How Much Do You Lose When Your Road Goes on a Diet?

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ABSTRACT

Transportation engineers and planners may implement road diets with the objective of reducing vehicle speeds and motor-vehicle crashes and injuries. Typical road diets consist of converting four-lane undivided roads into three lanes (two through lanes plus a center turn lane) with the remaining space used for bicycle lanes, sidewalks, and/or on-street parking. This study investigated the actual effects of road diets on motor-vehicle crashes and injuries using data from cities in California and Washington state.

A “before” and “after” analysis using a “yoked comparison” study design of the road diet and comparison sites indicated that the percent of crashes at the road diet sites during the “after” period was slightly lower than at the comparison sites. Further analysis using a negative binomial model controlling for possible changes in ADT, study period, and other factors indicated no significant treatment effect. Crash severity was virtually the same at road diet and comparison sites. However, there were differences in crash type distributions between road diet and comparison sites but not between “before” and “after” periods.

Implementation of a road diet should be made on a case-by-case basis where traffic flow, vehicle capacity, and safety are all considered. Also, the effects of road diets should be evaluated further under a variety of traffic and roadway conditions.

INTRODUCTION

Continued growth and decentralization throughout the United States have increased the demand for multipurpose uses of both residential and arterial streets. As a result, some cities in the U.S. have reduced the number of travel lanes on some of their arterial and collector streets. These conversions commonly involve restriping four-lane undivided roads as three lanes (two through lanes plus a two-way left-turn lane). The fourth lane may be converted to bicycle lanes, sidewalks, and/or on-street parking. In other words, the existing cross-section is re-allocated. These lane-reduction conversions are often called “road diets” (Figure 1). A few road diets are conversions from four-lane roads into two-lane roads, by restriping and/or by adding landscaped median islands. According to Burden and Lagerwey (*1*), four-lane roads with ADTs of up to 25,000 have been converted to road diets.

Road diets can potentially offer benefits to both vehicles and pedestrians. On a four-lane street, drivers change lanes to pass slower vehicles (*e.g.*,vehicles stopped in the left lane waiting to make a left turn). By comparison, on a two-lane street, drivers’ speeds are limited by the speed of the lead vehicle. Thus, road diets may reduce vehicle speeds and vehicle interactions during lane changes, which could potentially reduce the number and severity of vehicle-to-vehicle crashes. Road diets may also benefit pedestrians, because they will have two lanes of traffic (instead of four) to cross and motor vehicle speeds are likely to be lower. Recent research by Zegeer *et al.* (*2*) on crosswalk safety found a reduction in pedestrian crash risk for two- and three-lane roads, compared to roads with four or more lanes. Bicyclists may also benefit, especially when bicycle lanes are added (*3*).

Road diets may result in lower vehicle capacity compared to four-lane streets. However, on a four-lane street, the left lane is often utilized as a left-turn lane. With high levels of oncoming traffic, left-turning motorists waiting for an adequate gap will cause considerable delay to through traffic. Thus, the four-lane street will have less capacity than it could potentially have. Under most ADT conditions tested, road diets have minimal effects on vehicle capacity, because left-turning vehicles are moved into a common two-way left-turn lane (*1,4*). However, for traffic ADTs above approximately 20,000 on road diet sections, there is an increased likelihood that traffic congestion will increase to the point of diverting traffic to alternate routes.

The purpose of this paper is to investigate the effects of road diets on motor vehicle crashes and injuries.

PAST RESEARCH

A summary of case studies of road diets in U.S. and Canadian cities is shown in Table 1. Some of the case studies included comparisons of the number of crashes before and after the conversion to a road diet. These comparisons have shown that road diets can reduce the total number and severity of crashes. However, the studies had certain limitations. In some cases, only selected intersections and midblock sections were evaluated, instead of the entire road diet section. Also, no comparisons with non-road diet locations were made in any of the studies. The observed reduction in crashes, therefore, could have been a citywide phenomenon (such as a reduction in crash reporting) and not necessarily the result of installing road diets. Finally, no evaluations were conducted of the impact on crashes along alternate routes after installation of the road diet.

After this review of previous research, it was determined that a more extensive study was required to further investigate the effects of road diet conversions on safety. Such a study would use detailed crash data from before and after the conversion to a road diet and would also compare road diets with similar streets that were not converted. This paper describes such a detailed investigation of crashes on road diet conversions in two states.

STUDY METHODOLOGY

Selected Sites

This study evaluated road diets at locations in several California and Washington cities that had installed road diets. These two states were selected for two reasons. First, it was learned that several cities in California and Washington had installed road diets. Second, both states are part of the Federal Highway Administration's Highway Safety Information System (HSIS). Therefore, it was felt that the necessary high-quality crash data for a large number of crash, roadway, and vehicle variables would be available for study.

Research Designs

A four-group study design was utilized – a “treatment” and a “comparison” group were selected, and data were obtained for two time periods, one “before” the treatment was installed and one “after” installation for each site in each group. More specifically, the road diets (*i.e.*, treatment sites) were matched with four-lane streets that were otherwise similar (*i.e.*, comparison sites). Thus, crash data were obtained for four groups: 1) road diet sites – “before” period, 2) road diet sites – “after” period, 3) comparison sites – “before” period, and 4) comparison sites – “after” period.

The data were analyzed using two different methods: 1) a site-by-site analysis in what is referred to as a “yoked comparison” design (since each treatment site had one or more matched comparison sites); and 2) a “comparison site” analysis, in which treatment and comparison sites were combined in their respective groups for each time period, and a negative-binomial model of crashes per mile was developed to examine the impact of the treatment while controlling for other variables such as ADT, city, and length of study period.

Most comparison sites were four-lane undivided roads near the road diets (such as a parallel road one or two blocks away or a road perpendicular to the road diet). A few comparison sites were unconverted (*i.e.*, four-lane undivided) sections of the same road beyond where the road diet was installed. The comparison sites were selected to be similar to the road diets in terms of roadway functional class, type of development (*e.g.*, commercial or residential), speed limit, intersection spacing, and access control.

Many streets, especially in Seattle, had cross-sections that were wide enough for four lanes (13.4 m (44 ft) but were only striped for two lanes. The streets had 6.7-m (22-ft) lanes, and the lanes accommodated both through traffic and on-street parking. These streets were not selected as comparison sites because these streets would operate as two-lane streets when vehicles were parked along the curb.

It was thought that the road diets could possibly prompt some motorists to divert onto nearby four-lane roads (including comparison sites) so as to avoid the slower road diet route. These comparison sites were considered to be “nearby comparison sites” because motorists who wanted to use alternate routes could travel along the nearby comparison sites instead. The additional traffic could possibly influence the number, types, and severity of crashes at the nearby comparison site.

“Faraway comparison sites” were comparison sites that were in other areas of the city and would not be candidates for motorists to use as an alternate route to avoid a road diet section. Any increases in ADTs at faraway comparison sites were presumed to result from other factors and not the installation of road diets.

Site Selection

Local traffic engineers in California and Washington were contacted to determine where road diets were located. Road diets were identified in eight cities: Bellevue (WA), Mountain View (CA), Oakland (CA), Sacramento (CA), San Francisco (CA), San Leandro (CA), Seattle (WA), and Sunnyvale (CA). Note that these are not the only cities in California and Washington that have road diets.

Candidate comparison sites were identified through a review of maps and discussions with local traffic engineers. Field visits to the eight cities were made to verify that the candidate comparison sites were suitable. Subsequently, one or more nearby comparison sites was selected for each road diet. Faraway comparison sites were also selected, but suitable faraway comparison sites could not be found for every road diet. Some road diets were rejected because they were installed before 1990 or because a suitable nearby comparison site could not be found.

The final list of sites contained 30 road diets and 50 comparison sites in eight cities. (12 road diets and 25 comparison sites are included in this paper.) The road diets ranged in length from 0.13 km (0.08 mi) to 4.09 km (2.54 mi). The comparison sites ranged in length from 0.21 km (0.13 mi) to 4.88 km (3.03 mi). Local traffic engineers did not have complete "before" and "after" ADT data for every road diet and comparison site. At a few locations, the ADTs were of questionable accuracy, possibly due to irregularities in how the values were obtained.

Crash Variables

Local traffic engineers provided crash data for the road diets and comparison sites. The crash data were computer-generated summary lists of crashes and their characteristics rather than hard-copy police crash reports.

The following crash variables were used in the analyses that are discussed in this paper:

1. Date of crash (day, month, and year)
2. Crash type (angle/turning, head-on, rear-end, sideswipe, etc.)
3. Number of injuries
4. Number of fatalities

Crash Data Periods

For the purposes of this study, a three-month transition period was defined, which included the month before road diet installation, the month of installation, and the month after installation. The transition period was defined for two reasons: 1) work on the road diet may have started the month before; and 2) motorists need some time to become familiar with the new traffic patterns of the road diet. The transition period separates the "before" period from the "after" period. Crashes that occurred during the three-month transition period were excluded from the analysis.

Three years (36 months) of "before" and three years of "after" data were considered desirable for each road diet and comparison site. The actual amount of data varied considerably from site to site, depending on how much data the city had available, and when the road diet was installed. At most locations, one or more years of data were obtained for each of the “before” and “after” periods. Because all four seasons were represented, seasonal variations in crashes due to weather conditions, etc., were accounted for.

ANALYSIS

Crash data were initially obtained for 30 road diets and 50 comparison sites. However, many locations had small sample sizes of crashes because of short segment lengths, short data periods, or low ADTs. Therefore, a subset of 12 road diets (2,068 crashes) and 25 comparison sites (8,556 crashes) were chosen for the analyses that are reported in this paper. These locations generally had segment lengths of at least 0.81 km (0.50 mi). Road diets and comparison sites were placed into 11 groups, each consisting of 1 or 2 road diets and their matching comparison site(s). Road diets and comparison sites in each group were located in the same city, thereby accounting for possible differences in crash reporting practices among cities. Preliminary crash analyses revealed that nearby and faraway comparison sites were similar; so, nearby and faraway comparison sites in each group were combined for the analyses reported in this paper.

Before the basic analyses were conducted, changes in the road diet and comparison site ADTs were examined to determine whether motorists were diverting off road diets and onto nearby comparison sites. ADT data for the years immediately before and after road diet installation were available for four road diets, five matching nearby comparison sites, and four matching faraway comparison sites. The “before” period ADTs on the road diets ranged from 10,179 to 16,070; on the nearby comparison sites they ranged from 14,003 to 17,000; and on the faraway comparison sites, 5,480 to 22,600. A comparison of the ADTs found that, on average, the ADTs on the four road diets increased by 6.4 percent. A slightly higher increase of 9.4 percent occurred on the five nearby comparison sites. The ADTs on the four faraway comparison sites increased by 6.7 percent. For the sites included in this analysis, any diversionary effect of road diets is limited. Instead, the dominant phenomenon is an overall increase in ADT, the result of population growth and other factors.

The crash-related analyses were divided into five categories:

1. Crash trends in the “before” period to determine the validity of the comparison sites
2. “Before” and “after” crashes at individual groups of treatment/comparison sites
3. Analyses involving crashes as a function of traffic volumes
4. Crash severity
5. Crash types

FINDINGS

Crash Trends in the "Before" Period

Year-by-year crash trends in the "before" period were examined for all 11 groups of road diets and comparison sites. The objective was to see whether the comparison sites were a good match with the treatment sites in terms of having similar crash trends.

Crash data were available for the same years for all sites within a group. Because the road diets were installed over a period of several years, the "before" intervals differed considerably from site to site. Within most groups, the road diet and comparison sites had quite parallel trends in crashes per month. Crashes per month were plotted instead of crash rates, because ADTs were not always available. A sample plot is shown in Figure 2.

The proportion of crashes that happened at road diet sites among all crashes occurring at either road diet or comparison sites was then examined, on a year-by-year basis. Trends in these proportions would indicate that crashes at road diets and comparison sites were not following parallel trends. To provide an estimate and test of significance of a trend component, logistic regression models were fit to three groups of sites with a total of four road diets and seven comparison sites (Groups 2, 9, and 11 in Table 2). These groups had five or more years of "before" data.

The trend components were *not* statistically significant (p = 0.2815, 0.6131, and 0.1196, respectively). In other words, there were no significant differences in crash trends between the road diet sites and their matching comparison sites. For the sites in other cities, the proportions did not consistently increase or decrease over the years for which "before" data were available. Since it did not appear that crashes at the comparison sites behaved very differently over time from those at the road diet sites in the "before" period, it was concluded that the comparison sites were a good match to the road diet sites.

"Before" and "After" Crashes

Using standard "yoked comparison" analysis techniques, a three-way contingency table analysis was done using 10 groups, with 11 road diets and 24 matching comparison sites. Table 2 shows before-and-after crash frequencies (*i.e.*, total number of crashes) and the percent occurring in the "after" period for road diets and comparison sites within each group. In all 10 groups, the percent of road diet crashes occurring in the "after" period was the same or lower than the corresponding percent for the comparison sites. In four groups, this difference was at least marginally statistically significant.

When data from all 10 groups were pooled, a somewhat higher percent of crashes at the comparison sites occurred in the "after" period than at the road diet sites (41.0 percent vs. 35.8 percent). Crash frequencies were generally higher at comparison sites than at road diet sites. A Cochran-Mantel-Haenszel test of overall significance across the 10 groups was statistically significant (P^2_{1df} =7.5307, p = 0.0061). The estimated risk ratio indicates that the percent of crashes at road diet sites in the "after" period to be about 6 percent less likely than a crash at a comparison site, with 95 percent confidence limits of 0.003 and 0.106. On average, crash frequencies at road diets in the "after" period were approximately 6 percent lower than at the corresponding comparison sites.

ADTs generally increased on road diets and comparison sites, but there was no clear pattern as to whether road diets or comparison sites had greater increases. Before-and-after data on speed variance, turning queues, and other traffic flow characteristics were not available. Further research is needed determine whether the crash reductions observed on road diets can be attributed to lower speeds, fewer conflicts, or possibly other factors.

Analyses Involving Crashes as a Function of Traffic Volumes

The before-and-after analysis described above was based solely on crash counts. For those sites that had reliable ADT data, it was possible to further analyze crashes as a function of ADT. ADT data were not available for sites in Oakland or San Francisco; so, three of the groups from the before-and-after analysis were excluded from the crash rate analysis. However, a group of sites in Seattle that was not used in the before-and-after analysis due to differing "before" and "after" time periods for the road diets and comparison sites was included. A total of 8 groups, with 8 road diets and 14 comparison sites were included in these analyses. ADTs on the road diets ranged from 8,133 to 15,658 in the "before" period and from 8,300 to 16,482 in the "after" period. ADTs on the comparison sites ranged from 5,480 to 24,183 in the "before" period and from 7,006 to 26,100 in the "after" period.

Raw crash rates were first examined to see if meaningful findings might emerge. Crashes, ADT, and study period length were combined to calculate a crash rate per million vehicle miles of travel for each site in both the "before" and "after" periods. Figure 3 shows the distributions of these crash rates for road diets and comparison sites in the "before" and "after" periods, indicating that the distributions of crash rates at the road diets are less variable than those at the comparison sites, with the mean crash rates at the road diets slightly lower than at the comparison sites. The means decrease slightly from the "before" period to the "after" period at both road diets and comparison sites, but not differentially.

While raw crash rates are somewhat useful, as noted by Hauer (*10*) and others, an examination of rates such as these cannot control for the effect of volume changes across time and can result in somewhat misleading results. Therefore, analyses of crashes as a function of traffic volume were carried out by fitting negative binomial regression models to the crash frequencies at each site, and using ADT and other factors as independent variables.

Table 3 shows results from the final model. These results show highly significant variation in crash rates with traffic volume and city, and lesser variation with site type. The city-by-city variations are probably the result of different operational conditions and crash reporting practices. Neither the period effect nor the period by site type interaction was statistically significant. A significant interaction effect would have indicated that crash rates changed from the "before" period to the "after" period differently on road diets than on the comparison sites (and thus that the road diets had an effect on crashes while controlling for ADT and city).

Parameter estimates for site type, time period, and their interaction are also shown at the bottom of Table 3. These estimates show crash rates per mile on the comparison sites to be somewhat higher than on road diet sites, to decrease slightly from the “before” to the “after” time period, and to decrease somewhat less on the comparison sites than on road diet sites. The last two estimates were not statistically significant, however, again indicating the lack of a road diet effect on crashes per mile.

Crash Severity

A crash was classified as property damage only (PDO) if no injuries or fatalities occurred. Otherwise, it was classified as an injury or fatal crash, as appropriate. It was expected that crashes on road diets would be less severe (*i.e.*, a higher percentage of PDO) in the “after” period, if motorists were indeed driving more slowly after the road diets were installed. However, vehicle speed data were not collected before or after the road diets were installed.

The severity analysis included 10 groups, with 10 road diets and 20 comparison sites. The total number of crashes was 7,919. San Francisco was excluded from this analysis because the majority of its crashes resulted in injuries and/or fatalities. Due to local reporting practices, many PDO crashes are not reported. The effects of changing reporting thresholds are discussed in Zegeer *et al*. (*11*). In this analysis, the “after” period in Seattle extended through December 31, 1996 only, because the number of injuries and fatalities for crashes occurring on January 1, 1997 or later were not available.

Overall, approximately 63 percent (5,007) of the crashes resulted in no injuries or fatalities. The remaining 37 percent (2,912) of the crashes had at least one injury or fatality. These percentages were quite similar for both road diet and comparison sites, and in both the “before” and “after” time periods. Injury rates did, however, tend to vary somewhat from city-to-city and among the matched groups of sites.

The crash severity model (in the form of a logistic regression model fit to the injury severity data) found that “Group” was the only significant factor ($P^2_{9df} = 347.69$, $p < 0.0001$). Crash severity was virtually the same at road diets and comparison sites and did not change with the time period. The city-by-city variations are most likely the result of different crash reporting practices in each city.

An initial hypothesis was that injury and fatal crashes would decrease on road diets, relative to comparison sites, due to lower vehicle speeds on road diets in the “after” period. Since before-and-after speed data were not available, it cannot be determined if vehicle speeds actual decreased. Also, the crash summaries only listed the number of injuries and fatalities in each crash. None of the summaries categorized the injuries by severity (*i.e.*, an “A” (incapacitating), “B” (non-incapacitating), or “C” (possible) injury). It is possible that road diets could have resulted in fewer “A” injuries (and more “B” and “C” injuries) compared to comparison sites. Determining if this was the case would require more specific crash severity data.

Crash Types

Another question of interest concerned whether or not crash types would be different after road diets were in place relative to comparison sites. The three most prevalent crash types at all sites were angle, rear-end, and sideswipe (Figure 4). While the crash type distributions were quite similar for the site type by period interaction, angle collisions were somewhat higher for the road diets and perhaps decreased somewhat less in the "after" period relative to the comparison sites. To investigate this, a logistic regression model was fit to a crash type variable (angle versus all other) using the same explanatory variables as the crash severity model. The results from this model again indicated a highly significant effect due to "Group" ($P^2_{9df} = 199.24$, $p < 0.0001$). Site type was also statistically significant ($P^2_{1df} = 13.24$, $p = .0003$), with the proportion of angle collisions higher on road diets than on comparison sites. Neither time period nor period by site type interaction was significant ($p = 0.5862$ and $p = 0.9575$, respectively).

A similar model showed the proportion of rear end crashes to be higher for the comparison sites, again with no significant interaction or period effects. The only significant effect in a model for sideswipe crashes was that due to "Group."

It is not clear why the crash type distributions were different between the road diets and the comparison sites – crash severity was virtually the same at road diets and comparison sites. One possible reason is the differences that exist between roadway sections due to variations in the numbers of driveways and intersections, vehicle speeds, vehicle mix, area type, and other factors. It may be that cities selected roadway sections for road diet installation at least partly due to such factors.

The variations in the crash type distributions among cities are likely the result of 1) how each city classifies crashes, and 2) what each city's reporting practices are. For example, Bellevue has a separate crash type for "parked vehicle." Several other cities usually classify crashes involving parked vehicles as "sideswipe." As another example, all of the California cities included "angle/turning" crashes in the total number of "right angle" crashes. In Bellevue and Seattle, "angle/turning" and "right angle" crashes were two separate crash types.

Summary of Findings

The key findings of this study are summarized below and in Table 4.

1. The road diets and comparison sites had similar year-by-year trends in crash frequencies in the "before" period. This finding was evidence that the comparison sites were a good match with the road diets.
2. Given the total number of crashes that occurred at the road diets and comparison sites, a higher percentage of the crashes at comparison sites (41.0 percent) occurred in the "after" period than at the road diets (35.8 percent) (Table 2). Crash frequencies at road diets in the "after" period were approximately 6 percent lower than at the corresponding comparison sites.
3. Crash rates did not change significantly from the "before" period to the "after" period. Crash rates were lower at road diets than at comparison sites, but road diets did not perform better

or worse over time (from the "before" period to the "after" period) relative to comparison sites.

4. Road diet conversions did not affect crash severity. About 37 percent of the crashes resulted in an injury or fatality. The percentages were quite similar for road diets and comparison sites, and for both the "before" and "after" periods.
5. Road diet conversions did not result in a significant change in crash types. Three crash types – angle, rear end, and sideswipe – accounted for about 80 percent of all crashes. Road diets had a somewhat higher percentage of angle collisions than the comparison sites had. On the other hand, the comparison sites had a higher percentage of rear end collisions than the road diets had. Both differences were significant. However, the changes between the "before" and "after" periods were not significant.

CONCLUSIONS

This study found that a significantly lower (approximately 6 percent) proportion of crashes occurred at road diets in the "after" period than at comparison sites in the "after" period. Thus, one may expect that converting a roadway segment from four-lane undivided to three lanes would likely reduce total crashes by 6 percent or less. Road diets were no better or worse than comparison sites with regard to crash rates and severity. Further research is needed to find out whether the crash reductions observed on road diets can be attributed to lower speeds, fewer conflicts, or possibly other factors.

It was beyond the scope of this study to examine potential non-safety benefits of road diets, such as creating the impression that cars are less dominant, enhancing the urban landscape, and improving the overall quality of life along the street. These non-safety benefits should be more thoroughly evaluated in future research. Also, traffic operations and capacity issues need to be fully considered at a given site prior to implementing road diets and other lane reduction measures.

Local traffic engineers should attempt to evaluate road diet conversions, whenever possible, in terms of safety and operational effects. In particular, it would be useful to conduct further studies of motor vehicle speeds, congestion, traffic volume, and traffic flow resulting from road diet conversions. Future operational studies under a range of traffic volumes and other conditions would be useful to help quantify the conditions where road diets would be appropriate.

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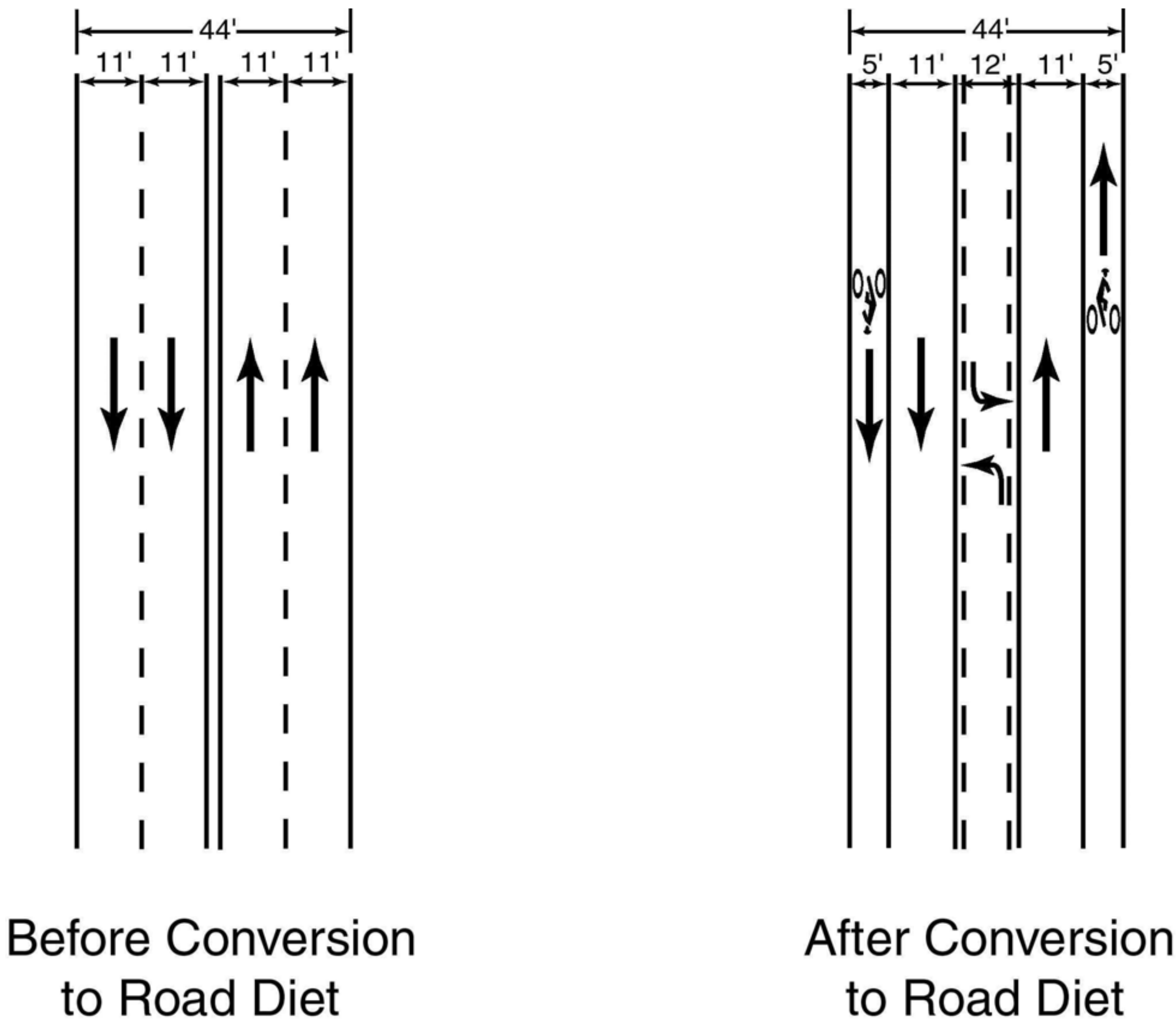

Figure 1. A Representative Road Diet.

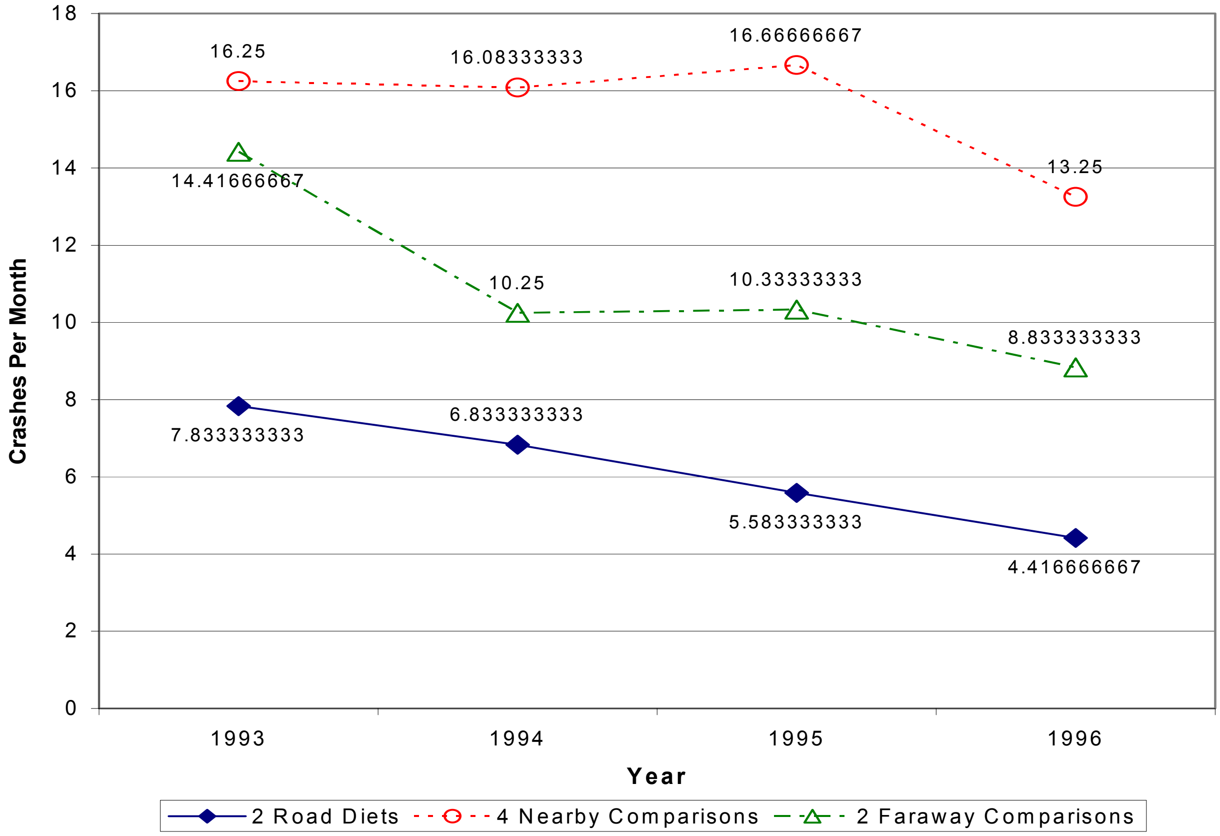

Figure 2. Crashes per Month on Road Diets and Comparison Sites in Oakland.
(Similar graphs were created for road diets and comparison sites in other cities, but are not included in this paper.)

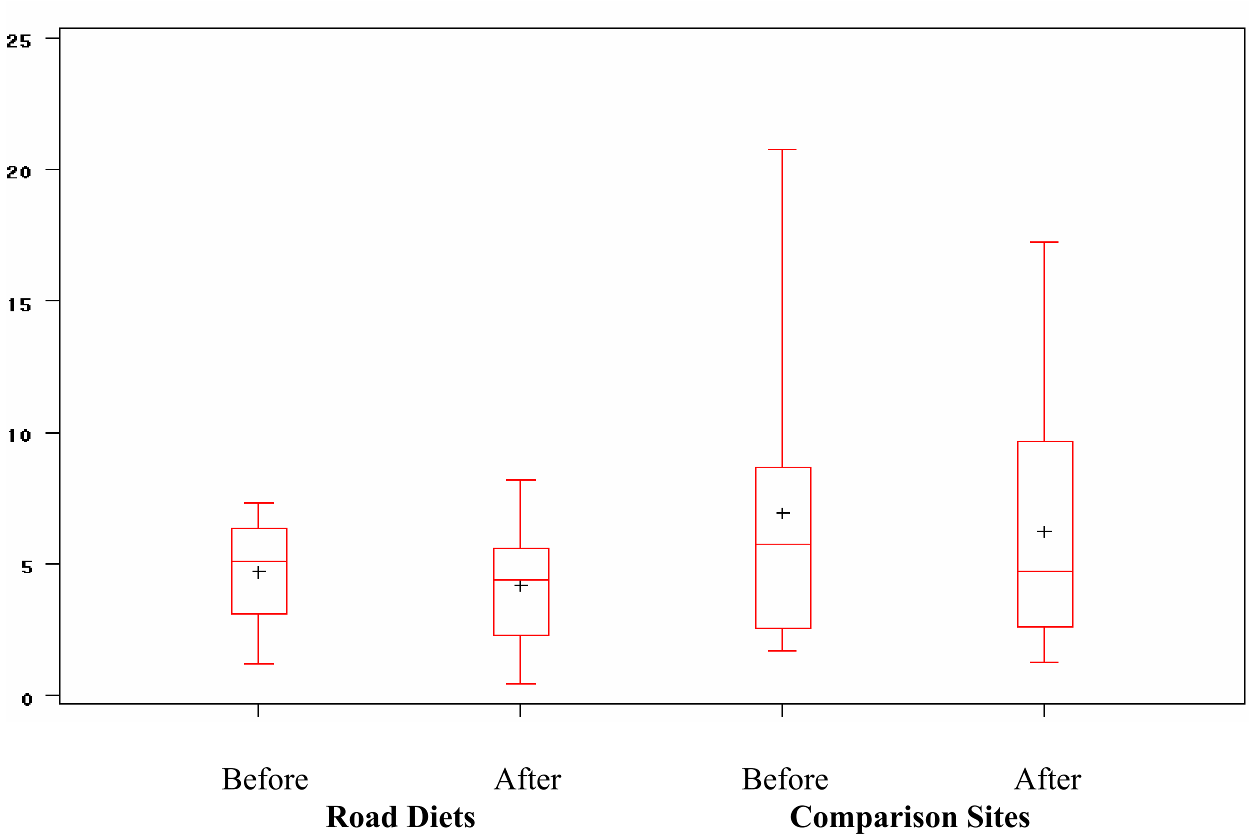

Figure 3. Crash Rates per Million Vehicle Miles.

Figure 4. Distribution of Crash Types for Road Diets and Comparison Sites.

Table 1. Summary of Case Studies of Road Diets in the U.S. and Canada.

Site Location	ADT	Change in Cross Section	Effect	Ref.
High Street, Oakland, CA	22,000 – 24,000	▪ 4 lanes reduced to 3.	▪ Crashes decreased from 81 to 68 per yr.	(5)
East 14th St. San Leandro, CA			▪ 52% reduction in crashes	(5)
Valencia St. San Francisco, CA	~22,000		▪ 10% reduction in ADT (to 19,979) ▪ 2-8% increase in ADT on 4 parallel streets. ▪ Crashes decreased from 73.2 to 62 per yr. ▪ Injury crashes decreased from 58.8 to 50 per yr. ▪ Bicycle use in PM peak hour increased from 88 to 215. ▪ Bicycle crashes increased from 10.1 to 12 per yr.	(6)
Polk St. San Francisco, CA		▪ 3 lanes reduced to 2. ▪ Bike lanes added to southern section.	▪ 2% reduction in ADT (to 16,300). ▪ Bicycle use in AM peak hour increased from 37 to 52. ▪ ADT on 2 parallel streets increased by 8 and 15%.	(7)
U.S. Highway 57, Sioux Center, IA			▪ Speed reduction of 2.7 km/hr (1.7 mph).	(4)
Burcham Rd. East Lansing, MI	11,000 – 14,000	▪ 4 lanes reduced to 3. ▪ Bicycle lane added.		(1)
Grand River Blvd. East Lansing, MI	23,000	▪ 4 lanes reduced to 3. ▪ Bicycle lane added.		(1)
Rice St. Minnesota		▪ 4 lanes reduced to 3.	▪ Injury crashes reduced by 33%.	(8)
St. George St. Toronto, Canada	15,000	▪ 4 lanes reduced to 2 (1993). ▪ Bicycle lanes added in both directions (1993). ▪ Addition of narrow, painted median (1993). ▪ Street narrowed from 14 m to 11 m (1996). ▪ Sidewalk widened (1996).		(9)
Davenport Rd. Toronto, Canada	30,000	▪ 6 lanes reduced to 4. ▪ Bicycle lanes added in both directions. ▪ Parking added in both directions.		(9)
Electric Ave. Lewistown, PA	13,000	▪ 4 lanes reduced to 3.	▪ Trip times unaffected. ▪ Number of crashes dropped to nearly zero.	(1)
Lake Washington Blvd. Kirkland, WA	20,000	▪ 4 lanes reduced to 3.	▪ Reduction in speeding. ▪ Reduced noise levels ▪ Easier access to street from driveways.	(1)
9 separate sites Seattle, WA		Various	Compare 3 yr before and after periods for each site: ▪ Total crashes reduced 34.1%. ▪ Injury crashes reduced 7.4%.	(1)

Table 2. Before and After Crashes at 10 Groups of Road Diets and Matched Comparison Sites.

Group Number	Site Type (Note 1)	Months of Data		Crashes		Percent		P-value
		Before	After	Before	After	After	P^2_{1df}	
1	R	40	106	63	164	72.3	.009	.9255
1	C	40	106	347	917	72.6		
2	R	91	25	102	32	23.9	.039	.8444
2	C	91	26	231	76	24.8		
3	Note 2							
4	R	56	56	82	74	47.4	.014	.9048
4	C	56	56	583	537	48.0		
5	R	35	75	152	252	62.4	2.995	.0835
5	C	35	75	95	208	68.7		
6	R	50	60	85	97	53.0	.538	.4632
6	C	50	60	793	1005	55.8		
7	R	74	19	44	8	15.4	.015	.9030
7	C	74	19	188	36	16.1		
8	R	42	48	16	4	20.0	8.275	.0040
8	C	42	48	61	73	54.5		
9	R	66	12	255	28	9.9	3.479	.0621
9	C	66	12	661	110	14.3		
10	R	53	25	121	39	24.4	4.180	.0409
10	C	53	25	877	419	32.3		
11	R	61	8	407	43	9.6	.002	.9610
11	C	61	8	1210	129	9.6		
Total	R			1327	741	35.8	Note 3	Note 3
Total	C			5045	3510	41.0		

Note 1 R = Road diet C = Comparison site

Note 2 The road diet in Group 3 consisted of two sections with different "before" and "after" periods, so this group was excluded from the before-and-after analysis.

Note 3 Overall test of association: $P2_{1df}$ = 7.5307, p = .0061.

Note 4 Risk of Crash in After Period at Road Diet Site Relative to Comparison Site:
Risk Ratio = .944, 95% confidence limits for risk ratio = .894, .997.

Table 3. Crash Rate Model: Likelihood Ratio Statistics and Parameter Estimates.

Likelihood Ratio Statistics

Source	DF	P^2	P-value
Traffic Volume	1	18.34	<.0001
City	3	44.90	<.0001
Time Period	1	2.01	.1564
Site Type	1	8.11	.0044
Period X Type	1	.40	.5278

Parameter Estimates

Parameter	Estimate	95 % Confidence Limits (Lower, Upper)	P-value
Comparison Site vs. Road Diet	.34	-.04, .73	.0794
After vs. Before	-.28	-.73, .17	.2267
Comparison Site in "After" Period	.17	-.36, .70	.5337

Table 4. Summary of Findings.

ANALYSIS CATEGORY	COMPARISON			
	Road Diets Before vs. After	Comparison Sites Before vs. After	"Before" Period Road Diets vs. Comparison Sites	"After" Period Road Diets vs. Comparison Sites
Crash Frequency	Reduction in "After" Period	No Change	No Difference	Road Diets Lower
Crash Rates	No Change	No Change	Road Diets Lower	Road Diets Lower
Crash Severity	No Change	No Change	No Difference	No Difference
Crash Type	No Change	No Change	Difference: 1. Road diets had a higher percentage of angle crashes 2. Road diets had a lower percentage of rear-end crashes	Difference: 1. Road diets had a higher percentage of angle crashes 2. Road diets had a lower percentage of rear-end crashes