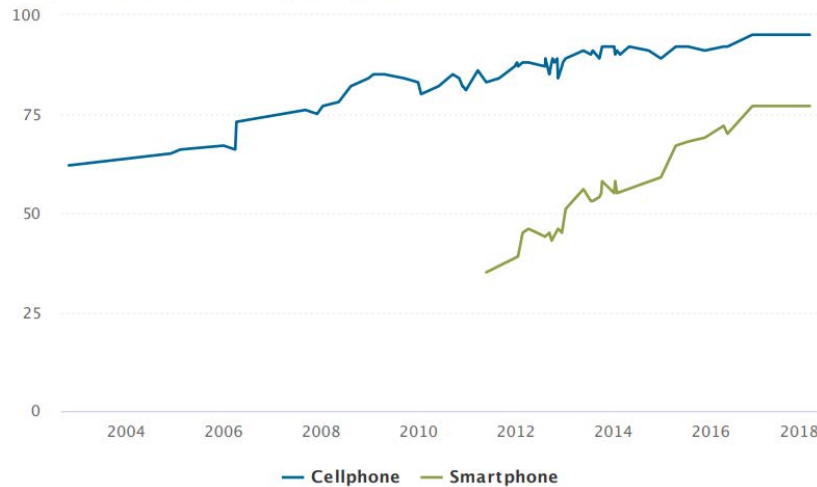POSTED 12:08 PM, OCTOBER 12, 2018, BY ERIC RUBLE

Scene of a light rail vs. pedestrian crash near Bayaud and Santa Fe.

Increased Ownership of Cellphones

- As of 2016, 95% of adults in the U.S. own a cellphone (8% increase from 87% in 2011).

% of U.S. adults who own the following devices

Cellphone — Smartphone

Source: Surveys conducted 2002–2018.
PEW RESEARCH CENTER

Distracted Walking Laws

- Several cities have enacted laws wherein pedestrians can be ticketed for crossing the street while texting.

Honolulu's 'Distracted Walking' Law Takes Effect, Targeting Phone Users

October 25, 2017 · 8:19 AM ET

BILL CHAPPELL

BYU-Idaho town outlaws texting, crossing street; study reveals dangers
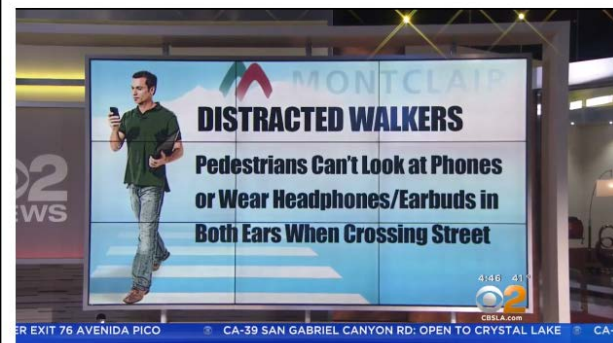
By Sara Lenz @saralenz
Published: September 21, 2011 11:00 am
Updated: Sept. 21, 2011 11:42 a.m.

Montclair Bans Distracted Walking

February 27, 2018 at 10:05 am   Filed Under: Distracted Walking, Montclair

DISTRACTED WALKERS
Pedestrians Can't Look at Phones or Wear Headphones/Earbuds in Both Ears When Crossing Street

Literature Review and Study Objectives

- Limited field-observed studies of pedestrian & bicycle behavior at HRGCs
  - No previous study examined distraction at HRGCs
- Previous observational studies have found age and group size to be associated with violations, and between 1.27 and 2.58 violations per train crossing event.
- **This observational study has three primary objectives:**
  1. **Determine the field observed prevalence of ped/bike violations at HRGCs, and analyze factors associated with such behavior.**
  2. **Determine the field observed prevalence of ped/bike distractions at HRGCs, and analyze factors associated with such behavior.**
  3. **Determined the field-observed speed of peds/bikes as they traverse HRGCs before/after train crossing events.**

Camera Setup for Naturalistic Ped/Bike Observations
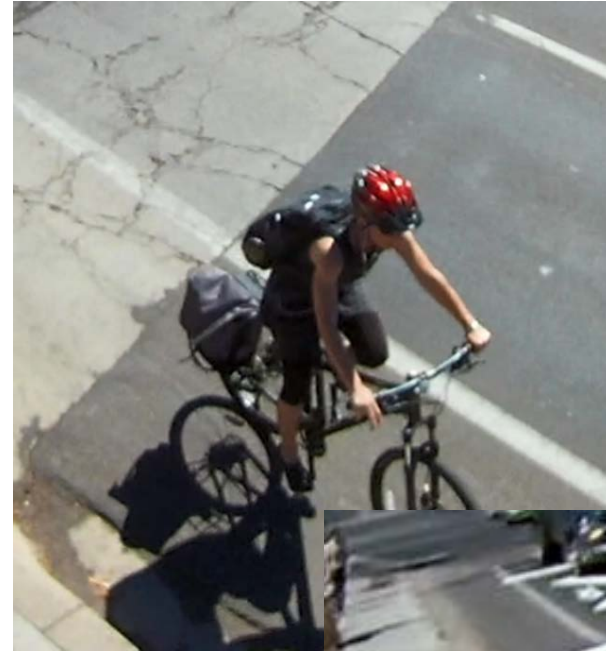
Study HRGCs

- Site Locations

  - Flagstaff, AZ

    (a) Beaver St. & Route 66

    - 530 Pedestrians

    (b) San Francisco & Route 66

    - 990 Pedestrians

NORTHERN ARIZONA UNIVERSITY
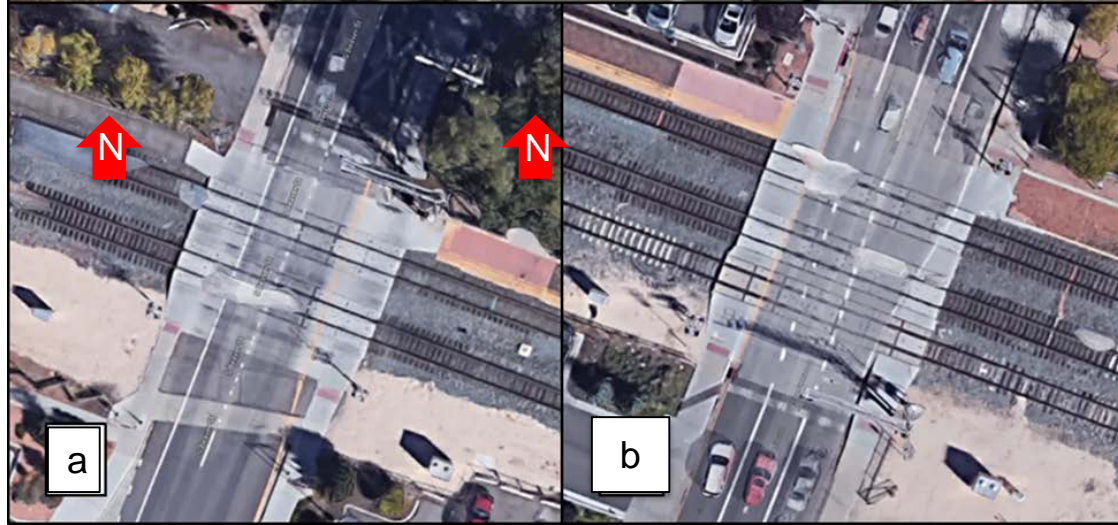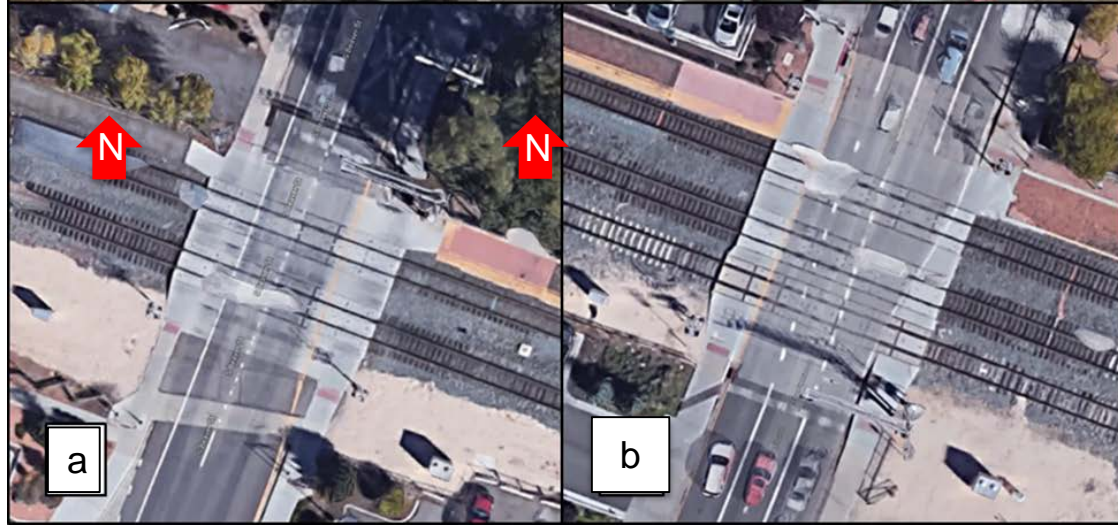
Types of Distractions Observed

- Distractions
  a. No Distractions
  b. Headphones
  c. Talking on Cellphone
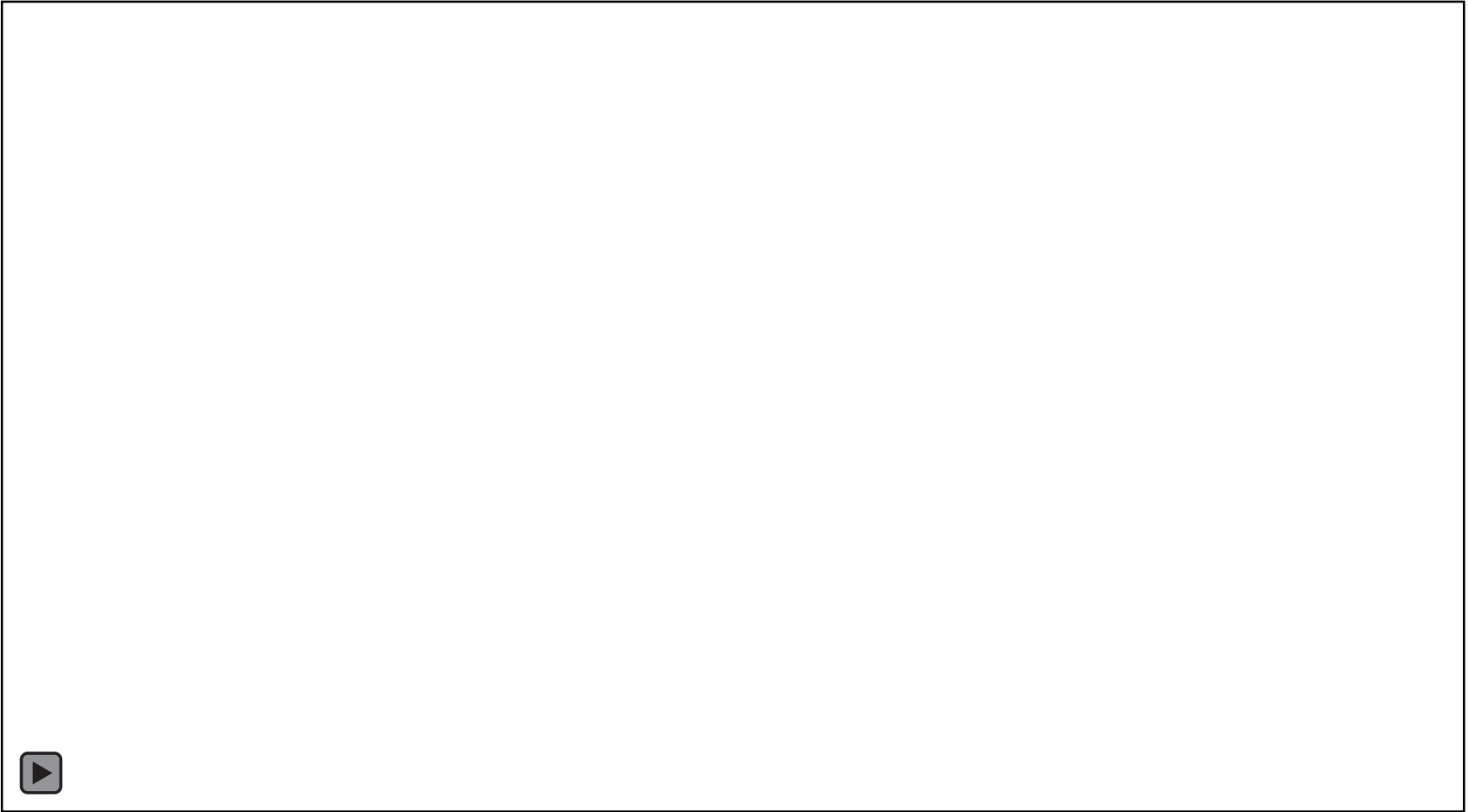 d. Texting on Cellphone
  e. Other

Video Example:
"Before Train" Violation

Video Example:
"After Train" Violations
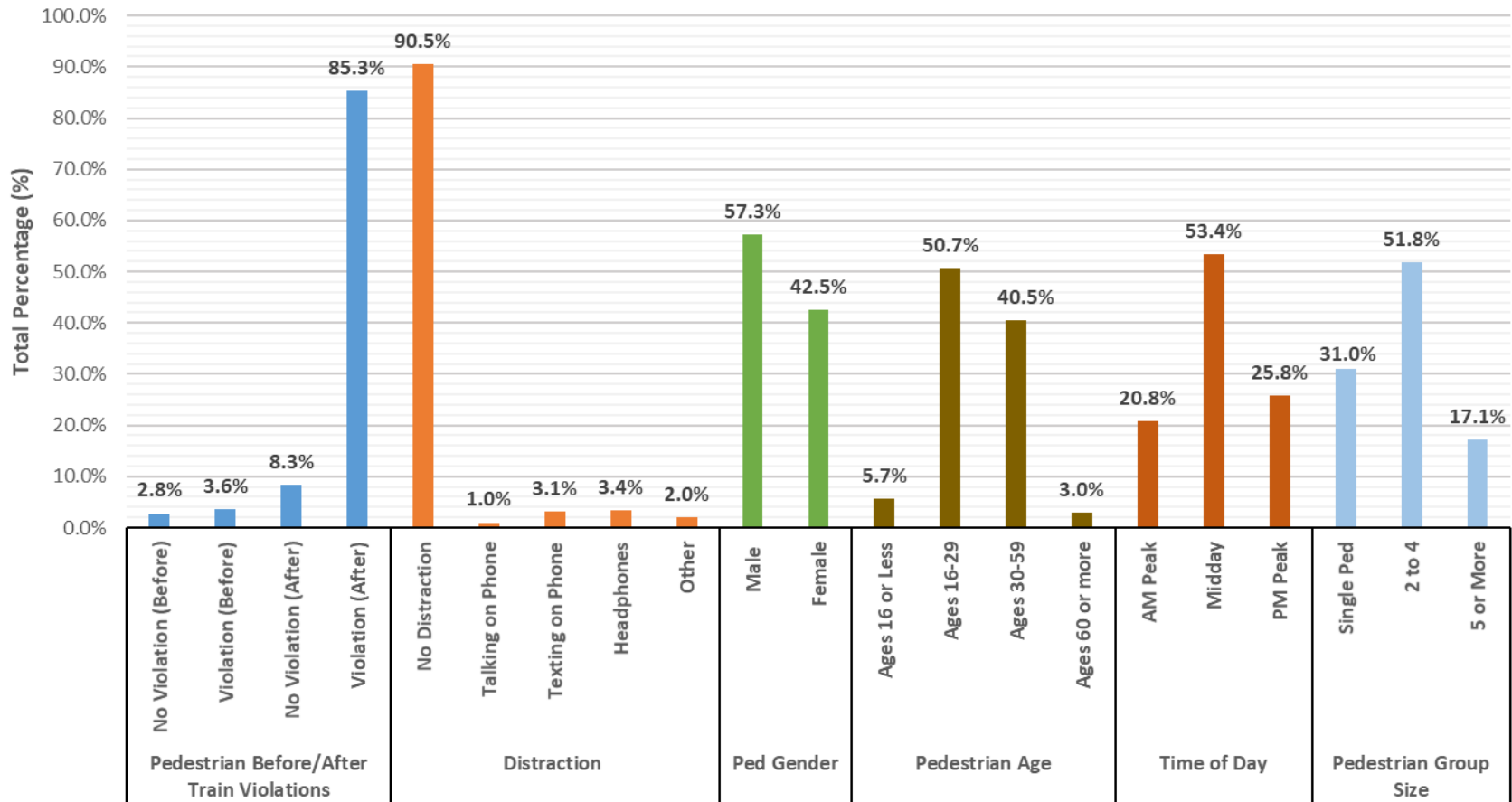
Video Example:
"After Train" Violation - Bike

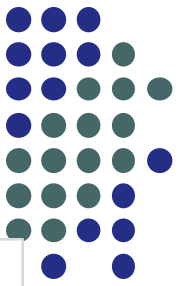# Summary Statistics for Pedestrian Observations

Summary Statistics for Pedestian Observations During Train Crossing At All Sites
*n = 1,522

n= 1,522 Peds

Summary Statistics for Bicyclist Observations

Summary Statistics for Bicyclist Observations During Train Crossing Events At All Sites
*n = 285
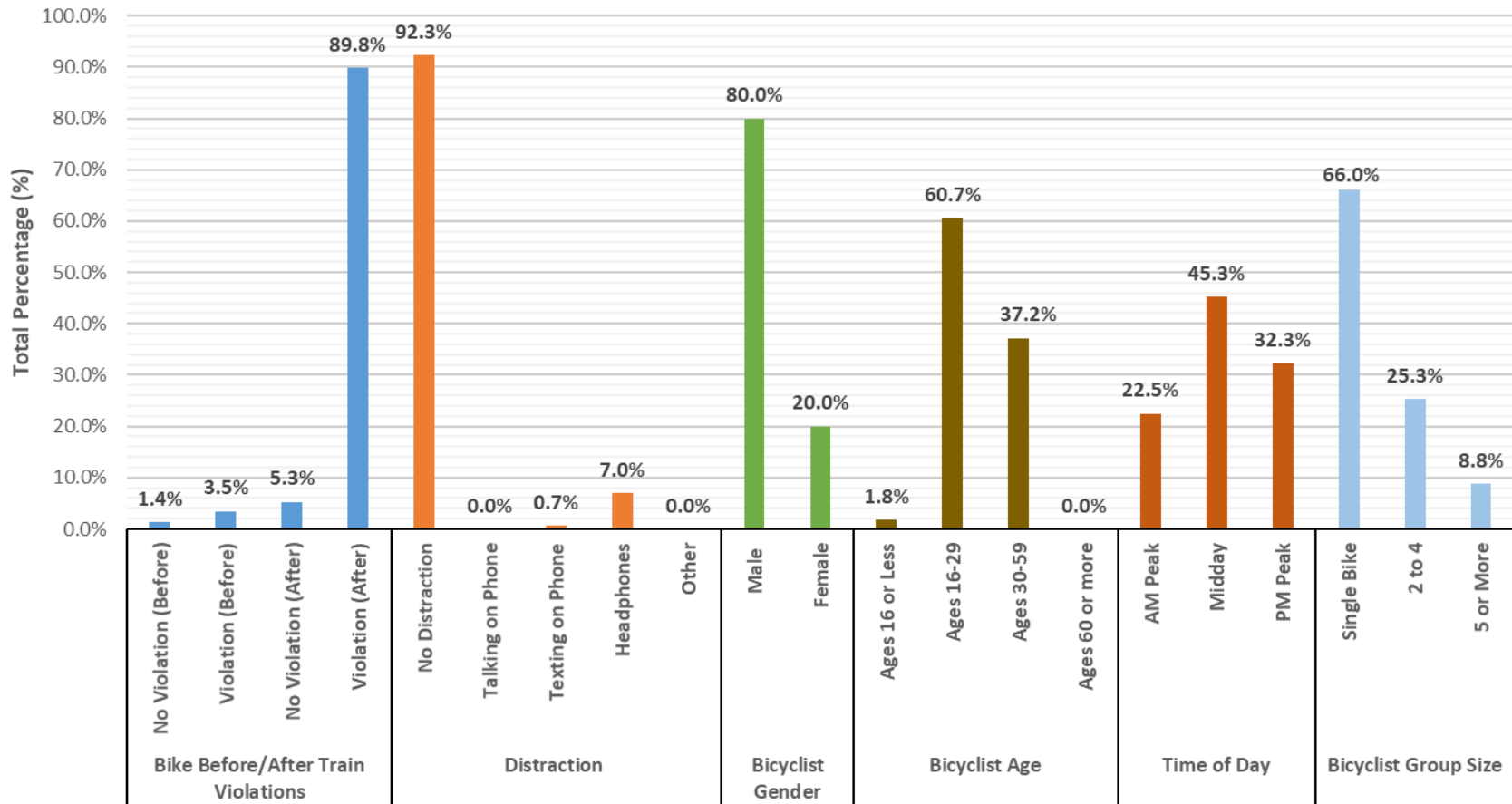
n= 285 bikes

Statistical Analyses

- When sample sizes were adequate, statistical analyses were performed beyond summary statistics:

- Binary logit models developed for distraction and violation analyses, linear regression used for walking speed analysis.

- Binary logit:

  - $$P_i = \frac{EXP[\beta_o + \beta_1 X_{1,i} + \beta_2 X_{2,i} + \cdots + \beta_K X_{K,i}]}{1 + EXP[\beta_o + \beta_1 X_{1,i} + \beta_2 X_{2,i} + \cdots + \beta_K X_{K,i}]}$$

- Linear regression: $S_i = \beta_0 + \beta_i X + \varepsilon_i$

Results – Pedestrian Violations

- Pedestrian Violations
  - Overall 5.1 violations per train crossing event.
  - 55 pedestrians observed violating active devices before train arrival (occurred during 1 in 5 train crossings):
    - 70.9% were male
    - 94.5% were between ages of 16-59
  - Majority of violations occurred after train departure:
    - **91.1% of all pedestrians observed crossing after train departure violated active devices.**
  - Peds age 29 or less most likely to violate.
  - Violations more likely in AM peak hour.
  - Groups of 5+ peds exhibited greater probability of violation.
  - Distraction not associated with violations.

Results – Pedestrian Distraction

- <u>Pedestrian Distraction</u>
- Overall, 9.5% of pedestrians were distracted as they traversed HRGC.
- Peds most likely to be distracted during PM peak hours.
- Peds age 29 or lost most likely to be distracted.
- Male pedestrians, and pedestrians crossing alone were more likely to cross distracted.

Variable	β	Std. Error	p-value	Marginal Effect
Constant**	-4.633	0.574	<0.001	N/A
PM Peak (3:00pm-6:00pm)**	0.500	0.189	0.008	0.045
Age 29 or less**	0.718	0.186	<0.001	0.059
Age 60 or more**	-0.712	0.192	<0.001	-0.058
Male Ped*	0.365	0.189	0.054	0.030
Group: Single Ped**	0.967	0.181	<0.001	0.089
Crossed After Train**	1.240	0.527	0.019	0.068
Restricted Log Likelihood (LL)	-476.510			
LL at Convergence	-445.949			

Note: ** denotes variable significant at 95% confidence level

* denotes variable significant at 90% confidence level

The Arizona Laboratory for Applied Transportation Research

Results – Ped Walking Speed

- <u>OLS Pedestrian Walking Speed Model</u>

Variable	β	Std. Error	p-value
Constant**	3.700	0.155	<0.001
San Francisco Site**	0.291	0.084	<0.001
Midday (11:00am-2:59pm)**	0.253	0.105	0.0157
PM Peak (3:00pm-6:00pm)**	0.341	0.121	0.0047
Near-side Gates**	0.184	0.082	0.0243
Age 29 or less**	0.462	0.073	<0.001
Age 60 or more**	-0.464	0.073	<0.001
Male*	-0.002	0.001	0.0875
Talking on Phone	-0.440	0.410	0.2831
Texting on Phone	-0.001	0.233	0.9979
Headphones**	1.100	0.222	<0.001
Single Pedestrian**	1.056	0.125	<0.001
Pedestrian Group Size 2-4**	0.383	0.114	<0.001
Crossed Before Train - No Violation**	1.302	0.245	<0.001
Crossed Before Train - Violation**	4.629	0.217	<0.001
R-Squared	0.333	N/A	N/A

Note: ** denotes variable significant at 95% confidence level

    * denotes variable significant at 90% confidence level

- Avg. walking speed = 5.2 fps.
- Greater than previous research and assumed values in FRA HRGC Handbook.

Results – Bicyclist Violations

- <u>Bicyclist Violations</u>
  - Out of the 285 bicyclists observed in this study, 266 (93.3%) violated active warning devices; the great majority being violations after train departure.
  - Overall, 97.7% of bicyclist violators were between ages 16-59, 80.1% were male, and only 7.0% were distracted.
  - Majority of bicyclists violations occurred individually.

Results – Bicyclist Distraction and Speed

- Bicyclist Distraction
  - Only 22 (7.7%) of bicyclists were observed distracted, with a majority listening to headphones (20 out of 22).
  - Distraction by talking/texting on cellphones was not a prevalent behavior for bicyclists.
- Bicyclist Crossing Speed
  - Overall average bicyclist HRGC crossing speed was 10.02 ft./sec.
  - Bicyclists crossing alone exhibited faster speeds as opposed to those in a group, while those distracted crossed slower.

Conclusions

- Engineering countermeasures such as channelization, barriers, or swing gates may help reduce violations.

- Violations most likely to occur after train departure, and committed by younger peds and those in groups.

- Installing a 'Another/Second Train Coming' sign described in the FHWA HRGC Handbook is another relatively low cost engineering countermeasure.
  - Reduce 'after train departure' violations
  - Active or passive

Limitations and Future Research

- Observations limited to weekday, mid-day times.
  - Investigate potential differences in behavior on weekends or evening/night times.
- Observations at HRGCs with two-way traffic roadways
- Differences in behavior at urban/ suburban/ rural areas and different geographic regions.

Thank You.
Questions?

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