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Evaluating High-Visibility Enforcement of Bicycle Passing Laws

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16. Abstract
This study selected Grand Rapids, Michigan, and Knoxville, Tennessee, to implement high-visibility enforcement (HVE) programs to increase compliance with laws requiring drivers to leave a minimum distance when passing bicycles. In Grand Rapids, a local ordinance required leaving 5 feet, and in Knoxville, the State law and local ordinance required a minimum 3 feet to pass. Police in both cities used the same type of ultrasonic measuring device to determine if drivers passing decoy officers on bicycles were too close. The ultrasonic measuring device was modified to store data and was used to collect evaluation measures by two groups of data collection riders—"staged riders" who rode repeatedly on routes on which enforcement was focused, and "volunteer riders" who used their bicycles as primary transportation. Each city developed its own publicity program to increase the visibility of the enforcement. HVE programs continued for approximately 4 months in each city. Results showed that the average passing distance in both cities during baseline was already well in excess of the prevailing legal requirement, but violations (passes closer than 5 feet in Grand Rapids and closer than 3 feet in Knoxville) were still high (26.0% in Grand Rapids and 5.0% in Knoxville). By the end of the HVE programs, statistically significant increases in average passing distance and significant decreases in violations were achieved in both cities. Police had no problems using the ultrasonic measuring device to identify violators and chose to issue more warnings than tickets.

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Although the study would not have been possible without the assistance of these and other people, groups, and agencies, the findings and opinions expressed herein are those of the authors and not necessarily those of these contributors.

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Executive Summary

This study tested a high-visibility enforcement (HVE) approach to improving compliance with laws requiring motorists to pass a bicyclist at a minimum distance of 3 feet and 5 feet.

Background

According to the National Center for Statistics and Analysis, 846 bicyclist and other non-motorized cyclist fatalities occurred in the United States as a result of traffic crashes in 2019 (NCSA, 2020b) – a 36% increase over the last decade (NCSA, 2020a). Analyses of driver and bicyclist behaviors that lead to bicycle involved motor vehicle crashes and bicyclist fatalities consistently reveal that the motorist overtaking a bicyclist from behind is the most frequent situation that results in a bicyclist fatality (e.g., Wright et al., 2019; Hunter et al., 1995; Cross & Fisher, 1977). To address this situation, laws have been passed at the State, county, and municipal levels requiring a minimum passing distance (e.g., 3 feet, 5 feet) when a motorist passes a bicycle. The need to obey these laws, especially when awareness is heightened by HVE, might also prompt motorists to increase their search for bicycles and to leave more space when overtaking them.

The HVE countermeasure approach in which increased enforcement is coupled with intensive publicity to enhance the effect of the enforcement and deter undesirable behavior was used successfully by Van Houten et al. (2013) in an analogous situation: to improve motorists yielding to pedestrians at crosswalks. This study attempted to emulate the basic approach used in that study.

Objectives

The objectives of this study were to:

1. Select a motorist behavior required or prohibited by a law and related to bicycle safety;
2. Develop an HVE program to address motorist behavior as detailed by that law;
3. Select test locations;
4. Assist the test sites in the implementation of the HVE program; and
5. Evaluate both the implementation process and the behavioral outcomes produced by the HVE program.

Method

Selection of Target Motorist Behavior

The first step of the study involved selecting a vehicle and traffic law that addressed a specific driver behavior related to a defined bicycle involved motor vehicle crash type. Based on the results of a companion study (Wright et al., 2019), bicycle overtaking laws were selected as the study focus. The majority of existing State and local laws specify 3 feet as the required distance, but laws requiring 5 feet passing clearance have begun to emerge around the country. NHTSA commissioned a study of both passing distances to provide a more complete picture of the use of passing distance laws as a safety countermeasure.

Site Selection

Researchers examined potential test sites that had the passing distance laws of interest and selected Grand Rapids, Michigan, (5-foot local ordinance) and Knoxville, Tennessee, (3-foot State law and local ordinance). While Grand Rapids and Knoxville are in different regions of the country, the bicycle riding seasons and extent of bicycling are quite similar as are the demographics and socioeconomics. As reported anecdotally by bicycle advocates in each city, the priority given bicycling as a mode of transportation also appears similar in the two cities.

Enforcement

One essential component of an HVE program is the enforcement itself. Police in each test city needed an objective and legally acceptable way to determine the precise distance of a pass. They also needed an enforcement strategy capable of intercepting offenders reliably and safely. The approach by the two cities was similar and was based on the use of a commercially available, ultrasonic, distance measuring device, the C3FT, made by Codaxus LLC in Austin, Texas. The cities also both used “decoy” police officers riding bicycles as the triggers for enforcement action. If someone passed the decoy officer too closely, the officer would radio to a chase officer in a car or on a motorcycle who would then stop the offender and warn or cite the driver.

The police in the test cities focused their enforcement on a limited number of routes (three in Knoxville and four in Grand Rapids) distributed across each city and selected because of high bicycle and motor vehicle traffic, potentially high passing-law violations, and the availability of safe places to pull violators over.

Measurement of Passing Distance

The police used the ultrasonic measurement system in both cities to determine if a violation occurred. The measurement system was paired with a GoPro HERO 5 Black portable, high-resolution video camera (Figure ES-1) to document the violation by simultaneously video recording the measurement system’s display and an image of the passing vehicle. The measurement system could be set for a violation distance of 36 in. (3-foot law in Knoxville) or 60 in (5-foot law in Grand Rapids). If the system measured a distance less than or equal to the set threshold, the display would “freeze” at the actual measured distance, and an alert would sound. The project provided each city with two ultrasonic measurement units, initial training, and an operations manual.

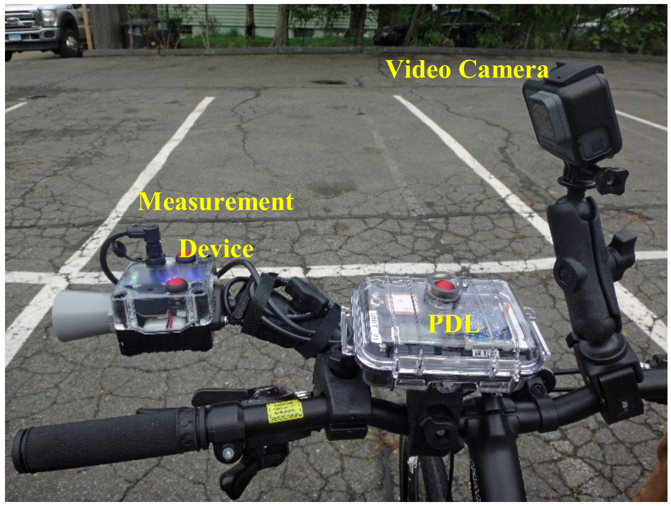


Figure ES-1. Data Collection System

The current study used the ultrasonic measurement device both for enforcement and, in an augmented version, as a data collection device. The augmentation consisted of the addition of a portable data logger (PDL), also shown in Figure ES-1, that stored distance measurements from the device along with time and GPS location on an onboard microSD card.

Enforcement Procedure

Grand Rapids Police Department (GRPD) generally used two police bicycle riders and two chase motorcycles or cars for each enforcement operation. Knoxville Police Department (KPD) used a single bicycle rider and chase car. The GRPD conducted 25 enforcement operations of about 4 hours each from July 13, 2018, to October 30, 2018. KPD conducted 28 enforcement operations of approximately 90 minutes duration from September 28, 2018, to December 12, 2018.

During any traffic stops associated with the HVE, officers in both cities used discretion regarding whether to issue a ticket, verbal warning, or written warning. Warning flyers prepared by the police departments were given to all drivers who violated the passing distance laws and were also widely distributed at the outset of the programs at city events. During the stops, officers used a short, standardized script to tell drivers about the seriousness of the problem, the correct driver behavior, and the existence of the ongoing HVE campaign.

Messages/Publicity

The second component of an HVE campaign consists of education in the form of publicity or messages concerning the existence and intensity of the enforcement, the high probability of getting caught, and the possibility of a significant sanction (fines and possible insurance repercussions) for commission of the offense. The HVE program leaders at each site developed and disseminated the program publicity.

Each site held a press conference to initiate the program, generate publicity, and educate the public concerning the program's goals. Coinciding with the initial press conferences, both sites added details of the law, the enforcement program, and the consequences of receiving a ticket to their websites. Grand Rapids also held another press conference on November 19, 2018, to coincide with the end of the collection of evaluation data for the program and to generate a final surge of publicity.

The Grand Rapids Traffic Safety Department coordinated the HVE with its Vison Zero (VZ) program. In addition, it used a lawn sign adapted from Kalamazoo. Grand Rapids also employed 10 feedback signs such as the one shown below in Figure ES-2 to alert drivers to the ongoing rate of compliance with the 5 foot passing ordinance and the record compliance to date. These signs were updated 14 times during the program. Compliance started at 77% and ended at 83% with a high of 84% achieved during the eighth week of the program.

Figure ES-2. Feedback Sign Used in Grand Rapids

Figure ES-3. Knoxville Program Banner

In addition to the earned media generated from newspapers, TV, and radio, Knoxville focused on the mass distribution of 58,852 information flyers designed by the city's graphic artist that used its program-generated theme: *Minimum Three in Tennessee*. These flyers were distributed to all school children with their take-home material and also handed out at city events. The program theme was also used on a large, standing banner that was unveiled at the opening press conference and used at other relevant city events thereafter (Figure ES-3).

Evaluation Design

The program evaluation in both cities consisted of pre/post measures of the distance motorists gave to bicycles when they passed them on the roadway. The distance measures were collected using two different data collection approaches each of which used the ultrasonic measurement device, as follows.

1. "Staged riders," who were expert bicyclists recruited at both sites to ride bicycles on the designated enforcement routes.
2. "Volunteer riders," who were experienced bicyclists who used their bicycles as a primary means of transportation and therefore rode all over town.

Thus, the staged riders provided data that was specific to the enforcement routes and a look over time at possible driver behavior change on the same routes and conceivably of at least some of the same drivers. The volunteer riders provided a more general citywide picture of behavior over time at each study site.

HVE Program and Evaluation Timelines

Each site was encouraged to operate its HVE program in its own style and by its own timeline. The project provided technical help and limited financial support to help maintain schedules and to facilitate the evaluation. Grand Rapids, as the more northerly site, was selected to begin first to maximize bicycle riding time before the onset of shorter days and colder fall and winter weather. The Knoxville opening press conference was approximately 2 months after the one in Grand Rapids.

In order to create a meaningful time variable for analyses, researchers defined time periods at each site. The baseline period began when collection of each evaluation measure started and ended with the initial press conferences. Since the countermeasures mounted by each site consisted of several separate interventions at different times after the press conference, the post period was subdivided based on the start times of the major additional interventions at each site. In Grand Rapids the post period was divided into Post 1, Post 2, and Post 3. In Knoxville there were two periods of intervention defined—Post 1 and Post 2.

Results

The Data

The primary evaluation data were the processed outputs from the ultrasonic measurement devices consisting of passes of a bicycle by a motor vehicle. All of the staged rides were conducted in daylight, mostly in the hours before lunch during which most of the enforcement was mounted. Volunteer riders were instructed to use the ultrasonic measurement devices whenever they rode during daylight. Use of the devices at night by the volunteer riders was not required and was at the discretion of each rider. The resulting sample of night data was relatively small and not distributed across all volunteer riders. Also, no enforcement took place at night. It was therefore decided to conduct analyses only on data collected between sunrise and sunset, and therefore no nighttime data is included in Table ES-1 and Table ES-2 that show sample sizes at each site by defined program period.

Table ES-1. Total Daytime Passes of Knoxville Data Collection Riders

	Baseline N	Post 1 N	Post 2 N
Staged Riders (N = 4,907)	2,530	1,282	1,095
Volunteer Riders (N = 14,620)	7,194	3,640	3,786
TOTAL (N = 19,527)	**9,724**	**4,922**	**4,881**

Table ES-2. Total Daytime Passes of Grand Rapids Data Collection Riders

	Baseline N	Post 1 N	Post 2 N	Post 3 N
Staged Riders (N = 13,373)	3,046	5,462	2,855	2,010
Volunteer Riders (N = 5,986)	1,038	2,560	1,210	1,178
TOTAL (N = 19,359)	**4,084**	**8,022**	**4,065**	**3,188**

Analytic Approach

To determine whether motorists passed bicyclists at a greater distance after initiation of the HVE program, linear regressions were performed to analyze differences in mean (average) passing distance before and after the implementation of the program. Additional analyses using logistic regression examined the number of passes that were violations of the passing distance law. Although the prescribed minimum passing distance was 3 feet in Knoxville and 5 feet in Grand Rapids, passes under 5 feet and less than 3 feet were examined at both sites to provide a more complete picture of the possible effect of the HVE on close passes. This was particularly relevant in Grand Rapids where the 5-foot distance was mandated by a city ordinance enacted well before the study began that remained in effect and was more stringent than the 3-foot Michigan State law that became effective on September 27, 2018, while the study was underway.

Results Summary

Analyses examined changes in average passing distance, passes less than 5 feet, and passes less than 3 feet in both cities. The results are summarized in Table ES-3.

Table ES-3. Summary of Passing Distance Results

Measure	Baseline		Last Wave*		Difference (% Change)	Significance**
	M	SD	M	SD		p
Knoxville Staged						
Average (in.)	76.26	17.92	77.35	15.08	1.09 (1.4%)	*ns*
< 5-ft (%)	17.63	38.11	11.87	32.36	-5.76 (-32.7%)	<.001
< 3-ft (%)	4.98	21.76	3.11	17.35	-1.87 (-37.6%)	*.017*
Knoxville Volunteer						
Average (in.)	77.76	15.60	79.21	15.15	1.5 (1.9%)	<.001
< 5-ft (%)	15.79	36.47	14.58	35.23	-1.21 (-7.7%)	*ns* ***
< 3-ft (%)	4.21	20.09	3.99	19.57	-0.22 (-5.2%)	*ns*
Grand Rapids Staged						
Average (in.)	77.66	14.32	79.93	13.85	2.27 (2.9%)	<.001
< 5-ft (%)	13.39	34.07	10.25	30.34	-3.14 (-23.5%)	.004
< 3-ft (%)	3.09	17.30	2.09	14.31	-1.00 (-32.3%)	*ns*
Grand Rapids Volunteer						
Average (in.)	75.38	19.72	79.24	18.06	3.86 (5.1%)	<.001
< 5-ft (%)	26.01	43.89	18.17	38.57	-7.84 (-30.1%)	<.001
< 3-ft (%)	8.86	28.43	6.45	24.58	-2.41 (-27.2%)	*ns*

Note. Linear regression used to test average. Logistic regression used to test violation rates.
* Post 2 Wave in Knoxville; Post 3 Wave in Grand Rapids.
** Comparing last evaluation wave to baseline.
*** Percent passes < 5ft in Post 1 Wave was 18.32 and significant p=.003.

Table ES-3 shows that all of the observed changes, whether they reached statistical significance, were in the desired directions. Average passing distance increased, and violations decreased. This is precisely what the HVE programs were trying to accomplish.

Discussion

This study showed that HVE programs directed at bicycle passing laws can increase compliance, which should improve safety. Average passing distance increased and violations of the prevailing law decreased at both sites. Thus, there is no clear-cut choice between the two passing distances based on just response to the HVE. It is worth noting, however, that securing passage of a 5-foot law may be more difficult than enacting a 3-foot law. In spite of the existence of a 5-foot ordinance in Grand Rapids and several other Michigan cities and consideration of 5-foot and 4-foot requirements, the Michigan State Legislature decided to pass a statewide 3-foot law. Thus, there appears to be a trade-off between attempting to pass a 5-foot law that may have slightly superior safety performance because of the greater buffer distance between the car and bicycle and a 3-foot law that still performs well and is easier to get accepted.

Background

This study tested an HVE approach to improving compliance with laws requiring motorists to pass a bicyclist at a minimum distance of 3 feet and 5 feet. Figure 1 depicts the basic requirements of these distance-based bicycle passing laws. When a motorist overtakes a bicyclist from the rear, the law specifies a required or minimum passing distance that must be left in order to protect the bicyclist (McLeod, 2016).

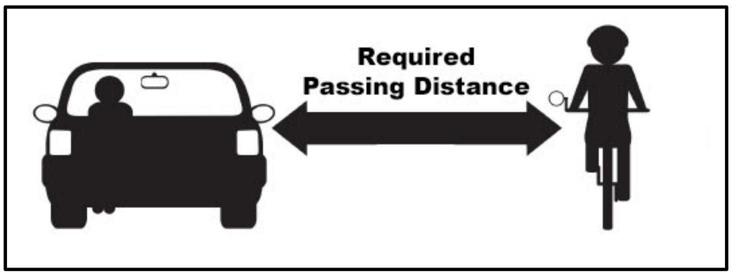


Figure 1. Required Passing Distance

The Problem

According to the NCSA, 846 bicyclist and other non-motorized cyclist fatalities occurred in the United States as a result of traffic crashes in 2019 – the most fatalities since 1990 (NCSA, 2020b). Analyses of driver and bicyclist behaviors that lead to bicycle involved motor vehicle crashes and bicyclist fatalities consistently reveal that the motorist overtaking a bicyclist from behind is the most frequent situation that results in a bicyclist fatality (e.g., Wright et al., 2019; Hunter et al., 1995; Cross & Fisher, 1977).

Analysis suggests that the motorist in these overtaking bicyclist crashes either never sees the bicyclist or misjudges the lateral distance between the motor vehicle and bicyclist and strikes the bicyclist from behind (Cross & Fisher, 1977). To address this situation, laws have been passed at the State, county, or municipal level requiring a minimum passing distance when a motorist passes a bicycle. Compliance with these laws should reduce distance judgement errors on the part of the motorist. The need to obey these laws, especially when awareness is heightened by HVE, might also prompt motorists to increase their search for bicycles and to leave more space when overtaking them.

The extent and visibility of enforcement as well as the severity of the sanction associated with a violation affect motorist compliance with traffic laws (Thomas et al., 2008; Blomberg, 1992; Blomberg et al.,1987). This led to the HVE countermeasure approach in which increased enforcement is coupled with intensive publicity to enhance the effect of the enforcement and deter undesirable behavior. HVE has been shown to promote increased seat belt use, such as in the widespread *Click It or Ticket* seat belt initiatives (NCSA, 2021; Tison & Williams, 2010) and to result in better compliance with yield to pedestrian statutes (Van Houten et al., 2013, 2017).

The work of Van Houten et al. (2013) was an attempt to improve the safety of pedestrians, one class of vulnerable road users. The approach used plainclothes police officers acting as pedestrians to make an entry into a marked crosswalk thereby prompting oncoming motorists to yield as required by the vehicle and traffic law. Other downstream officers stopped and warned drivers who violated this law during the initial weeks of the program and warned or ticketed them thereafter. Public information, including pamphlets, portable "sandwich board" signs, school flyers, radio ads, earned media, and signs providing feedback of the most recent percent of drivers yielding, supplemented the enforcement efforts. The program resulted in a significant and enduring improvement in driver behavior, not only at the intersections where police focused enforcement, but also at untreated locations nearby (Van Houten et al., 2013, 2017).

The success of the approach used by Van Houten et al. (2013) in changing motorist behavior to make pedestrians safer suggested that similar opportunities for improving bicyclist safety might exist. This study attempted to emulate the basic approach used successfully to get drivers to change their behavior when approaching pedestrians in crosswalks to achieve an analogous improvement in motorist behavior when a bicyclist is encountered in a specific road situation defined in the vehicle and traffic law.

Objectives

The objectives of this study were to:

1. Select a target motorist behavior required or prohibited by a law;
2. Develop an HVE program to address that motorist behavior;
3. Select test locations;
4. Assist the test sites in the implementation of an HVE program; and
5. Evaluate both the implementation process and the behavioral outcomes produced by the HVE program.

It is important to note that although the global focus of the study was on reducing crashes involving bicycles and motor vehicles, the specific behaviors of interest were only those of motorists who might strike a bicyclist on the roadway. This is fully analogous to the approach employed by Van Houten et al. (2013) that dealt with driver behavior when approaching crosswalks as a way of safeguarding pedestrians.

Method

Selection of Target Motorist Behavior

The first step in the study involved selecting a vehicle and traffic law that addressed a specific driver behavior related to a defined bicycle/motor vehicle crash type. A companion study (Wright et al., 2019) examined the existence and frequency of bicycle involved motor vehicle crash types as a precursor to the present study. Based on the results of that study and a review of the literature, bicycle overtaking laws were selected as the study focus. The specification in these laws that a driver must leave a minimum passing distance when overtaking a bicyclist is similar in nature to the requirement for motorists to yield to pedestrians in crosswalks studied by Van Houten et al. (2013). The majority of State and local laws specify 3 feet as the required distance, but laws requiring 5 feet passing clearance have begun to emerge around the country based on the assumption that a greater passing distance (assuming similar compliance) would further enhance safety. It was therefore decided to study both passing distance laws to provide a more complete picture of the use of passing distance laws as a safety countermeasure.[1]

Research Questions

Once researchers selected the study's target behavior, they could express the remaining study objectives as a set of research questions. The choice of both 3-foot and 5-foot bicycle passing laws as the study focus led to the development of three research questions of interest.

1. Can an HVE program increase motorist compliance with a bicycle passing law?
2. Which law, 3-foot or 5-foot, results in safer motorist behavior?
3. Do HVE programs have a differential effect based on whether the prevailing law specifies a 3-foot or a 5-foot passing distance?

The first question can be answered by a focus on any passing distance law but likely only for the distance specified in that law. It would be speculation, for example, to attempt to generalize the results obtained under a 3-foot law to the likely response to a 5-foot law and vice versa because of the differences in required behaviors and the likely behavioral response of drivers. This difficulty led to the development of the second and third research questions.

Site Selection

To answer all three research questions discussed above, the study design included two sites—one with a 3-foot law and one with a 5-foot requirement. The ability to answer these questions also depended on the selection of appropriate test sites and the development of HVE programs by those sites. The goal of site selection was to find cooperative sites where the field portion of the study could be conducted. The candidate sites had to be interested in bicycle safety to ensure that local officials and law enforcement would have sufficient motivation to develop and execute the HVE program and have the appropriate 3-foot or 5-foot law or ordinance in effect. Medium-sized (population in the range of 150,000 to 250,000) cities or counties with a single law enforcement agency were preferred for ease of implementation. Based on the experience of the study team, larger sites would require resources beyond those available for the project, and

[1] The web site at www.ncsl.org/research/transportation/safely-passing-bicyclists.aspx contains a frequently updated list of the status of State bicycle passing laws.

smaller locales would not provide sufficient bicycle routes and passing opportunities for the evaluation.

Researchers examined potential test sites that had the passing distance laws of interest, had similar bicycling, demographic, and socioeconomic characteristics, and had a reasonable likelihood of cooperating with the study. After reviewing dozens of potential locations, Grand Rapids, MI (5-foot law) and Knoxville, TN (3-foot law) were selected. At the time of the study, the Grand Rapids bicycle passing ordinance (Ord. No. 79-48, 7-24-79; Ord. No. 2000-01, § 2, 1-4-00; Ord. No. 2015-52, § 2, 9-22-15) specified:

> *The driver of a motor vehicle overtaking a bicyclist proceeding in the same direction shall allow the bicyclist at least a five-foot separation between the right side of the driver's vehicle, including all mirrors or other projections, and the left side of the bicyclist at all times.*

The State law of Tennessee (Tenn. Code Ann. § 55-8-175) at the time of the study specified:

> *The operator of a motor vehicle, when overtaking and passing a bicycle proceeding in the same direction on the roadway, shall leave a safe distance between the motor vehicle and the bicycle of not less than three feet (3ft) and shall maintain the clearance until safely past the overtaken bicycle.*

Knoxville had an ordinance (Sec. 17-446) virtually identical to the Tennessee State law. If the Knoxville Police Department cited a violator against the city ordinance instead of the State law, any resulting fine revenue would stay in the city.

Researchers visited both sites, and held discussions with city officials, police, and bicycle advocates. Both sites were already aware of and concerned by the bicycle passing problem and expressed a sincere interest in participating in the study. The most relevant differences between the sites relate to the provisions of the passing requirement (5 feet versus 3 feet), the coverage of the law (local ordinance in Grand Rapids versus State law and ordinance in Knoxville), weather, and geographic location. While Grand Rapids and Knoxville are in different regions of the country, the bicycle riding seasons and extent of bicycling are quite similar as are the demographics and socioeconomics. As reported anecdotally by bicycle advocates in each city, the priority of bicycling as a mode of transportation also appears similar in the two cities.

Operational and Behavioral Differences between 3-foot and 5-foot Laws

As part of the selection of Grand Rapids and Knoxville, project staff had the opportunity to discuss the original passage, enforcement, and adjudication of their 5-foot and 3-ft passing laws with relevant local officials. These discussions highlighted potential significant operational and driver-response/behavioral differences between 5-foot and 3-foot laws. For example, although there appears to be general agreement among members of law enforcement that 5 feet is a safer passing distance than 3 feet, they admitted a greater reluctance to hold motorists to a 5-foot standard, particularly on narrow two-lane roads, because it generally requires the motorist to move fully into the oncoming lane.

Drivers' required compliance and actual behavioral responses to the two laws appear quite different. For example, it is a reasonable assumption that motorists face different issues when complying fully with 5-foot rules than with 3-foot rules. It is virtually impossible to pass a bicyclist by 5 feet while remaining in a single travel lane. Thus, a "full pass" including moving well into the next lane (which would be the oncoming lane on a two-lane road) is necessary. On the other hand, it is possible in wide lanes to make a 3-foot pass while remaining in the lane, and, even if encroachment in the next lane is required, its extent is minimal. These differences could affect a driver's willingness to comply with the passing requirement, the manner in which drivers will comply, the extent and focus of education needed as part of the program, and the type of behavioral measures employed in the evaluation. It is also possible or even likely that drivers attempting to comply with a 5-foot law but not actually achieving a 5-foot separation might still give a bicyclist more room than motorists complying with a 3-foot law.

The need to move well into the oncoming lane to achieve a 5-foot pass suggests that some of the messages in the HVE publicity component must be handled differently in a 3-foot versus a 5-foot site. In the former, the message can be focused on making sure to leave 3 feet with just a reference to the possible need to cross the centerline to comply. At a 5-foot site, the publicity must focus strongly on both the need to give 5 feet and the permissibility of crossing the centerline to comply. In both cases, in order to be consistent with the HVE approach, messaging would also have to focus strongly on the ongoing enforcement and the likelihood of getting stopped and ticketed.

Enforcement

One essential component of an HVE program is the enforcement itself. It is desirable for the enforcement to be fair but vigorous, newsworthy, and targeted so that it is clearly focused on the problem being addressed. The bicycle passing law being enforced depends on a driver giving a specified distance (3- or 5 feet) when passing a bicyclist. The police in each of the test cities needed an enforcement strategy capable of intercepting violators to warn or ticket them. The strategy also had to create visibility so that the media and driving public could see that the enforcement process was actually being carried out. Finally, the police also needed an objective and legally acceptable way to determine the precise distance of a pass.

Fortunately, two cities, Austin, Texas, and Chattanooga, Tennessee, were identified that had already independently initiated programs to enforce bicycle passing laws and were willing to share their experiences with researchers on this project. Meetings were held with police and other officials in both cities to learn about the origin of their programs, observe their procedures, and obtain copies of their material. The approach by the two cities was quite similar and was based around a commercially available distance measuring device. Based on these analogous enforcement efforts, researchers specified data collection enforcement strategies and instrumentation and worked together with officials in Grand Rapids and Knoxville to implement them in association with a project-supplied evaluation component. While this project aimed to catalyze HVE programs in each city, researchers did not want to direct them or dictate their tactics. An evaluation by the research team of city-designed and run programs was desired in order to provide the most realistic and potentially transferrable results.

Enforcement Approach

Austin and Chattanooga both used "decoy" police officers riding bicycles as the triggers for enforcement action. If someone passed the decoy officer too closely, the officer would radio to a chase officer in a car or on a motorcycle who would stop the offender and warn or cite the driver. This approach seemed to work well and was fully analogous to the decoy pedestrian approach used by Van Houten et al. (2013) to enforce yielding to pedestrians in crosswalks. Both the

GRPD and KPD specialists taking part in the study liked this approach, and it was therefore adopted for this study at both sites.

Based on the experiences in Austin and Chattanooga, the police in the test cities focused their enforcement on a limited number of routes spread across each city selected because of high bicycle and motor vehicle traffic, potentially high passing law violations, and the availability of safe places to pull violators over. The project staff worked with city officials concerned with bicycle safety (e.g., bicycle/pedestrian coordinator), traffic engineering, police, and bicycle advocates in each city to define the areas in which enforcement would be applied. In Grand Rapids, this resulted in three routes, one in each of the city's three wards. Each route included a north/south and an east/west road that intersected approximately at their midpoint. Officers patrolled each route at their discretion based on prevailing traffic conditions and rotated among the three routes to balance the enforcement geographically.

The GRPD typically used two bicycles and two chase cars or motorcycles for each enforcement deployment. The enforcement team consisted of volunteer officers on overtime. The bicycle officers usually wore plain clothes but sometimes dressed in their normal bicycle patrol uniforms. Weather permitting, police and researchers scheduled the enforcement operations a day or two before the scheduled staged rides for evaluation data collection (see below). The involved police managers concluded that using motorcycle officers would be the best chase approach, and they used them whenever they were available. Bicycle officers made some stops themselves, particularly when the violations occurred in heavy, slow-moving traffic. This approach is similar to the one that had previously evolved in Chattanooga.

In Knoxville four enforcement routes were defined that covered a large part of the central city. Three of the routes were loops that began and ended at the centrally located police headquarters. These covered the areas north, south, and east of the center of the city. The fourth route covered the western area of the city and was a linear route that was ridden out and back by the decoy officers. As in Grand Rapids, enforcement was distributed across the routes at the discretion of the operating police. Table 1 on the next page presents the basic characteristics of the enforcement routes in each test city.

Knoxville enforcement operations typically used a single bicycle patrol officer as a decoy along with a single chase car. The officers were in uniform. The enforcement operations were part of regular duty for the traffic and bicycle units.

Enforcement Procedure

As mentioned previously, GRPD used two police bicycle riders and two chase cars or motorcycles for each enforcement operation. Sometimes the officers wore bike uniforms, but most of the time officers dressed as civilians in approved GRPD plain clothes. KPD used a single bicycle rider and chase car. The GRPD conducted 25 enforcement operations from July 13, 2018, to October 30, 2018. The typical GRPD enforcement operation ran for approximately 4 hours, resulting in a total of approximately 100 enforcement hours. The KPD conducted 28 enforcement operations from September 28, 2018, to December 12, 2018. The typical enforcement operation lasted approximately 1.5 hours, resulting in a total of 42 enforcement hours.

Table 1. Characteristics of Enforcement Routes

Route	Main Streets	Length (mi)	Road Type	Percent of Route
Grand Rapids				
Ward 1	Leonard – Alpine to Turner Alpine – Leonard to Stocking	5.4	3-lane, no bike lane 2-lane, no bike lane	50% 50%
Ward 2	Leonard – Fuller to Monroe College – Hastings to Leonard	4.8	3-lane, bike lane 2-lane, no bike lane 5-lane, no bike lane 2-lane, bike lane	48% 32% 12% 8%
Ward 3	Burton – Division/Madison to Plymouth Madison – Burton to Hall/Franklin	2.4	3-lane, bike lane 2-lane, no bike lane	61% 39%
Knoxville				
North	E Hill Ave S/N Hall of Fame Dr NE E Woodland Ave W Glenwood Ave N Broadway St E Summit Hill Dr	5.7	4-lane divided, no bike lane 4-lane divided, bike lane 3-lane, no bike lane 2-lane, no bike lane 5-lane, no bike lane 4-lane, no bike lane 5-lane, bike lane	27% 19% 17% 13% 8% 8% 8%
South	E Summit Hill Dr S Hall of Fame Dr Henley St E Moody Ave S Haven Rd Anita Dr Sevier Ave Council PL S Gay St W Hill Ave Women's Basketball Hall of Fame Dr Howard Baker Jr. Ave	9.1	2-lane, no bike lane 4-lane divided, no bike lane 2-lane, bike lane 3-lane, bike lane 5-lane, bike lane Multi-lane divided, separate bike lane	46% 20% 15% 7% 6% 6%
East	E Hill Ave E Summit Hill Dr Hall of Fame Dr E Magnolia Ave N Elmwood St Linden Ave Martin Luther King Jr Ave	5.6	5-lane, bike lane 2-lane, no bike lane 4-lane divided, no bike lane 4-lane divided, bike lane 3-lane, bike lane 3-lane, no bike lane	42% 21% 17% 8% 6% 6%
West	Lyons View Pike S Forest Park Blvd Sutherland Ave NW N Concord St	8.4	2-lane, no bike lane 3-lane, no bike lane 4-lane, no bike lane	78% 20% 2%

During any traffic stops associated with the HVE, officers in both cities used discretion regarding whether to issue a ticket, verbal warning, or written warning. Warning flyers prepared by the police departments were given to all drivers who violated the passing distance laws, and were also widely distributed by the police at the outset of the programs at city events in which the police participated and as part of traffic stops for violations other than for bicycle passing. The warning served as an initial education phase during which officers stopped as many violators as possible. This gave officers time to use a short, standardized script to tell the driver about the seriousness of the problem, the correct driver behavior, and the existence of the ongoing HVE campaign. Appendix A shows copies of the warning flyers used by the police in Grand Rapids and Knoxville.

Measurement of Passing Distance

Police used the ultrasonic measurement system in both cities to determine if a violation occurred. The measurement system was paired with a portable, high resolution video camera (Figure 2) to document the violation by simultaneously video recording the measurement system display and an image of the passing vehicle (Figure 3). When an enforcement activity was in progress, the measurement system and video camera (as well as the officers' body cameras if available) were on continuously and the measurement system was set to "capture mode" in which the display would freeze at any measured distance less than or equal to a preset threshold. The measurement system alarm threshold could be set by the user to any value up to 99 in. The units for this study were therefore set to a default violation distance of 36 in. for the 3-foot law in Knoxville and to 60 in. for the 5-foot law in Grand Rapids. If the system measured a distance less than or equal to the set threshold, the display would "freeze" at the actual measured distance truncated down to whole inches (e.g., 49 in. as shown in Figure 3), and a warning buzzer sounded. The display remained frozen until reset by pushing either of the red buttons on the device shown in Figure 2 or Figure 3.

The measurement system is designed to avoid false positives; that is, readings that might show a driver in violation because of the inherent accuracy characteristics of the sensor and electronics. The advertised tolerance of the measurement system used in this study is +1.5/-0.0 in. This means, for example, that an object just outside 36.00 in. might be displayed as being 37-38 in. away (+1.5 in tolerance) but will never be displayed as falling closer than 36 in. from the device (-0.0 in. tolerance).

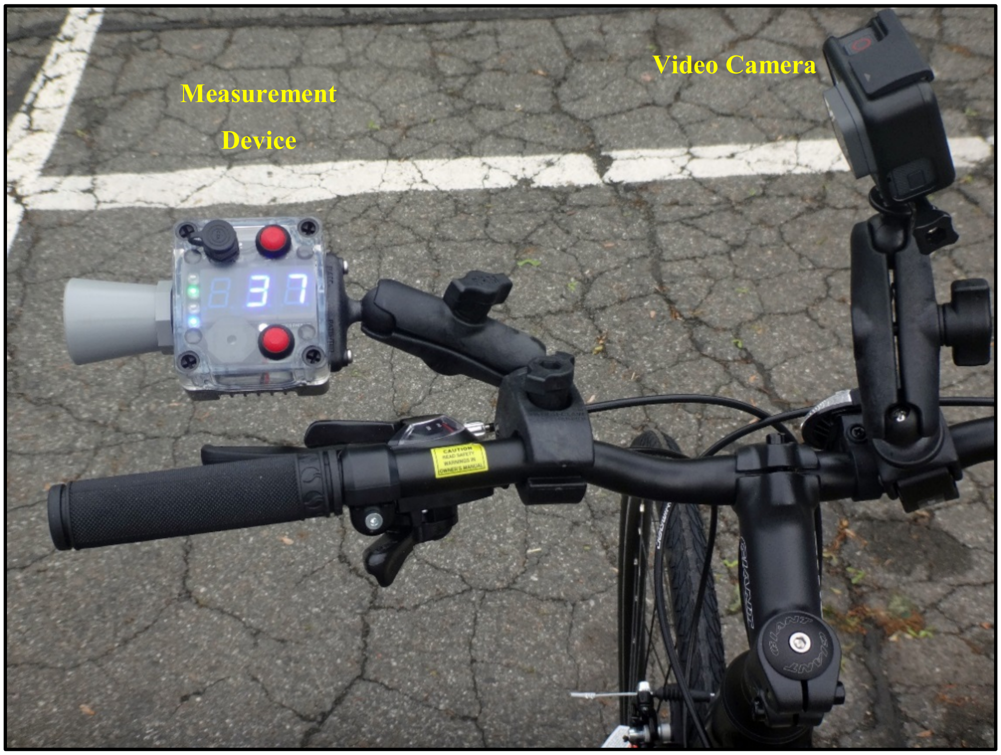


Figure 2. Police Enforcement System

Figure 3. Typical Video Image Recorded

The current study used the measurement device both for enforcement and, in an augmented version, as a data collection device. The augmentation consisted of the addition of a portable data logger (PDL) designed and built according to the project's requirements (Figure 4). The PDL stored distance measurements as shown on the measurement system display along with time and

GPS location on an onboard microSD card. When operated for data collection, the measurement system was placed in continuous mode so it would not freeze at a threshold, and the display was turned off so the data collectors had no feedback of what was being recorded. A flashing LED on the PDL indicated that it was on and capturing data. All PDL modes were user selectable in the field through a series of button presses. In practice, researchers set the units at the beginning of the study and data collectors only had to turn them on and off as well as offload data from the PDL that were stored on a microSD card within the device.

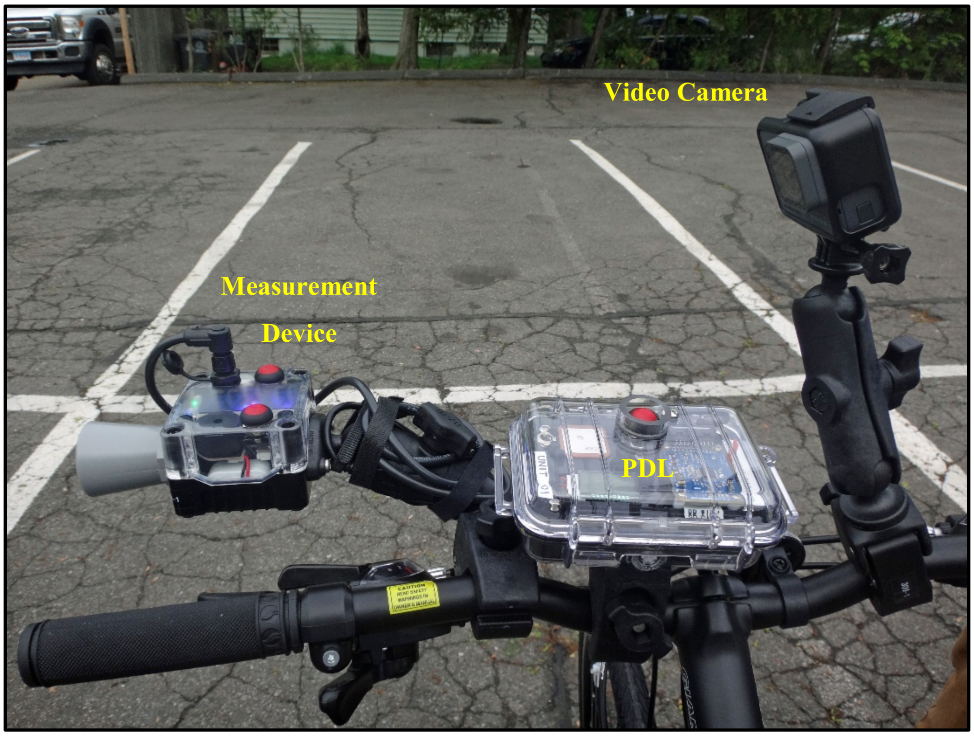


Figure 4. Measurement Device With PDL Augmentation

Officer Training on the Measurement Device

Prior to the start of the campaigns, the project staff together with the police liaisons in each city conducted a training class that covered the use and maintenance of the measurement device, the enforcement procedure and routes, and ticket and warning issuance. Practice operations were then run with members of the project staff in attendance to answer any questions about the measurement device. The project staff prepared a detailed instruction manual and associated training outline for the enforcement approach and the use of the measurement device. The project also provided each department with two complete measurement systems including the distance measurement unit, a video camera, and bicycle mounting brackets.

Messages/Publicity

The second component of an HVE campaign consists of education in the form of publicity or messages concerning the existence and intensity of the enforcement, the high probability of getting caught, and the possibility of a significant sanction for committing the offense. The objectives of the project included assisting the test cities with the development of messages by providing data and background information as well as by providing a limited amount of funding for production (e.g., printing). It was left to the HVE program leaders at each site to develop and disseminate the program publicity.

In addition to the police flyers distribution discussed above, each site held a press conference to initiate its program, generate publicity, and educate the public concerning the program's goals. The Grand Rapids opening press conference was held on July 10, 2018, and Knoxville's was held on September 20, 2018. Grand Rapids also held another press conference on November 19, 2018, to coincide with the end of the program evaluation data collection and to generate a final surge of publicity. Each press conference was well covered by the local media (see examples of coverage for Grand Rapids and Knoxville in Appendices B and C). To coincide with the press conferences, both sites added details of the law, the enforcement program, and the consequences of receiving a ticket to their websites.

The Grand Rapids Traffic Safety Department had a media and marketing firm under contract as part of its Vison Zero (VZ) program. This firm was given a further engagement by the project not only to coordinate the press conferences but also to promote earned media and to log instances of mention of the bicycle passing enforcement program. In addition, the project adapted a lawn sign used in Kalamazoo by adding indication of the joint sponsorship of GRPD and the VZ program (see Appendix B). These were distributed citywide by project and city personnel with special emphasis on locations on and near the enforcement routes.

Michigan maintained several changeable message signs over some of the highways in Grand Rapids. The city had previously been given occasional access to these signs to display pertinent safety messages. They were available for approximately 2 weeks during this campaign and carried a message that a 5-foot pass was required in the city. Grand Rapids also employed 10 feedback signs shown below in Figure 5 (five locations each with two signs, one in each direction) to alert drivers to the ongoing rate of compliance with the 5-foot passing ordinance and the record compliance to date. These signs were updated 14 times (approximately weekly) during the program as new data became available from the data collection activities of the volunteer riders described below. Compliance started at 77% (as shown in Figure 5) and ended at 83% with a high of 84% achieved during the eighth week of the program. The signs were modeled after the ones used by Van Houten et al. (2013) that showed the percentage of drivers yielding to pedestrians in crosswalks in the successful Gainesville program.

In addition to the earned media generated from newspapers, TV, and radio, Knoxville focused on the mass distribution of 58,852 information flyers designed by the city's graphic artist that used their program-generated theme: *Minimum Three in Tennessee* (see Appendix C). These flyers were distributed to all school children with their take-home material and also handed out at city events. The program theme was also used on a large, standing banner unveiled at the opening press conference and used at other relevant city events thereafter (Figure 6).

In summary, both cities used earned media generated by press conferences, their web sites, police flyers, and other localized media of their choice to raise the visibility of the enforcement program in an effort to increase its effectiveness.

Figure 5. Feedback Sign Used in Grand Rapids

Figure 6. Knoxville Program Banner

Evaluation Design

The program evaluation in both cities consisted of pre/post measures of the distance motorists gave to bicycles when they passed them on the roadway. The distance measures were collected using two different data collection approaches involving totally separate groups of expert bicyclists who were recruited through the local bicycle advocacy groups:

- "Staged riders," who were expert bicyclists recruited at both sites to ride bicycles instrumented with the ultrasonic measurement devices, video cameras and PDLs on the designated enforcement routes. Data collection took place before, during, and after the enforcement activities were mounted. It was reasoned that motorists on the roads where enforcement took place would be most likely to know about the program and to respond to it. For each staged ride, the staged riders completed half of the ride wearing enhanced, extra-high-visibility material consisting of a fluorescent bicycle helmet cover, a fluorescent bicycle vest or shirt (depending on prevailing temperature), and two small but bright flashing red LED lights placed on their backs. For the other half of each ride, they wore their typical bicycle attire, which was also quite conspicuous and characteristic of the type of gear worn by experienced bicycle riders. Figure 7 shows an example of staged riders in the two visibility conditions.
- "Volunteer riders," whose bicycles were equipped with measurement devices and PDLs but without a video camera. These riders were experienced bicyclists who used their bicycles as a primary means of transportation and therefore rode all over town. They

typically commuted to work on their bicycles when the weather permitted. They agreed to turn on the data collection equipment on their commutes and other daily riding throughout the study period (before, during, and after HVE began). Conspicuity was not enhanced for volunteer riders, but, as expert cyclists, they typically wore clothing or accessory gear that enhanced their conspicuity to passing motorists.

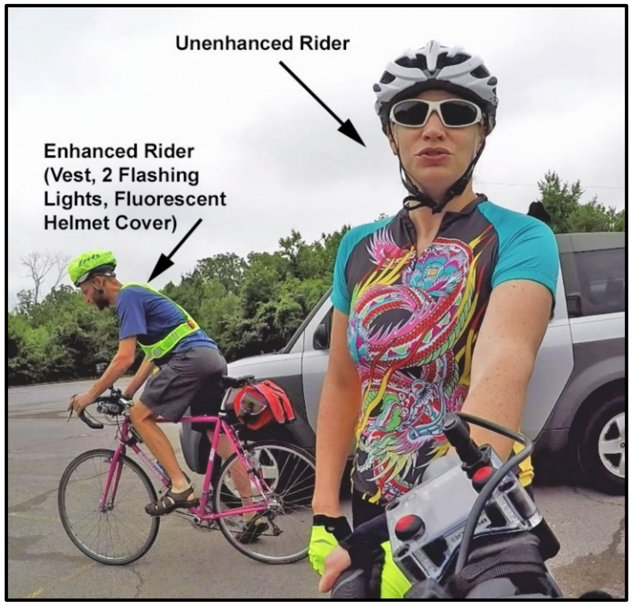


Figure 7. Enhanced and Regular Appearance of Staged Riders

Thus, the staged riders provided data that was specific to the enforcement routes and provided a look over time at possible driver behavior change on the actual enforcement routes and conceivably of at least some of the same drivers. The volunteer riders provided a more general citywide picture of behavior over time at each study site. All bicyclists were instructed to ride individually on their routes to best represent the overtaking crash situation that passing laws are designed to prevent and ensure the data collection equipment would accurately detect passing motorists.

Data Processing

The data stored in the PDLs required multi-stage processing before it could be analyzed. The PDLs stored raw data encoded according to a schema developed for use with the measurement device. The first processing step involved running a program that converted the raw data to 10 per sec measures of the distance of any object from the measurement device along with the clock time at which the measure occurred. The measurement device is designed to output a maximum distance of 99 in. Therefore, a measure of 99 in. indicated “99 in. or more.”

The measurement device used in this experiment cannot discriminate a car passing a bicycle from a bicycle passing one or more stopped or slowing cars, a fixed object closer than 99 in., or a momentary “wobble” of the bicycle that could result in the device taking a reading of the ground. It simply outputs the distance it measures every tenth of a second. To identify actual instances of vehicles passing the bicycle, researchers created logic rules and implemented them in a program that filtered out sequences of tenth of a second measures that were unlikely to be instances in which a motor vehicle passed the bicyclist (i.e., too few or too many tenth-of-a-second measures in the apparent pass). The rules for this program were derived by comparing the recorded measurements with video sequences from the cameras. The output of this second program was readable by SPSS Version 22 statistical software for statistical analyses.

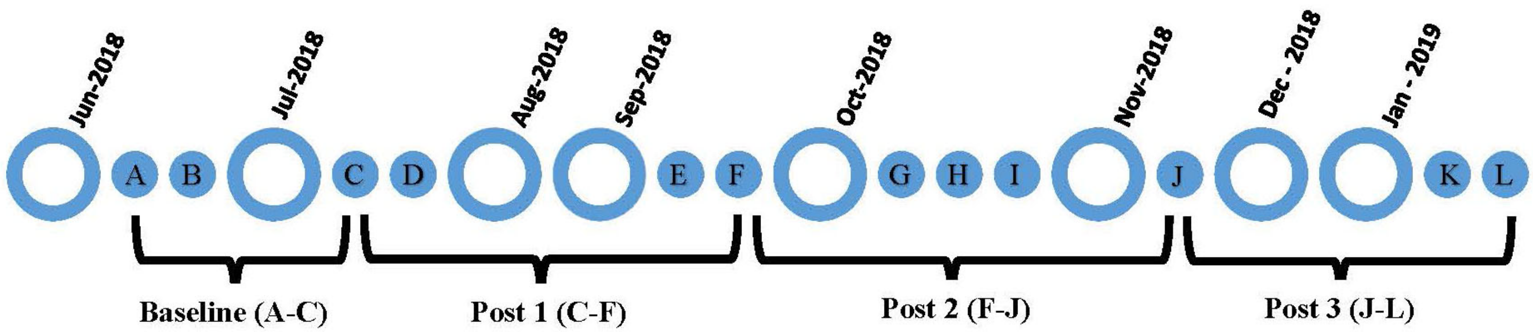
Institutional Review Board

A study such as this must be reviewed and approved by an IRB before it can collect data. After the sites were selected and all procedures had been developed, an application was submitted to the Western Michigan University (WMU) IRB. This IRB reviewed the study since Dr. Ron Van Houten, a professor at WMU, participated as a senior researcher on the study team, and several of his graduate students assisted the evaluation in Grand Rapids. The IRB formally approved the study on May 22, 2018, thereby permitting activities to begin shortly thereafter.

HVE Program and Evaluation Timelines

Each site was encouraged to operate its HVE program in its own style and by its own timeline. The project provided technical help and limited financial support to help maintain schedules and to facilitate the evaluation. Due to production schedules for the measurement devices with the PDLs, the two sites had to be started sequentially. Grand Rapids, as the more northerly site, was selected to begin first to maximize bicycle riding time before the onset of shorter days and colder fall and winter weather. The Knoxville opening press conference was approximately two months after the one in Grand Rapids. Figure 8 shows the HVE program and evaluation timeline for Grand Rapids, and Figure 9 shows the timeline for Knoxville.

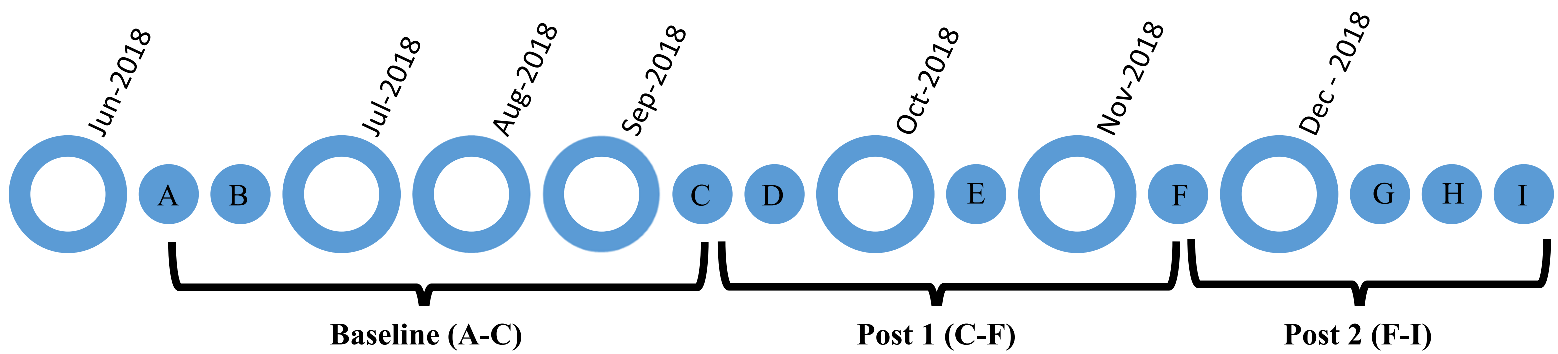
In order to create a meaningful time variable for analyses (see below), researchers defined time periods at each site. The baseline period began when collection of each evaluation measure (Volunteer and staged rider observations) started (points A and B in Figure 8 and Figure 9) and ended with the initial press conferences (point C in the figures). Since the countermeasures mounted by each site consisted of several separate interventions at different times after the press conference, the post period was subdivided based on the start times of the major additional interventions at each site. In Grand Rapids the post period was divided into Post 1, Post 2, and Post 3 based on the events shown in Figure 8. In Knoxville there were two periods of intervention defined—Post 1 and Post 2—as indicated in Figure 9.



<u>Major HVE Campaign Events</u>

A. June 7, 2018 – Random Rider Baseline Data Collection Begins
B. June 8, 2018 – Staged Rider Baseline Data Collection Begins
C. July 10, 2018 – Initial Press Conference
D. July 17, 2018 – GRPD Start Enforcement
E. September 23, 2018 – Changeable Message Signs Deployed
F. September 27, 2018 – Michigan Statewide 3-ft Law Goes Into Effect
G. October 1, 2018 – Lawn Signs Deployed
H. October 15, 2018 – Feedback Signs Deployed
I. October 30, 2018 – GRPD Enforcement Ends
J. November 19, 2018 – Program Conclusion Press Conference
K. January 17, 2019 – Random Rider Data Collection Ends
L. January 18, 2019 – Staged Rider Data Collection Ends

Figure 8. Grand Rapids HVE Program Timeline



Major HVE Campaign Events

A. June 27, 2018 – Random Rider Baseline Data Collection Begins
B. June 29, 2018 – Staged Rider Baseline Data Collection Begins
C. September 20, 2018 - Initial Press Conference
D. September 28, 2018 – KPD Start Enforcement (warnings only)
E. October 9, 2018 – KPD Begin Issuing Citations
F. November 5, 2018 – 58,852 Educational Flyers Distributed Across K-12 Knox County Schools
G. December 12, 2018 – KPD Enforcement Ends
H. December 27, 2018 – Staged Rider Data Collection Ends
I. December 27, 2018 – Random Rider Data Collection Ends

Figure 9. Knoxville HVE Program Timeline

Results

The Data

The primary evaluation data consisted of the processed outputs from the measurement devices representing passes of a bicycle by a motor vehicle. These included the time of day, the distance from the bicycle (0-99 in.), and the duration of the pass (number of consecutive 0.1 sec measures). The same data outputs were available for both the Staged and Volunteer rides. For analysis, the raw data were converted to measures, such as average passing distance, as described under the analytic approach below.

Data were collected periodically throughout the study beginning with an extended effort before any interventions began to collect a robust sample to characterize the baseline. The resulting sample sizes of daylight motor vehicle/bicycle passes for each type of ride and study period are shown below in Table 2 for Knoxville and Table 3 for Grand Rapids. All of the staged rides were conducted in daylight, mostly in the hours before lunch during which most of the enforcement was mounted but never at the same time as the enforcement. Volunteer riders were instructed to use the measurement device whenever they rode during daylight. Use of the devices at night by the volunteer riders was not required and was at the discretion of each rider. The resulting sample of night data was relatively small and not distributed across all volunteer riders. Also, no enforcement took place at night. Researchers decided to conduct analyses only on data collected between sunrise and sunset, and therefore no nighttime data is included in in Table 2 or Table 3.

Table 2. Total Daytime Passes of Knoxville Data Collection Riders

	Baseline N	Post 1 N	Post 2 N
Staged Riders (N = 4,907)	2,530	1,282	1,095
Volunteer Riders (N = 14,620)	7,194	3,640	3,786
TOTAL (N = 19,527)	**9,724**	**4,922**	**4,881**

Table 3. Total Daytime Passes of Grand Rapids Data Collection Riders

	Baseline N	Post 1 N	Post 2 N	Post 3 N
Staged Riders (N = 13,373)	3,046	5,462	2,855	2,010
Volunteer Riders (N = 5,986)	1,038	2,560	1,210	1,178
TOTAL (N = 19,359)	**4,084**	**8,022**	**4,065**	**3,188**

The data collection objective for both staged and volunteer data collection was to amass as large a sample of naturally occurring passes as possible. The team of volunteer riders in Knoxville included four riders while the team in Grand Rapids had three. The Knoxville riders also had somewhat longer commutes to work and better riding weather in the late fall and early winter months than did the volunteer riders in Grand Rapids. These factors likely accounted for much of the larger sample of volunteer rider passes in Knoxville. The staged ride routes in Knoxville had somewhat lower traffic densities than those in Grand Rapids thereby accounting for at least some of the difference in sample sizes. Overall, the samples of both types of rides in each city are robust and sufficient to support the types of analyses reported below.

Analytic Approach

To determine whether motorists passed bicyclists at a greater distance after initiation of the HVE program, a linear regression for continuous data was performed for each city to analyze differences in mean (average) passing distance before and after the implementation of the program. The linear regression models included program wave as the predictor, with the defined program waves of baseline, Post 1, Post 2, and Post 3 period in Grand Rapids (see Figure 8) and baseline, Post 1, and Post 2 in Knoxville (see Figure 9).

The mean passing distance addresses the entire population of passing motorists most of whom comply with the prevailing law and stay well away from a bicyclist. This can be seen from the large value of the mean passing distances for both sites shown below. Researchers therefore used additional logistic regression analyses for binary outcomes to examine the number of passes that were violations of the law. Again, these models included program wave as the predictor. Although the prescribed minimum passing distances were 3 feet in Knoxville and 5 feet in Grand Rapids, passes under 5 feet and less than 3 feet were both examined at each site.

Researchers decided to analyze 5-foot and 3-foot passing distances as well as average passing distance at each site to provide a more complete picture of the possible effect of the HVE on close passes. This was particularly relevant in Grand Rapids where the 5-foot distance was mandated by a city ordinance enacted well before the study began that remained in effect and was more stringent than the 3-foot Michigan State law that became effective on September 27, 2018, while the study was underway. Publicity related to the 3-foot State law could have affected the knowledge and behavior of Grand Rapids drivers even though they were required to follow the stricter 5-foot law. In Knoxville, the applicable laws were the 3-foot Tennessee statute and an essentially identical Knoxville ordinance throughout the study period. Nevertheless, the strong emphasis on bicycle safety at that site and the publicity requesting motorists to give bicyclists more room might have affected passes closer than 5 feet as well as those less than 3 feet, which were actual violations of the law.

For each analysis, a main effects test and appropriate pairwise comparisons are presented when warranted by a significant finding. A large number of tests were included in the analysis plan. Under these circumstances, even if the comparisons are planned, the α level across all tests exceeds the α level for any one test, and some adjustment of α for each test is appropriate. To compensate for the large number of comparisons, a Bonferroni adjustment where slightly more stringent α levels are used with each test to keep α across all tests at reasonable levels was employed (Tabachnick & Fidell, 1989).

Model results are first presented based on the staged rider data to determine direct effects of HVE on the road segments within each test site on which the enforcement took place. Models analyzing the volunteer rider data are presented subsequently to examine citywide effects and shed light on the generalizability of results to routes that did not receive elevated enforcement.

Another way to examine the passing distance data visually is to plot the average passing distance for various percentiles from 10 to 100 of the passing vehicles. When the baseline and the final wave of the HVE program are compared (Post 2 in Knoxville and Post 3 in Grand Rapids), a picture of the source of any change in overall average passing distance can emerge. This may help in interpreting the results of the statistical analyses by providing more detail about any change over time.

Staged Riders

Analysis of the staged rider data provides a look at possible HVE program effects over time directly on the road segments where police applied the visible and publicized enforcement. As discussed earlier, these were streets with high volumes of both bicycle and vehicle traffic. Since the staged rides were duplicated for each study period with respect to route and time of day, they provide a look at effects that control to some extent for factors such as location and traffic conditions. Also, as discussed earlier, conspicuity of the staged riders was systematically manipulated in an attempt to increase it above the normally high level used by the expert bicyclists who served as staged riders. An additional set of analyses was therefore conducted in which conspicuity condition was entered as an independent variable. These analyses indicated that the different levels of conspicuity deployed (the normal rider attire, which was typically quite conspicuous, and the purposefully enhanced extra-high conspicuity condition for the study) had no statistically significant effect on average passing distance or the frequency of close passes. This is consistent with the finding of other researchers (e.g., Walker et al., 2014). Thus, the staged rider results below are presented collapsed across the conspicuity variable.

Knoxville—Average Passing Distance

No significant differences were found for Knoxville staged rider average passing distance (in inches), $\chi^2 = 5.46$, df = 2, $p = .065$, $R^2 = .001$ (see Figure 10). Note that the average passing distance in Knoxville was quite large even before initiation of the program. The Tennessee law requires giving a bicyclist a minimum of 3 feet (36 in.), but the baseline average passing distance was more than double that at 76.26 in. The averages in the two post periods did increase slightly from baseline, but the differences from baseline were not statistically significant. As mentioned above, because there was no significant main effect, no pairwise comparisons were conducted.

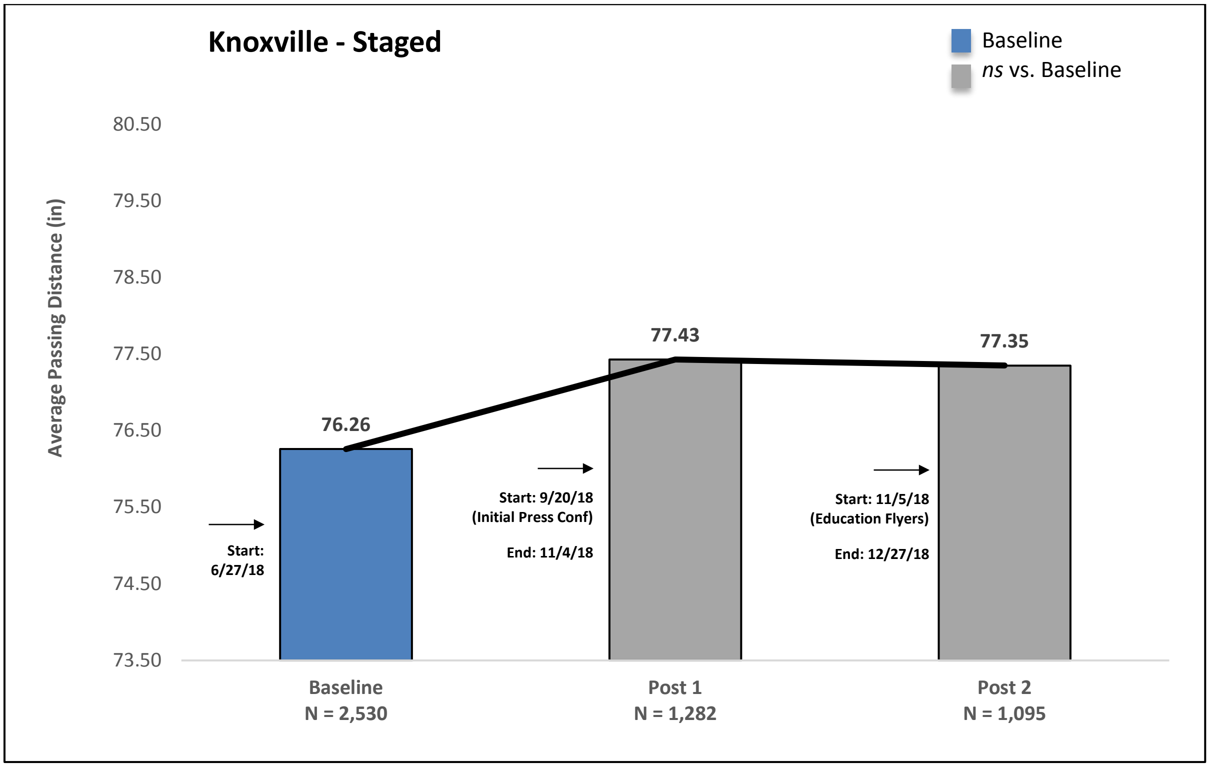


Figure 10. Knoxville Staged Riders Average Passing Distance

Knoxville—Passes < 5-ft

Even though the law applicable to Knoxville required only a 3-foot pass, passes less than 5 feet were also examined within the staged rider data (see Figure 11). A significant difference was found for Knoxville staged rider passes less than 5-ft, $\chi2 = 20.93$, df = 2, $p<.001$, Nagelkerke $R^2 = .007$. Wave was a significant predictor, $\chi2 = 20.15$, df = 2, $p<.001$. Passes less than 5 feet decreased significantly from baseline ($M = 17.63\%$, $SD = 38.11\%$) to Post 2 ($M = 11.87\%$, $SD = 32.36\%$), $p<.001$, a reduction of 32.7%. Passes closer than 5 feet also declined from baseline to Post 1 (17.63% to 14.66% of passes or a 16.8% decrease), but the drop did not reach statistical significance.

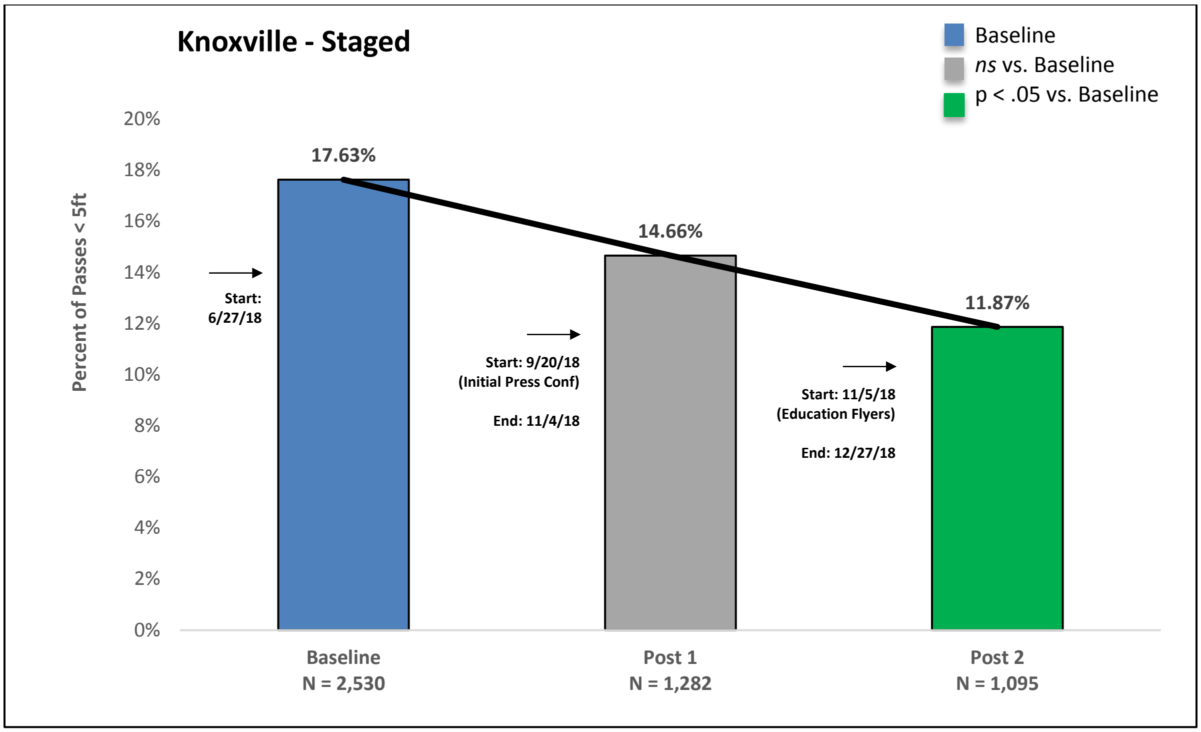


Figure 11. Knoxville Staged Riders Passes < 5-ft

Knoxville—Passes < 3-ft

A pattern similar to the one for passes closer than 5 feet was found for passes less than 3-ft (see Figure 12) although, as would be expected, the percentage of passes closer than 3 feet was considerably less than the percentage of those closer than 5 feet. A significant difference was found for Knoxville staged rider passes less than 3 feet, $\chi 2 = 9.17$, df = 2, $p = .010$, Nagelkerke $R^2 = .006$. Wave emerged as a significant predictor, $\chi 2 = 8.90$, df = 2, $p = .012$. Passes less than 3 feet decreased significantly from baseline ($M = 4.98\%$, $SD = 21.76\%$) to Post 2 ($M = 3.11\%$, $SD = 17.35\%$), $p = .017$, a decrease of 37.6%. Passes less than 3 feet in the Post 1 period decreased by 31.1% from baseline, but the decline did not reach significance.

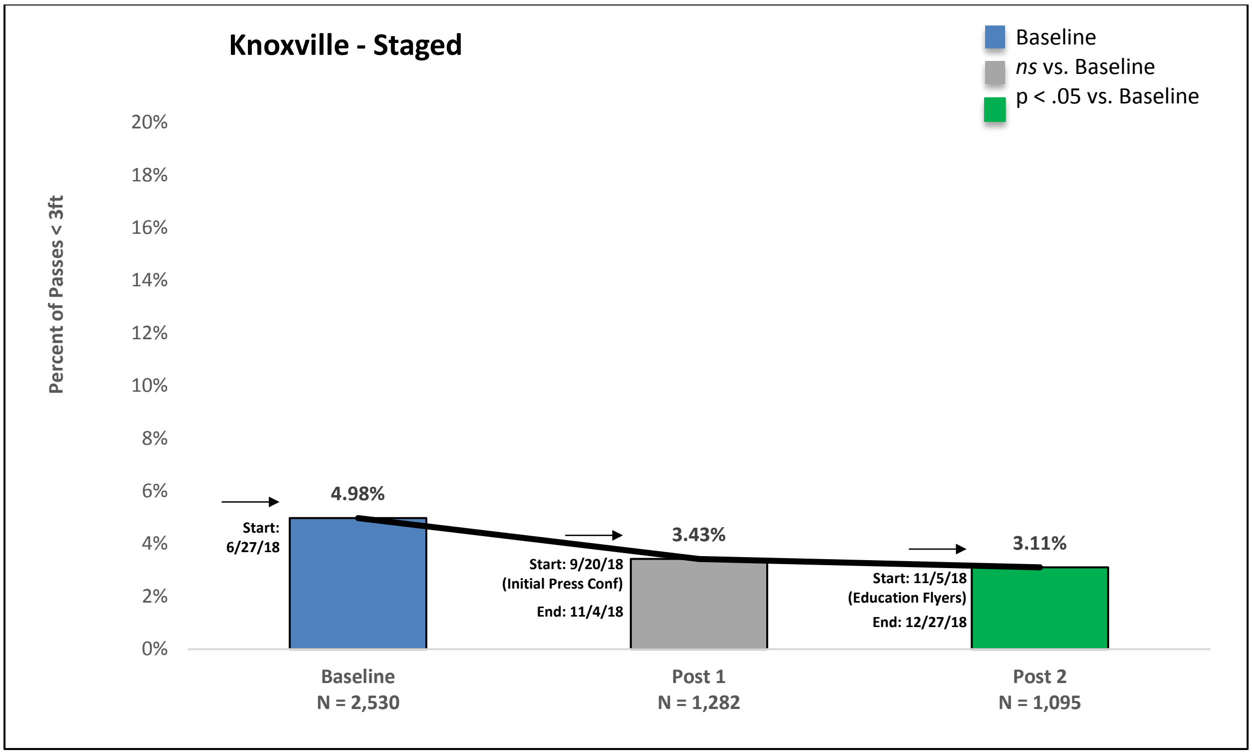
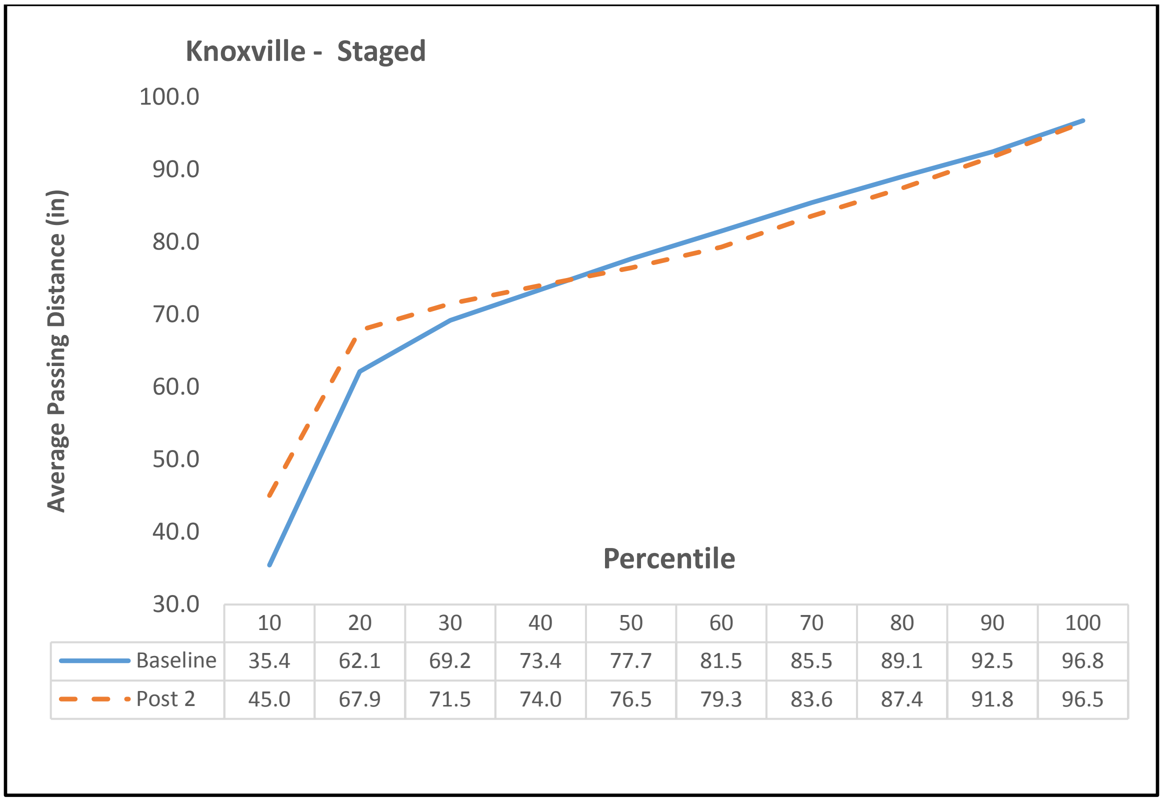


Figure 12. Knoxville Staged Riders Passes < 3-ft

Knoxville—Percentile Distributions

Figure 13 shows the percentile distribution of the average passing distance in Knoxville for the baseline and Post 2 waves. The largest shifts are evident for the 10th and 20th percentiles, which are the closest passes. The 10th percentile at 35.4 in. is less than the legal specification during baseline and increases to 45.0 in. during Post 2, which is greater than the 3-ft legal requirement. The 20th percentile, although well above the required distance at baseline, still increases by almost 6 in. by Post 2, and the 30th percentile increases by over 2 in. The remainder of the distributions for baseline and Post 2 are similar with all values greater than twice the legal requirement.



	10	20	30	40	50	60	70	80	90	100
Baseline	35.4	62.1	69.2	73.4	77.7	81.5	85.5	89.1	92.5	96.8
Post 2	45.0	67.9	71.5	74.0	76.5	79.3	83.6	87.4	91.8	96.5

Figure 13. Knoxville Staged Rider Average Passing Distance Percentiles

Grand Rapids—Average Passing Distance

The average passing distance for motorists going by the Grand Rapids staged riders increased significantly, $\chi 2 = 61.01$, df = 3, $p<.001$, $R^2 = .004$ (see Figure 14). Wave was a significant predictor, $\chi 2 = 61.14$, df = 3, $p<.001$. Average passing distance increased significantly from baseline ($M = 77.66$, $SD = 14.32$) to Post 2 ($M = 79.86$, $SD = 13.69$), $p<.001$ (2.8% increase), and to Post 3 ($M = 79.93$, $SD = 13.85$), $p<.001$ (2.9% increase). The increase from baseline to Post 1 (0.49 in or 0.6%) was not significant. There also was a significant increase in average distance of 1.71 in. (2.2%) from Post 1 ($M = 78.15$, $SD = 13.87$) to Post 2 ($M = 79.86$, $SD = 13.69$), $p<.001$ and of 1.78 in. (2.3%) from Post 1 to Post 3 ($M = 79.93$, $SD = 13.85$), $p<.001$.

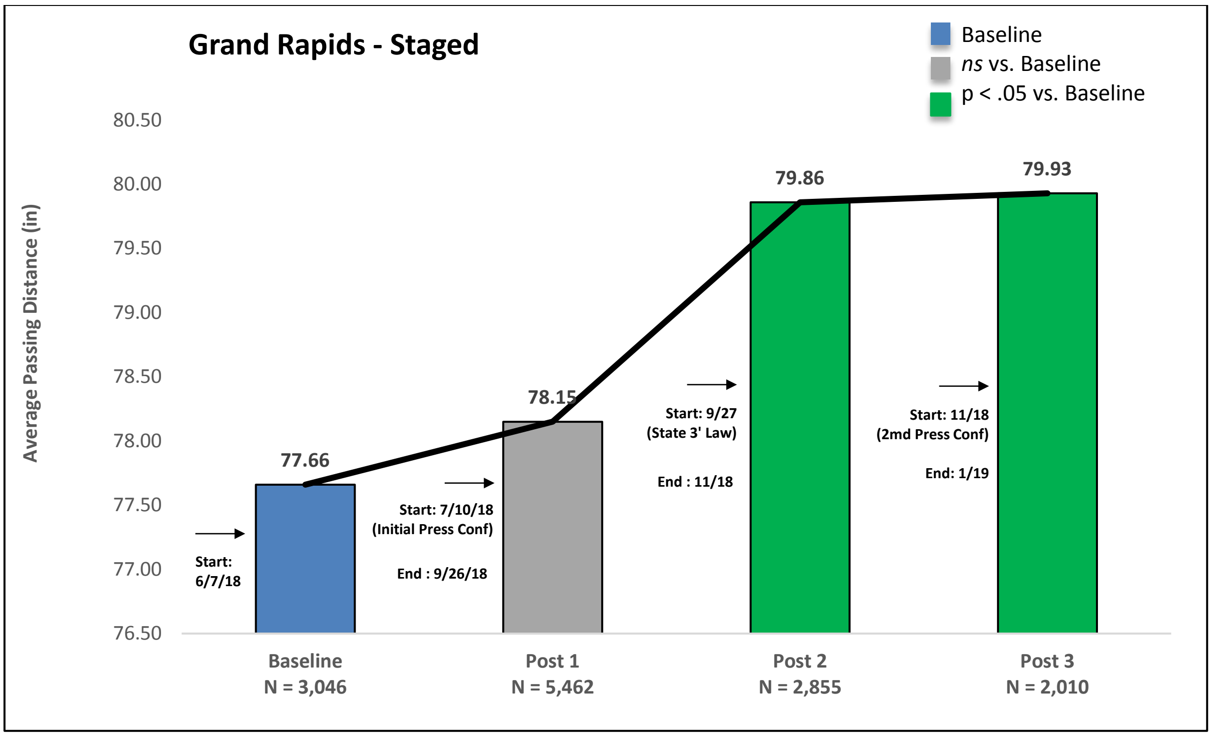


Figure 14. Grand Rapids Staged Riders Average Passing Distance

Grand Rapids—Passes < 5-ft

As shown in Figure 15, a significant difference was found for Grand Rapids staged rider passes closer than 5-ft, $\chi 2 = 26.73$, df = 3, $p<.001$, Nagelkerke $R^2 = .004$. Wave emerged as a significant predictor, $\chi 2 = 26.02$, df = 3, $p<.001$. Passes less than 5 feet decreased from baseline (M = 13.39%, SD = 34.07%) to Post 2 (M = 10.37%, SD = 33.95%), $p = .002$ (22.6% decline), and to Post 3 (M = 10.25%, SD = 30.34%), $p = .004$ (23.5% decline). There was no significant change from baseline to Post 1. Passes closer than 5 feet also decreased by 22.0% from Post 1 (M = 13.29%, SD = 34.07%) to Post 2 (M = 10.37%, SD = 30.49%), $p = .001$, and by 22.9% from Post 1 to Post 3 (M = 10.25%, SD = 30.34%), $p = .001$.

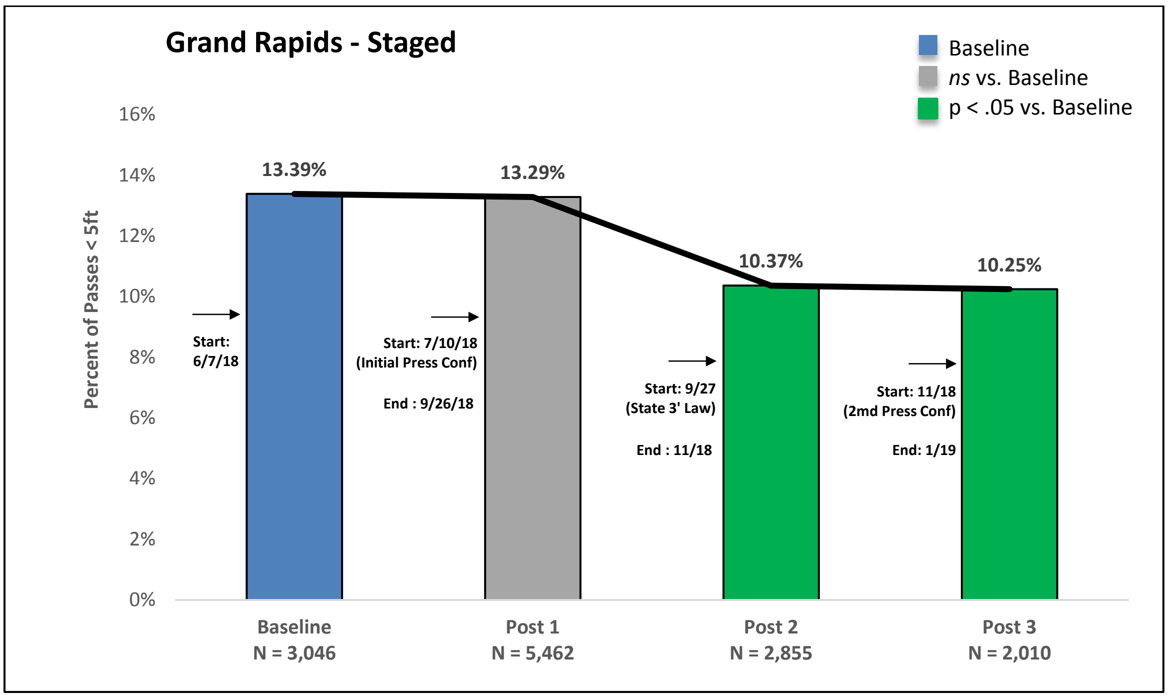


Figure 15. Grand Rapids Staged Riders Passes < 5-ft

Grand Rapids-Passes < 3-ft

No significant differences were found for Grand Rapids staged rider passes closer than 3-ft, $\chi2$ = 6.72, df = 3, p = .082, Nagelkerke R^2 = .002. As shown in Figure 16, the percentage of passes at 3-ft or less from the bicycle was low at the outset and decreased as the evaluation progressed, but the declines did not reach statistical significance.

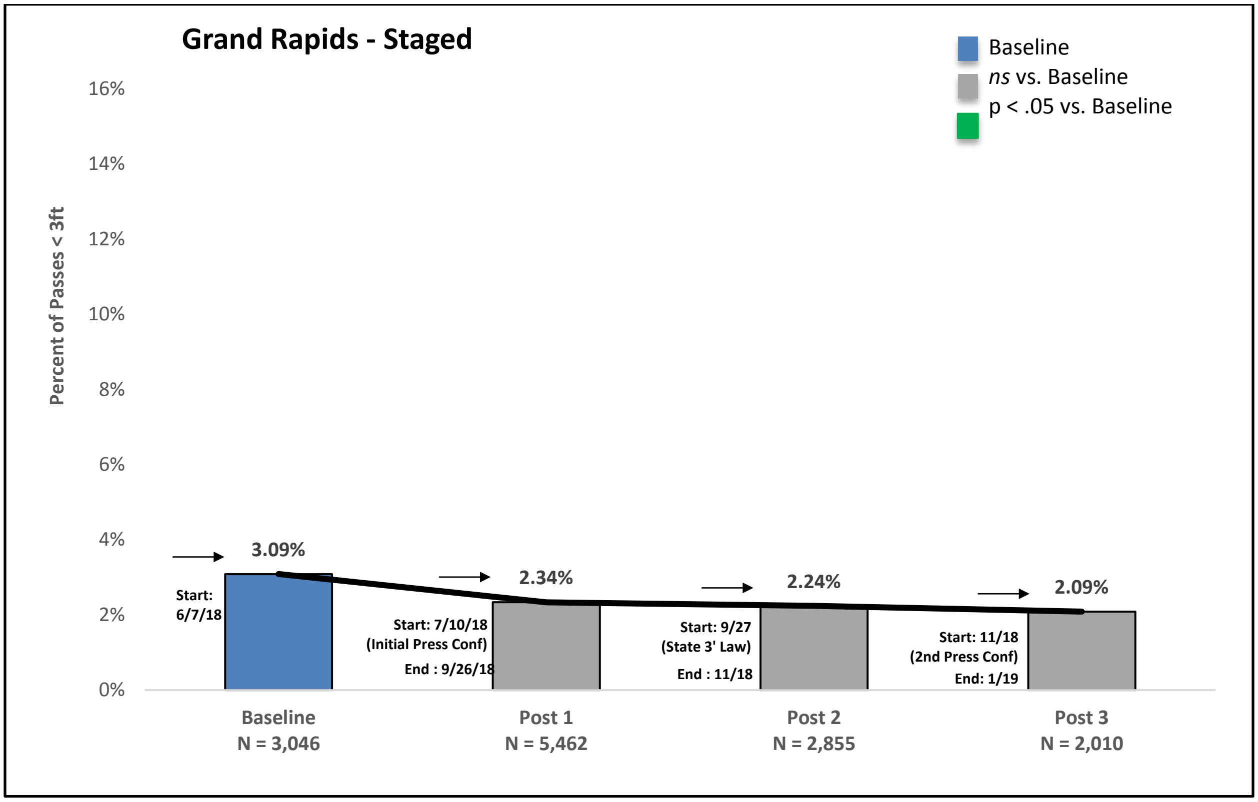
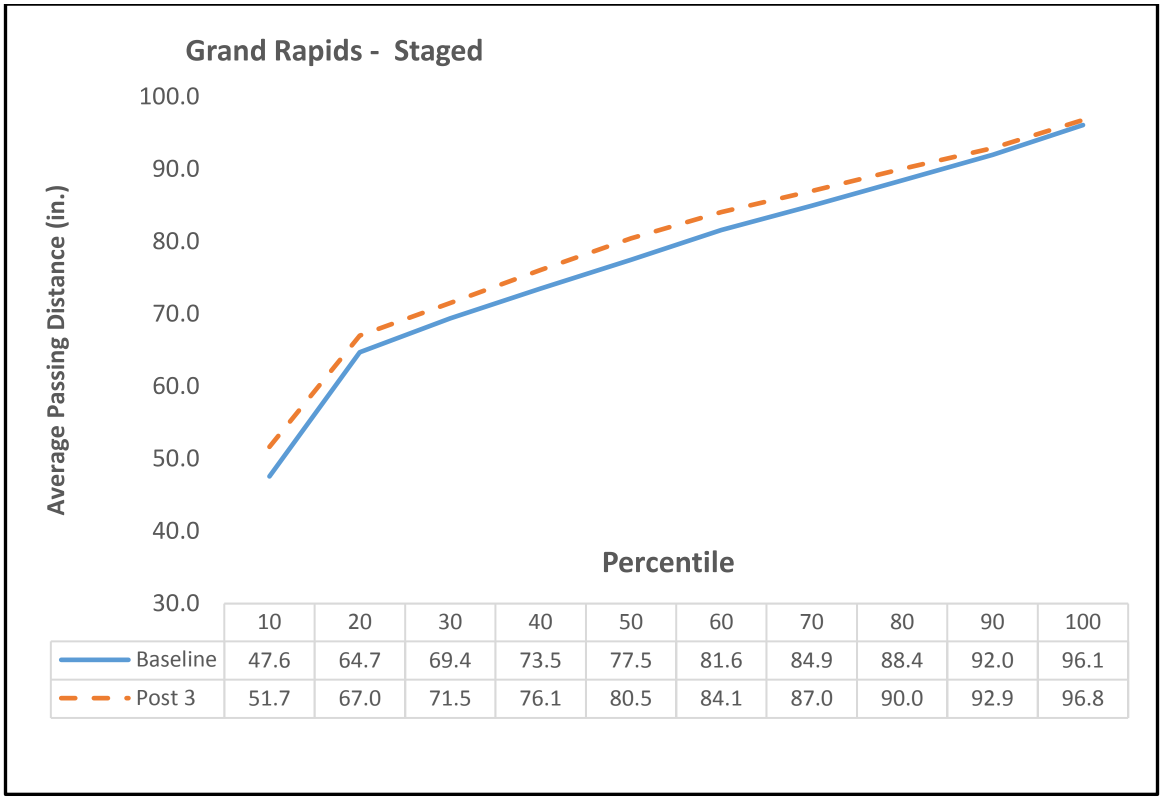


Figure 16. Grand Rapids Staged Riders Passes < 3-ft

Grand Rapids—Percentile Distributions

The percentile distributions for the baseline and Post 3 average passing distance in Grand Rapids are shown below in Figure 17. Unlike in Knoxville there appear to have been operationally meaningful increases in average passing distances in excess of 2.0 in. for the 10th through the 70th percentiles. The 10th percentile, although it increased by 4.1 in. from baseline, remained below the 5-ft (60 in.) legal requirement even in Post 3.



	10	20	30	40	50	60	70	80	90	100
Baseline	47.6	64.7	69.4	73.5	77.5	81.6	84.9	88.4	92.0	96.1
Post 3	51.7	67.0	71.5	76.1	80.5	84.1	87.0	90.0	92.9	96.8

Figure 17. Grand Rapids Staged Rider Average Passing Distance Percentiles

Volunteer Riders

The volunteer riders could ride and collet data anywhere and at any time they chose. As discussed earlier, most of their riding was conducted in daylight (sunrise to sunset), and therefore analyses used only the passes resulting from daylight rides. Since the volunteer riders were not constrained to particular roads, areas of town, or specific types of trip, their data is not as closely linked to the enforcement efforts as are the results from the staged riders. It is therefore reasonable to view results based on the volunteer riders as a more generalized effect of the HVE efforts in each city. The results below use the same measures—average passing distance, passes under 3 feet, and passes under 5 feet—as were employed for the staged rider analyses reported above.

Knoxville-Average Passing Distance

A significant difference was found for average passing distance (in inches) of the Knoxville volunteer riders, $\chi2 = 38.07$, df = 2, $p<.001$, $R^2 = .001$. Wave was a significant predictor, $\chi2 = 38.12$, df = 2, $p<.001$. Average passing distance decreased, but not significantly, from baseline to Post 1 but then increased in Post 2 (Figure 18). The change from baseline ($M = 77.76$, $SD = 15.60$) to Post 2 ($M = 79.21$, $SD = 15.15$), $p<.001$ (1.9%) was significant as was the 2.9% increase from Post 1 ($M = 76.99$, $SD = 17.12$) to Post 2 ($M = 79.21$, $SD = 15.15$), $p<.001$. As with the staged riders, it is noteworthy that the average passing distance for the volunteer riders, even before the intervention, was more than double the legal requirement.

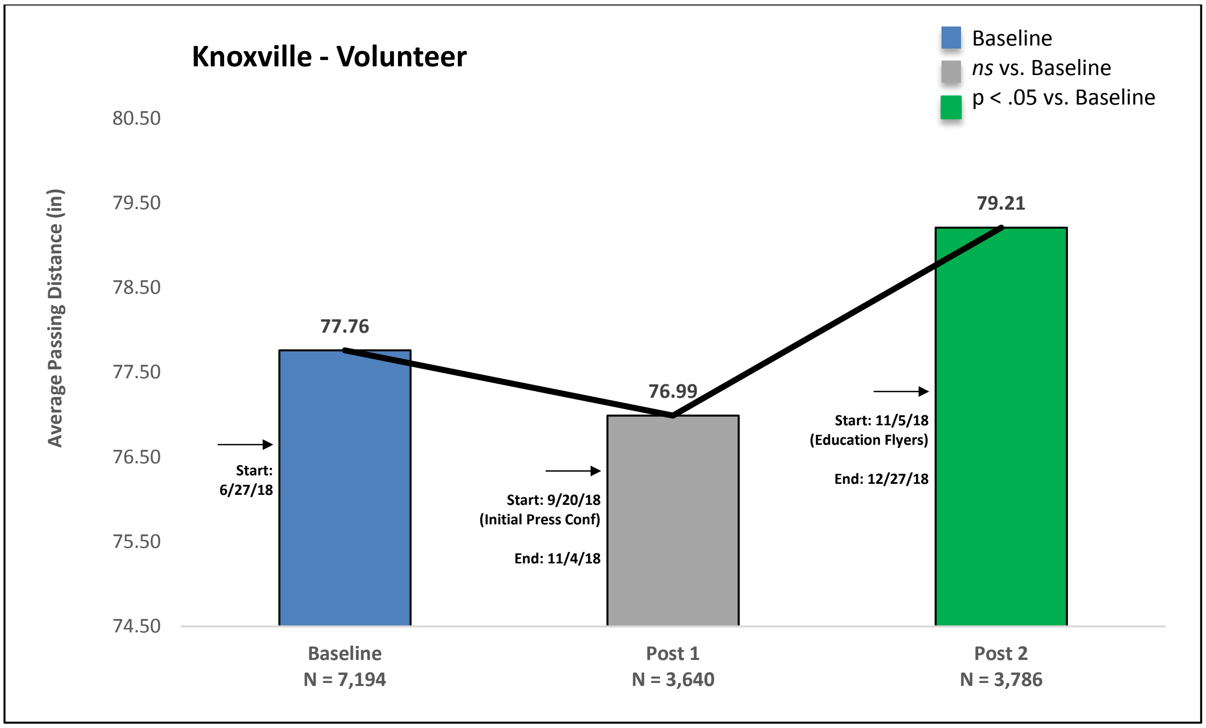


Figure 18. Knoxville Volunteer Riders Average Passing Distance

Knoxville-Passes < 5-ft

A significant difference was found for Knoxville volunteer rider passes closer than 5-ft, $\chi 2$ = 20.03, df = 2, p<.001, Nagelkerke R^2 = .002. Wave emerged as a significant predictor, $\chi 2$ = 20.25, df = 2, p<.001. Passes less than 5 feet actually increased significantly by 16.0% from baseline (M = 15.79%, SD = 36.47%) to Post 1 (M = 18.32%, SD = 38.69%), p = .003 as shown in Figure 19. They then decreased significantly (20.4%) from Post 1 (M = 18.32%, SD = 38.69%) to a level below baseline in Post 2 (M = 14.58%, SD = 35.23%), p<.001. The overall change from baseline to Post 2, however, was not significant.

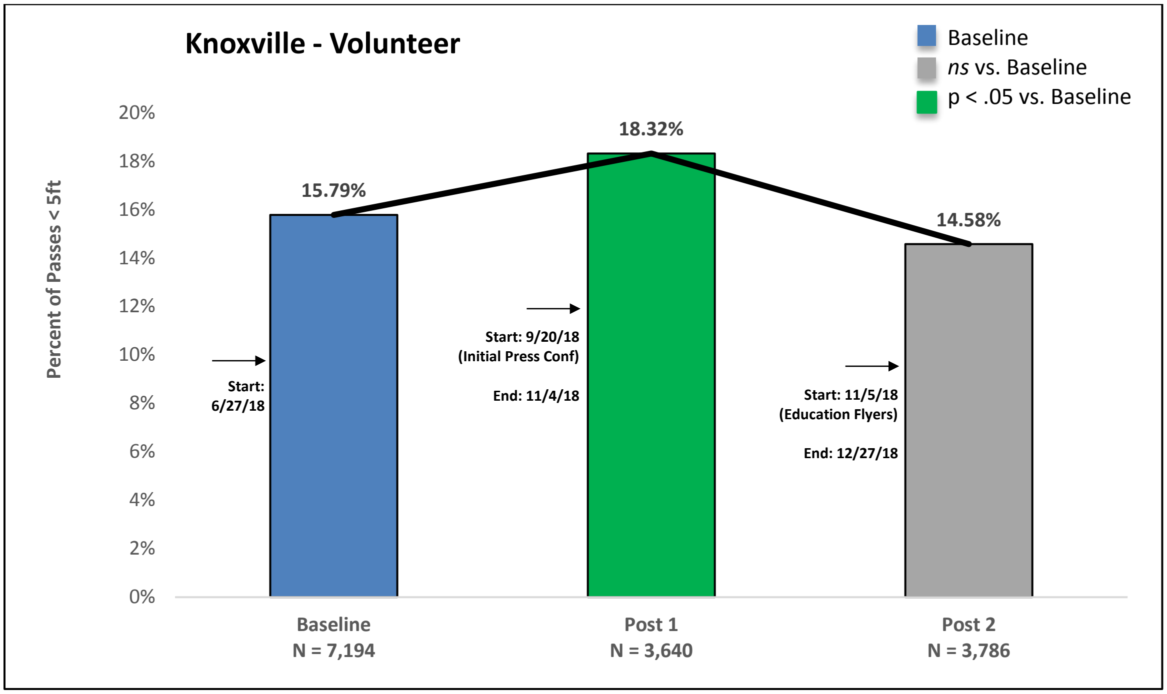


Figure 19. Knoxville Volunteer Riders Passes < 5-ft

Knoxville-Passes < 3-ft

As seen in Figure 20, the results for passes less than 3 feet in Knoxville showed a pattern similar to the one for 5-foot passes shown previously in Figure 19. A slight increase in passes that constituted violations between baseline and Post 1 was followed by a decrease in Post 2 to below baseline. Overall, a significant difference was found for the regression model of Knoxville volunteer rider passes less than 3 feet, $\chi2 = 6.65$, df = 2, $p = .036$, Nagelkerke $R^2 = .002$. Wave emerged as a significant predictor, $\chi2 = 6.82$, df = 2, $p = .033$. Even though the wave factor was significant, no wave-to-wave differences reached significance in the pairwise comparisons. Although looking at percentages there was a reduction in passes less than 3 feet, Post 2 (M = 3.99%, SD = 19.57%) was not significantly lower than Post 1 (M = 5.14%, SD = 22.08%), p = .053.

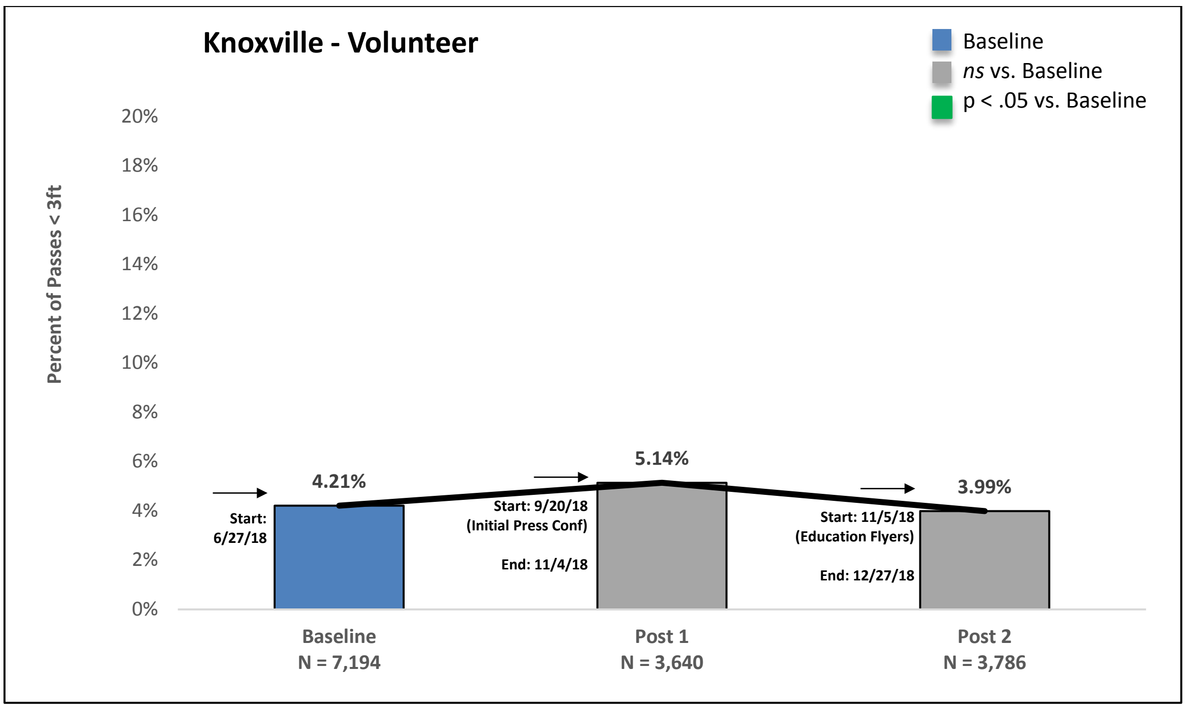
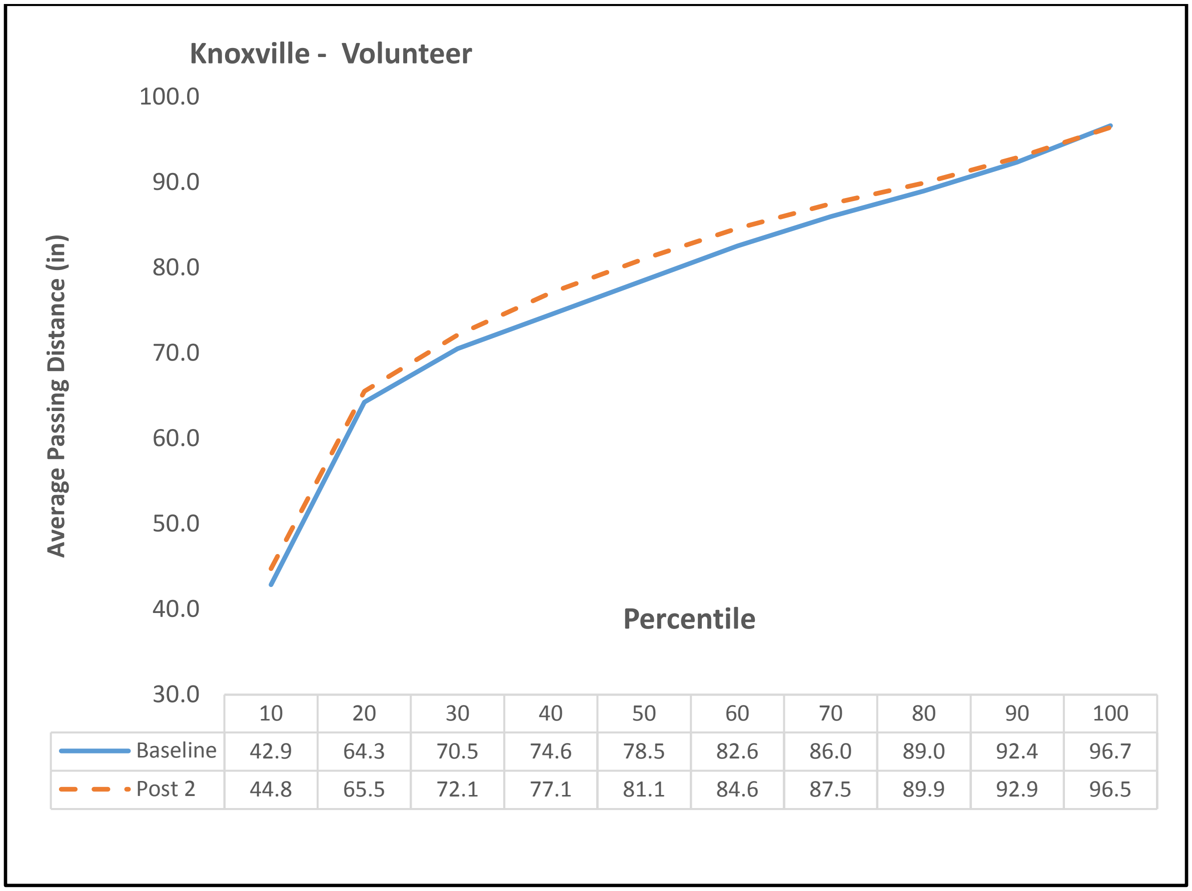


Figure 20. Knoxville Volunteer Riders Passes < 3-ft

Knoxville—Percentile Distributions

As shown in Figure 21, during baseline every percentile level was above the 36.0 in. required by law in Knoxville as measured by the volunteer riders. As shown earlier in Figure 18, the overall increase in average passing distance from baseline to Post 2 was significant. Much of that significant increase seems to have come from the middle of the distribution with the 40th and 50th percentiles each increasing 2.5 in. It is noteworthy that in Post 2 drivers at the 30th percentile and above were on average twice as far from bicyclists as the law required.



	10	20	30	40	50	60	70	80	90	100
Baseline	42.9	64.3	70.5	74.6	78.5	82.6	86.0	89.0	92.4	96.7
Post 2	44.8	65.5	72.1	77.1	81.1	84.6	87.5	89.9	92.9	96.5

Figure 21. Knoxville Volunteer Rider Average Passing Distance Percentiles

Grand Rapids-Average Passing Distance

As shown in Figure 22, a significant difference was found for Grand Rapids volunteer rider average passing distance (in inches), $\chi2 = 21.75$, df = 3, $p<.001$, $R^2 = .003$. Wave emerged as a significant predictor, $\chi2 = 21.79$, df = 3, $p<.001$. Average passing distance significantly increased 5.1% from baseline ($M = 75.38$, $SD = 19.72$) to Post 3 ($M = 79.24$, $SD = 18.06$), $p<.001$. Average passing distance also increased significantly from Post 1 ($M = 77.26$, $SD = 20.03$) to Post 3 ($M = 79.24$, $SD = 18.06$), $p = .023$ (2.6%). Overall, there was a monotonic increase in average passing distance from wave-to-wave, but the baseline to Post 1 and baseline to Post 2 differences failed to reach statistical significance.

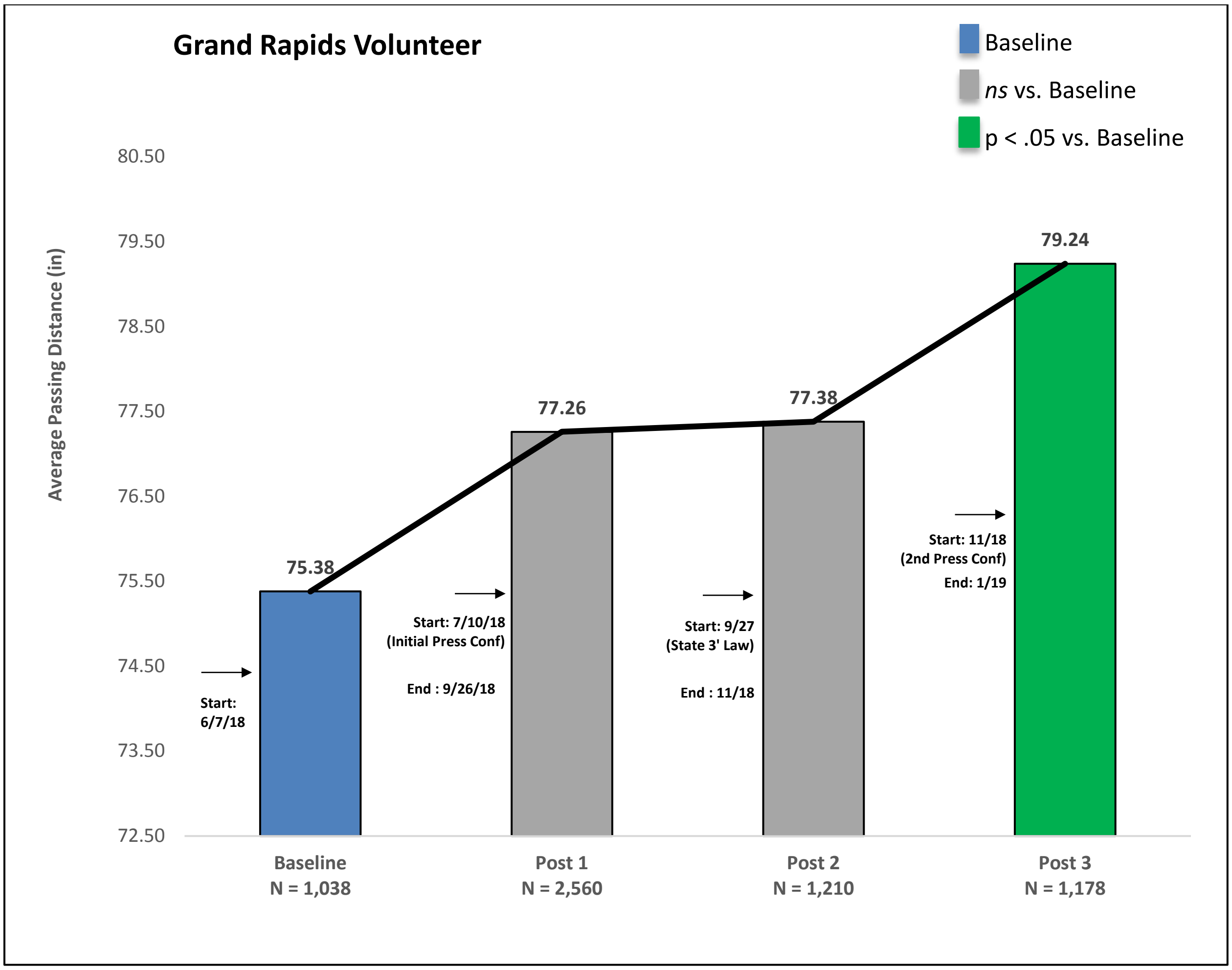


Figure 22. Grand Rapids Volunteer Riders Average Passing Distance

Grand Rapids-Passes < 5-ft

A significant difference was found for Grand Rapids volunteer rider passes less than 5-ft, $\chi2$ = 20.31, df = 3, *p*<.001, Nagelkerke R^2 = .005 (see Figure 23). Wave was a significant predictor, $\chi2$ = 19.92, df = 3, *p*<.001. Passes less than 5 feet decreased significantly (30.1%) from baseline (*M* = 26.01%, *SD* = 43.89%) to Post 3 (*M* = 18.17%, *SD* = 38.57%), *p*<.001. Five-foot violations also decreased significantly from Post 1 (*M* = 22.46%, *SD* = 41.74%) to Post 3 (*M* = 18.17%, *SD* = 38.57%), *p* = .012 by 19.1% and from Post 2 (*M* = 22.73%, *SD* = 41.92%) to Post 3 (*M* = 18.17%, *SD* = 38.57%), *p* = .034 by 20.1%.

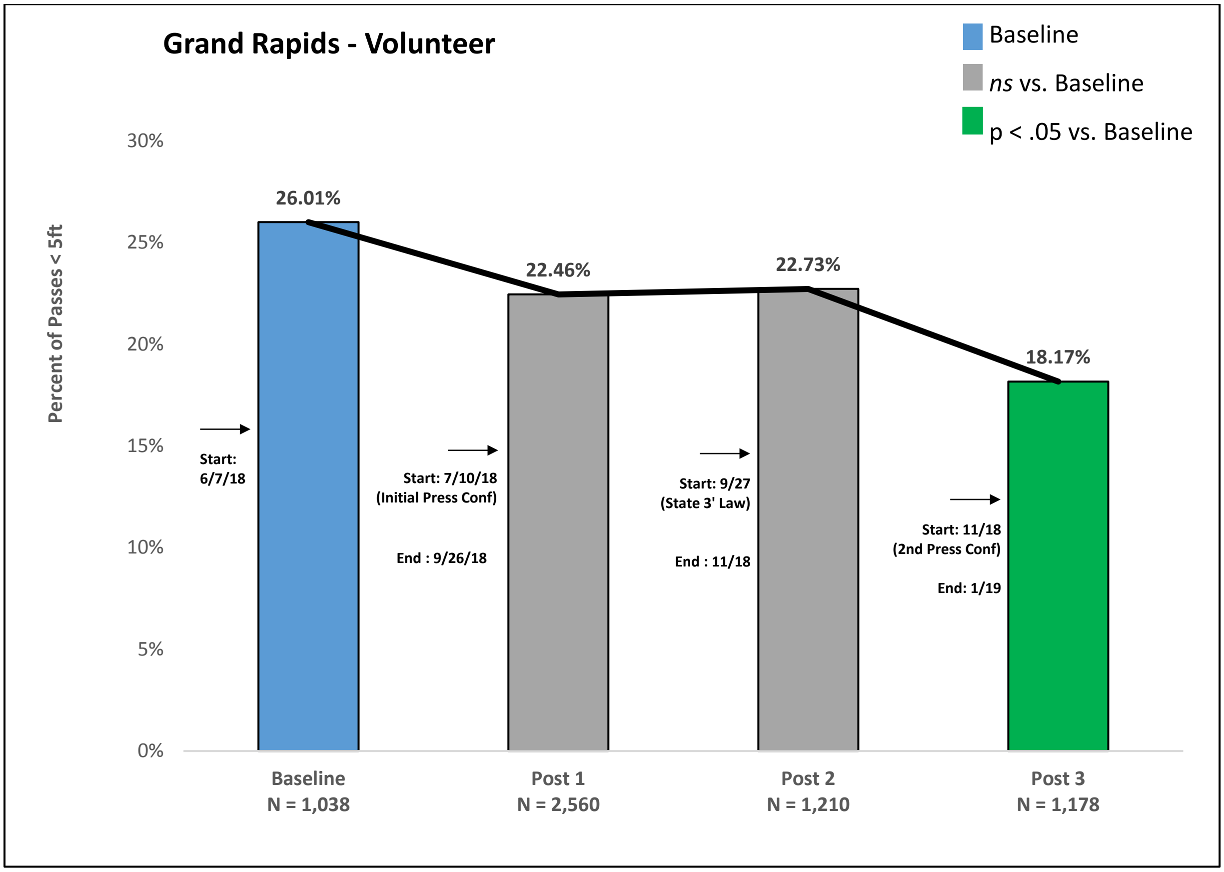


Figure 23. Grand Rapids Volunteer Riders Passes < 5-ft

Grand Rapids-Passes < 3-ft

A significant regression model was found for Grand Rapids volunteer rider passes less than 3-ft, $\chi2 = 7.94$, df = 3, $p = .047$, Nagelkerke $R^2 = .003$. Overall, wave was not a significant predictor in the model, but a review of Figure 24 shows an encouraging reduction in passes closer than 3-ft in the Post 3 period.

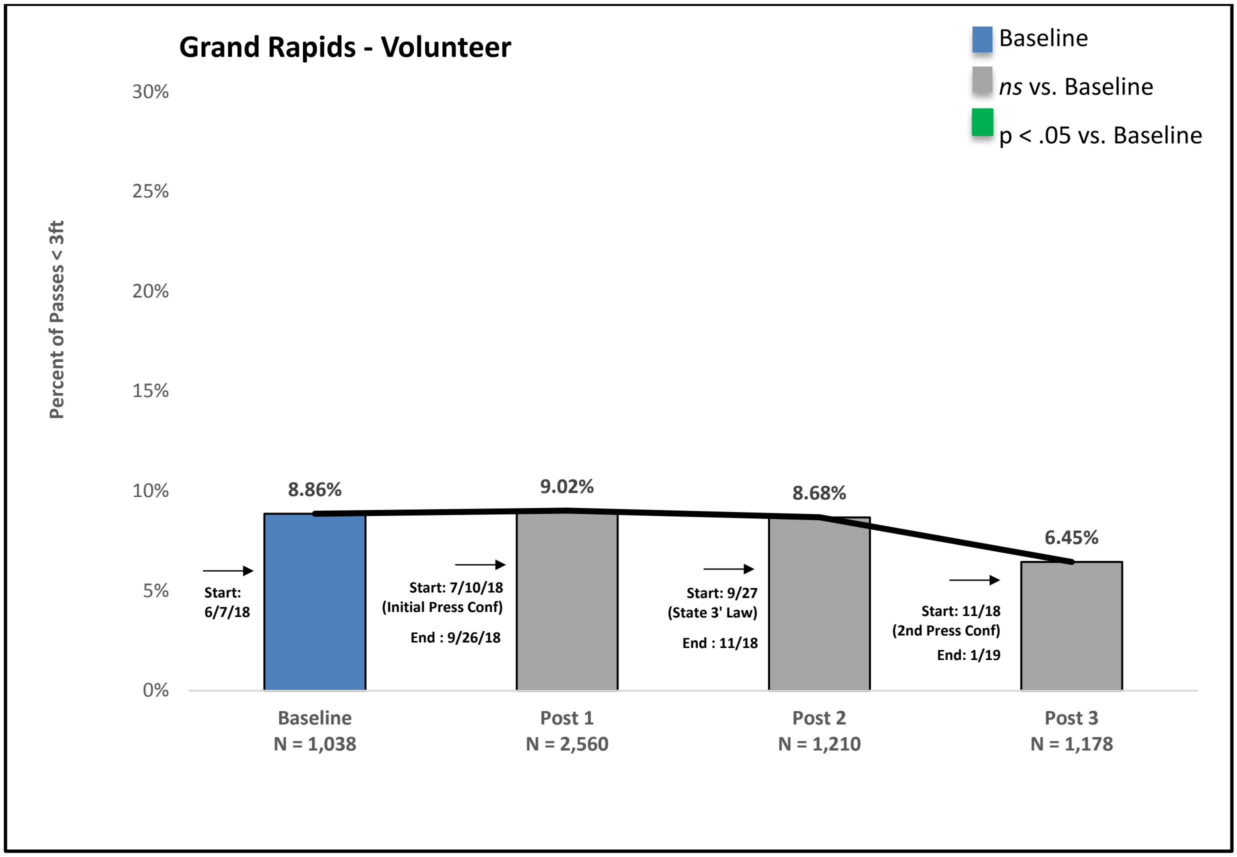
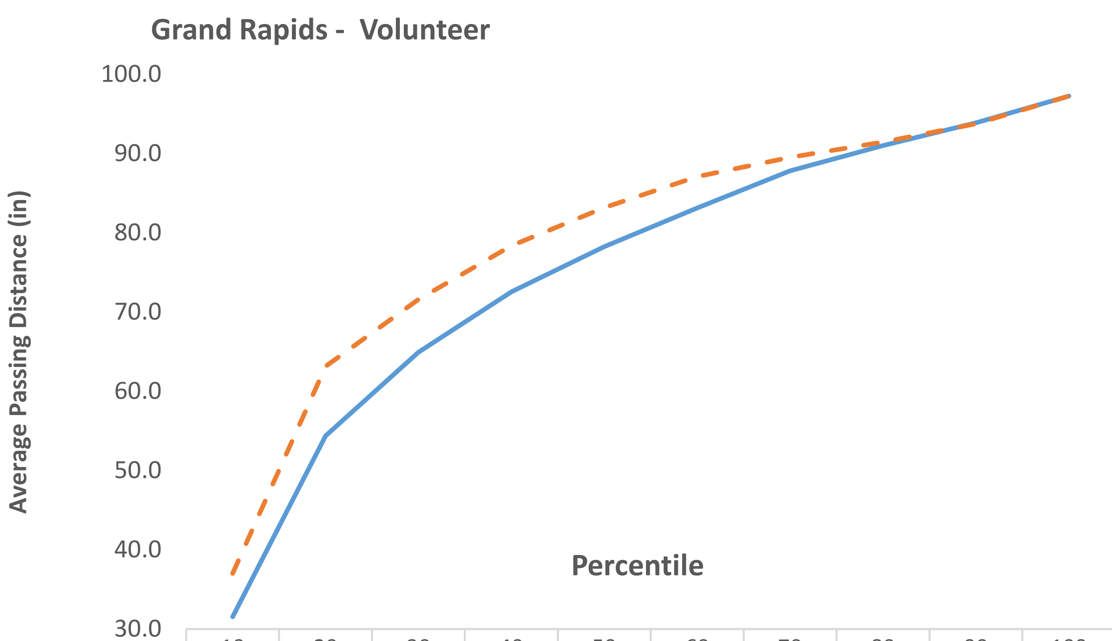


Figure 24. Grand Rapids Volunteer Passes < 3-ft

Grand Rapids—Percentile Distributions

Figure 25 shows the baseline and Post 3 percentile distributions for the average distance at which Grand Rapids volunteer riders were passed. The significant increase in average passing distance shown previously in Figure 25 consisted of notable changes from the 10th through the 70th percentiles. During baseline, both the 10th and 20th percentiles were passing at less than the legal requirement of 60.0 in. By Post 3, only the 10th percentile remained below the requirements of the Grand Rapids ordinance. The 50th percentile in the Post 3 wave was 23.2 in. above the legal requirement.



	10	20	30	40	50	60	70	80	90	100
Baseline	31.6	54.4	64.9	72.6	78.3	83.1	87.8	91.0	93.9	97.3
Post 3	37.0	63.2	71.6	78.4	83.2	87.1	89.5	91.5	93.8	97.3

Figure 25. Grand Rapids Percentile Volunteer Rider Average Passing Distance Percentiles

Feedback from Police, Data Collectors, and Involved City Personnel

In addition to the quantitative data reported above, inputs were obtained from the participating police officers, the data collection riders (volunteer and staged), and the involved city personnel concerning their thoughts and observations on the programs. These set a more complete context for the quantitative results presented above and represent an additional input to the discussion that follows.

The police at both test sites, as had their counterparts in Austin and Chattanooga, indicated that enforcing the passing laws using the ultrasonic measurement device was a manageable task. They also reported that it became increasingly difficult over time to find violators. Police from both sites indicated that they used the measurement device in much the same way they used radar for speed enforcement—the officer first judged whether a violation had likely occurred and then confirmed it with the device.

The police also reported that the two most common reasons stopped violators gave for committing the violation was that they did not see the bicycle or they misjudged the distance they were from the bicycle during the pass. A few drivers were belligerent, but most admitted their mistake and were apologetic. In the process of stopping and warning violators, the police in both cities found several people with outstanding warrants resulting in arrests for offenses such as driving with a suspended license, violating the open container law, multiple outstanding citations, and DUI/DWI. Since violation of the bicycle passing law created a reasonable probable cause for stopping the driver, these arrests were valid and added to the reasons the police liked the enforcement program.

The data collection bicyclists, both volunteer and staged, reported that the installation and use of the measurement device did not interfere with their normal riding style. They also believed that the presence of the measurement device on their bicycles did not affect the behavior of most passing motorists.

The participants in the HVE and evaluation activities, both civilian and law enforcement, reported virtually no negative response from the public. In Knoxville, where an extensive social media announcement of the program was mounted prior to the enforcement, there were some negative responses in social media, but no complaints were received in either city as the program unfolded. The data collection riders did not report a noteworthy change in either direction in the number of passing motorists who yelled disparaging remarks at them for riding on the roadway. Both the police and riders judged that motorists were giving them more room or at least were more aware of them after the program started. They did, however, note that violations remained uncomfortably close when they did occur.

All participants thought the enforcement program was worth continuing on a periodic or as needed basis. Suggestions included reprising it each spring coinciding with the start of the major bicycle riding season, reviving it from time-to-time in response to an increase in violations, or simply enforcing at random to maintain compliance. The police also suggested focusing more on single officer operations on more congested roads where the decoy officer on the bicycle can also make the stop and issue the warning or ticket. This is consistent with the evolution of the program in Chattanooga. It also helps compensate for the personnel shortages law enforcement agencies are reporting.

The Knoxville people in charge of the media component of the program thought the school flyers were critical and effective. They would have liked to add feedback signs to the program but could not get them scheduled within the time constraints of the evaluation. Grand Rapids personnel reported questions from the public about the meaning of the feedback signs indicating at least that they were noticed as they were in the Gainesville study by Van Houten et al. (2013).

Discussion

This study helped design and implement HVE programs in two cities, Grand Rapids and Knoxville. The HVE focused on driver compliance with laws that require giving bicyclists a minimum distance when passing (5 feet in Grand Rapids; 3 feet in Knoxville). The selection of this law as the focus of the study was based on an analysis of bicycle involved motor vehicle crash types also conducted under this study (Wright et al., 2019). The general approach followed that used by Van Houten et al. (2013) in Gainesville when testing an analogous HVE program directed at the law requiring drivers to yield to pedestrians in crosswalks at intersections. In both this and the Van Houten et al. (2013) studies, the focus was on motorist compliance to protect vulnerable road users—pedestrians and bicyclists.

Findings

The study focused on three research questions.

Can HVE Programs Increase Compliance With Bicycle Passing Laws?

The answer to this question is decidedly positive. The quantitative results augmented by the subjective impressions of the data collectors and police in both cities suggest that the HVE was effective at both sites in changing motorist behavior in the desired direction. Average passing distances increased, and there was convincing evidence that violations of the 3-foot (Knoxville) and 5-foot (Grand Rapids) passing requirements also decreased. The timing of the changes observed as well as the similarity of results from the two sites and anecdotal evidence from study participants strongly supports a conclusion that the measured changes were the direct result of the HVE programs.

Which Law Is Safer—3 Feet or 5 Feet?

The study results are equivocal on the point of which law is safer, but in a decidedly positive way. Both cities had baseline average passing distances that were much greater than their law required. It is unknown whether this makes them atypical without extensive data from other cities. Both also had undesirable baseline violation rates (4.98% of passes in Knoxville less than 3 feet and 13.39% of passes in Grand Rapids less than 5 feet from the staged rider data) that went down significantly (to 3.11% in Knoxville and 10.25% in Grand Rapids based on staged rider data). Thus, there is no clear-cut choice based on just response to the HVE.

It also can be argued that a violation under a 3-foot law is more of a safety risk than one under a 5-foot law. For example, based on staged rider data, a 10th percentile pass in Knoxville came within 35.4 in. of a bicyclist, whereas a 10th percentile pass in Grand Rapids was over a foot farther from the bicyclist at 47.6 in. Most bicyclists would prefer the extra margin and therefore favor the safety environment created by a 5-foot law. However, securing passage of a 5-foot law is difficult, as suggested by the failure of Grand Rapids and other Michigan cities to secure passage of a 5-foot State law. As mentioned earlier, Michigan did adopt a 3-foot State law that went into effect on September 27, 2018, and not a law with a 5-foot requirement or even a 4-foot compromise. Thus, there appears to be a trade-off between attempting to pass a 5-foot law that may have superior safety performance and a 3-foot law that still performs well and is easier to get accepted.

Does HVE Work Better With a 3-Foot or 5-Foot Law?

The addition of HVE should potentiate the safety benefits of either law. Based on the data collected in this study, the types and magnitude of responses in Knoxville and Grand Rapids were similar. No attempt was made to conduct a comparative statistical analysis because the differences between the data collection processes in the two cities precluded pooling the data. For example, the enforcement routes were different in number and nature as defined by the local safety experts. Nevertheless, even a cursory reading of the results above is sufficient to suggest that the general nature of the responses to the HVE efforts were similar in each city. Although some of the processes such as the choice of educational media were different, the objectives of the material development and dissemination were identical—to inform drivers of the existence of the law, to clarify their duties under the law, and to convince drivers that enforcement of the law was vigorous and the penalty (a fine and possible insurance increase) severe. Thus, similar HVE approaches should work to increase compliance with any bicycle passing law regardless of the clearance distance it prescribes.

Additional Findings

As would be expected, a larger effect was seen in the staged rider data than in the data from the volunteer riders likely because it was collected on the roads where enforcement actually took place. The significant increases in average volunteer rider passing distance in both cities is, nevertheless, noteworthy and suggestive of a generalization of the behavior change beyond the enforced roadways to the remainder of the roads in the test cities (or at least the extensive areas in which the volunteer riders rode). This spread of affect is similar to what was seen by Van Houten et al. (2013).

For half of the staged rides, an attempt was made to increase the conspicuity of the riders to try to make it virtually certain that the rider and bicycle were compelling visual targets that were highly likely to be detected by drivers. The rationale was that any statistically significant increased passing distance associated with highly enhanced conspicuity would provide some insight into the percentage of close passes caused by the failure of motorists who were actively searching to think about, search specifically for, detect, and recognize bicyclists. This attempt to promote a differential effect due to conspicuity in passes of the staged riders was not successful. This could have been because the experienced bicyclists who volunteered to serve as staged riders regularly wore clothing and accessories that already had sufficient conspicuity. Therefore, even though the addition of high-visibility vests, flashing LEDs, and fluorescent helmet covers theoretically increased conspicuity, the rider appearance before augmentation was already sufficiently conspicuous (see 0 above) to attract the attention of those motorists who could be affected (i.e., were sufficiently alert to respond to the stimulus presented).

The baseline data on average pass distance in both cities provides interesting insights into the prevailing pattern of driver behaviors when passing a bicyclist at least in more bicycle-friendly cities such as Knoxville and Grand Rapids. It is noteworthy that, regardless of data collection method (staged or volunteer) and city, the average passing distance was well in excess of 6-ft before the HVE programs even started. The typical baseline driver in Knoxville was giving more than double the passing distance required by law, and Grand Rapids baseline motorists passed an average of over a foot farther away than required. Nevertheless, many violations still occurred in both cities. It is not known whether these violations were committed by a relatively small number of incorrigible repeat offender drivers or whether they were spread broadly across the driving population. The fact that the average passing distance increased and the number of violations decreased in response to the HVE renders the answer to this question largely academic. Basically, coincident with the program, motorists in general apparently moved away from bicyclists as they passed, and the passes presenting the greatest risk (i.e., those closest to the bicyclists) also decreased.

Overall, the pattern of results of this study is similar to the one achieved by Van Houten et al. (2013) in changing the rate at which motorists yield to pedestrians in crosswalks. That effect proved persistent (Van Houten et al., 2017), which provides hope that at least some part of the current effects might endure.

Process Observations and Lessons Learned

As the study progressed, researchers observed the processes involved in site selection and liaison, HVE program development and implementation (enforcement and public information), and evaluation. The outcomes of the actions of the site and project personnel led to the development of some observations and lessons learned that can be beneficial in any future implementations of similar HVE programs.

Nature of the Violations

Theoretically, there are at least four reasons why drivers might violate a passing distance law:

- Ignorance of the law—Based on comments from drivers when police made stops, it is reasonable to assume that some drivers are unaware (or at least convincingly profess to be unaware) of the need to leave a minimum distance when passing a bicyclist and therefore pass closer than prescribed. Assessing the extent of this factor would have required a survey. It can be reasoned that although undesirable, close passes by an uninformed but vigilant driver who is aware of the presence of the bicyclist being passed do not represent a major compromise of safety.
- Misjudgment—Some drivers may be aware of the requirements of the law, see the bicyclist, and simply misjudge the distance at which they pass. The data from both the Volunteer and Staged rider collections contain an abundance of illegal passes that were close to the legally required passing distance. As with close passes due to not knowing the law, although undesirable, these are not extremely unsafe as long as a motorist is aware of and tracking the bicyclist and maintains adequate control of their vehicle.
- Bicyclist not detected—A bicyclist may not be detected by a passing driver for a number of reasons including low conspicuity, driver inattention, and driver distraction. If the bicyclist is not detected, then the passing distance is purely probabilistic, and some of the passes will be closer than desired. The bicyclist's back is to the oncoming vehicle, and the motorist does not see the bicyclist. This study attempted to see if eliminating (or at least minimizing) these types of detection failures by making staged riders hyper-conspicuous for some of their rides would be effective and therefore suggest the magnitude of any conspicuity component of the problem. No significant result was obtained. Either the conspicuity issue is not major or the expert bicyclists serving as staged riders in this study were already sufficiently conspicuous in their normal riding attire. Given the significant extent of distractions to which drivers are prone (e.g., Feng et al., 2019), the low conspicuity of many bicycle riders, and the conditions of this study, it

is reasonable to consider low bicyclist conspicuity as a possible contributing factor of the types of overtaking crashes of interest to this study.

- Deliberate—Bicyclists, including some of the Staged and volunteer riders in this study, report the belief that some motorists deliberately pass them too closely. They say some motorists even shout at them to get off the roads, and incidents such as this were captured by the video cameras during the staged rides. Although actual attempts to run down a bicyclist are likely rare, this type of deliberate harassment by passing too closely can lead to crashes by reducing safety margins.

It is not possible from the available data to determine the relative contribution of these various reasons to either the problem or the positive response to the HVE observed. The authors believe, however, that the experience amassed during this study tends to support the existence of these components of the problem and the applicability, to at least some extent, of HVE to each of them. The percentile data, particularly from the staged riders, also shows that some of the largest changes came from those motorists who passed closest to the bicyclists. Reducing the number of these close passes, regardless of how they are distributed across the hypothetical causes, certainly indicates a high possibility of crash reduction from HVE applications.

Enforcement

As part of this project, enforcement experience was examined from Austin and Chattanooga to provide background for the police in Grand Rapids and Knoxville. The development and application of the enforcement for the HVE in each of the test cities was then monitored. This led to several observations.

First, law enforcement needs a device that provides an objective, quantitative measure of the passing distance in order to mount an effective HVE campaign. Courts often accept evidence from such a device, and violators appear largely unwilling to challenge it when apprehended. The measurement device performed well in terms of equipment robustness and data accuracy and reliability. The involved police and data collection bicycle riders reported no systematic issues with the installation, use, or maintenance of the device.

Second, enforcement using bicycle patrol officers as decoy bicyclists along with other officers to stop the offenders appears to be an effective and relatively simple way to generate a reasonable number of interactions with offenders. The consensus among the law enforcement officers involved in the project was that motorcycle-mounted police were best for the chase duties because of their maneuverability in traffic at the speeds of motorists. However, participating officers also acknowledged that these motor officers are not available at many departments and that police in patrol cars could also be used effectively. The decoy officer can also double in the enforcement role in congested areas with many stop lights so that the officer acting as the decoy can catch up with the offending driver.

Third, there was a clear reluctance by police officers in the two test cities, and in Austin and Chattanooga before them, to issue large numbers of tickets. It was the judgment of the participating police officers that many, if not most, of the stopped offenders either did not know of the existence of the law or had committed an inadvertent violation. They therefore believed it was better policing to serve as educators, both with verbal admonitions and by passing out informational flyers, than to issue citations that would entail significant further work by the police, prosecutors, and the courts. They found this educational role to be fully consistent with community policing initiatives that most departments are emphasizing at this point.

Fourth, the choice of enforcement locations appears to be critical to the success of a program such as this. Both Grand Rapids and Knoxville routes provided the police and staged riders numerous violation encounters during the enforcement and data collection operations. Extending the enforcement activities to more areas of the cities would likely have expanded the reach of the program but would also have exacerbated the police personnel issues discussed below. In the future, programs not constrained by research timelines might profitably consider using more encompassing enforcement locations across their jurisdiction not only to increase the visibility of the enforcement activities and to ensure equitable enforcement but also to provide variety and interest for the participating law enforcement officers. In Austin, for example, the officer running the program rotates the enforcement location among the city's police districts and calls upon local district officers to participate. This appears to be one good approach, increases the personnel pool available to the program, and prevents officers from getting tired of the activities after the novelty wears off.

Fifth, law enforcement-related organizations report that the resources of many law enforcement agencies are stressed and, as a result, traffic-related activities have been de-emphasized. One of the consequences of this resource limitation is a reduction of bicycle patrols and motorcycle units. Thus, fielding the type of enforcement used in this program, particularly on a continuing basis, can be difficult. Nevertheless, police managers of the program activities in both cities indicated their intention to attempt to reprise the enforcement efforts when the time was opportune. They mentioned triggers such as the start of the bicycling season, bicycle-related events, a publicized bicycle/motor vehicle crash, and the opening of schools. Both sites indicated that the availability of the measurement devices provided by the project would help motivate the continuation of some level of enforcement. It is clearly also helpful if the locale has both an active, cooperative (non-confrontational) bicycle coalition as well as one or more law enforcement officers dedicated to improving bicycle safety. This certainly was the case in both Grand Rapids and Knoxville.

Overall, it appears that Grand Rapids and Knoxville each applied effective enforcement that was consistent with a community enforcement approach and was intended to utilize police in largely an educational role through traffic stops. The implicit motivation of the police was to focus on the groups of drivers who either were unaware of the requirement, did not concentrate sufficiently on maintaining enough passing distance, or harassed the bicyclists. The resulting efforts in both cities produced greater safety margins in the form of higher average passing distances and fewer violations of the locally applicable requirement.

Public Information

Each site developed its own public information component of the HVE program with minimal assistance from this project. Both sites initiated the HVE program with a press conference run by city officials. The conferences were widely covered by the local media and resulted in excellent publicity as described earlier. Both cities also developed a handout for police to use when they made enforcement stops and at any other appropriate opportunities. After these initial efforts, the two cities employed somewhat different media but with the common objective of informing drivers that:

1. drivers had to give sufficient space when passing a bicycle (3 feet in Knoxville; 5 feet in Grand Rapids);
2. by implication, drivers should be on the lookout for bicycles so they can control their passing distance;
3. if necessary to provide the required distance, drivers are permitted to cross the centerline when conditions are safe; and
4. an enforcement campaign was starting using an ultrasonic measurement device, and drivers could receive a ticket if they passed too close to a bicycle.

Grand Rapids used its existing Vision Zero web site (headsupgr.org) as a primary means of communication. As an early adopter of the Vision Zero approach, Grand Rapids had already made extensive use of this site to communicate safety information to drivers, pedestrians, and bicyclists. Adding information about the HVE campaign was therefore a natural extension of the communication being provided. Grand Rapids also used the lawn and feedback signs described earlier. Their existing contract public information agency participated and coordinated the Grand rapids efforts.

Knoxville uses city employees to develop and disseminate much of their safety public information. City graphics experts used the campaign objectives as a basis for the development of banners and an information sheet to be distributed as a take home for all students by the Knoxville Schools.

In the absence of data from a survey indicating exposure to the material as well as attitudes and knowledge before and after public information distribution, it is not possible to determine the extent to which the education efforts were received or to quantify their effects. Given the quality of the material, the extent of the distribution, each city's prior success with safety information programs, and the important role of the education component in HVE programs (e.g., Blomberg, 1982), it is likely that the Grand Rapids and Knoxville education efforts were effective.

One important lesson to be learned from the efforts at the two sites is the benefit of using existing media resources when mounting a new local HVE program. Both cities were able to act and react quickly to prepare and distribute the media they had selected. Development, production, and distribution capabilities were already familiar, and working relationships were well established. Rather than a "one size fits all" approach, the ability of each site to tap into past experience with organizations and people they trusted proved valuable to the success of the project.

Evaluation

In addition to observing the activities at both sites in as much detail as possible and debriefing the principal players at the end of the study, the major evaluation measure was bicycle passing distance as measured by the measurement device. It is important to emphasize that the device was designed and is marketed as a tool for enforcement not research. Nevertheless, with the minor modifications discussed earlier to add the PDL, it proved to be capable of also meeting the study's evaluation needs.

While the law is focused on the distance at which a vehicle passes a bicycle, reports from the bicyclists who served as data collection riders suggest that drivers may also respond by slowing and/or changing lanes if there are multiple lanes in the direction of travel. Detecting these behaviors would require the addition of a speed measurement capability (e.g., radar, lidar) and possibly one or more extra angles of video to the instrumentation suite for any future data collection activities.

The evaluation of the role of conspicuity and driver attention to the search for bicycles remains a complicated issue. The measurement paradigm used in this study of testing a high-conspicuity condition could work if the comparison condition were truly inconspicuous (or at least low in conspicuity). Even casual observations of bicyclists on the roadway suggest that many are wearing highly inconspicuous clothing (e.g., dark jeans and jackets) that can border on camouflage depending on ambient conditions. The experimental issue is the ethicality of placing experimenters or participants in live traffic without sufficient conspicuity. It is unlikely that an IRB would approve research with this approach unless it was in a well-controlled setting or simulator, which would have questionable validity. A realistic measure of the effect of conspicuity on passing driver position (plus speed and heading changes) likely can only be obtained in actual traffic. Thus, the definitive answer to this research question may not be practically obtainable. A detailed survey of drivers might be able to address some aspects of the relative contribution of conspicuity to the problem as well as the other potential reasons for close passes discussed above.

Limitations

Any experimental study, especially one conducted in the field, must be interpreted with full recognition of the limitations inherent in its design and execution. This study is no exception. The two study sites were recruited because of their sincere interest in bicycle safety and their knowledge of the prior work in Austin and Chattanooga. Thus, they can be considered as self-selected for the study. They are also similar in size at about 200,000 population. As such, they may not be representative of communities of all sizes in the US. They are also both bicycle friendly cities but cannot be proposed as representative of all locales with similar levels of interest in bicycle safety.

The collection of the primary evaluation measure for the study, passing distance, was dependent on the performance of the measurement device. This device appeared to perform appropriately and units were checked periodically throughout the study at known distances from objects to ensure they were working. Researchers also assessed the reasonableness of the distance readings when viewing the video recordings to develop the logic for deciphering passes in the recorded data. Therefore, researchers believe the data reported herein are a reasonable measure of the actual passing distances encountered during the study. As mentioned above, however, the lack of speed and lane position measures to augment the passing distance metric limited the ability to assess the full potential response of passing motorists to the presence of a bicycle before and after the HVE campaign.

A definitive safety assessment of HVE as applied to passing laws would require an examination of crash data with a focus on crashes in which the motor vehicle struck the bicycle while overtaking it. Tracking these types of crashes and reaching a statistical conclusion is difficult because they are relatively rare though serious events. A crash-based analysis was simply beyond the scope of the current research.

The enforcement bicycle-mounted police decoys and staged riders operated on the enforcement routes on different days. Both were equipped with measurement devices and video cameras on their bicycles. The volunteer riders also had measurement devices on their bicycles but not video cameras. Even though the bicycle types and attire of the data collection riders were markedly different than the police decoys, it is possible that the collection of the evaluation data also served as an additional intervention. The riders may have been mistaken for enforcement officers or simply could have served as a reminder of the HVE program. Program publicity at both sites did indicate that data collectors might be seen throughout the cities.

Despite these potential limitations and confounds, there is no apparent reason to reject this study's basic findings: (1) an HVE approach focused on laws requiring motorists to leave a specified passing distance when overtaking a bicyclist is possible using an accurate measuring device; (2) the application of HVE will result in improved motorist behavior as indicated by average passing distance and number of passes closer than prescribed by law; and (3) the enforcement and education components of HVE may have differing impacts on various segments of the driver population depending on the reason for their violation of the law.

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Appendix A: Police Flyers From Grand Rapids and Knoxville

This appendix contains warning flyers issued by the Grand Rapids and Knoxville Police Departments.

Grand Rapids Police Flyer

YOU JUST PASSED A BICYCLIST TOO CLOSELY!

You were stopped because the Grand Rapids Police Department measured you passing a bicyclist with less than the required 5-foot separation.

The law in Grand Rapids is clear:
*"The driver of a motor vehicle overtaking a bicyclist proceeding in the same direction shall allow the bicyclist at least a **five-foot** separation between the right side of the driver's vehicle, including all mirrors or other projections, and the left side of the bicyclist at all times."*

The City of Grand Rapids wants to make our streets safer for everyone.

- ✔ **Always look for bicyclists.**
- ✔ **Please give bicyclists at least 5 feet of separation from your vehicle when passing them.**

Save a life! Obey the Grand Rapids 5-Ft. Safe Passing Law.

If you received a ticket, you may reduce your cost by taking a court-approved education program.

CITY OF GRAND RAPIDS

An important traffic safety message from the City of Grand Rapids and the Grand Rapids Police Department.

GRAND RAPIDS POLICE

18-GRTS-0221-NHTSAEnforcementCard-010.indd 1 7/31/18 10:53 AM

(Front)

SAFETY TIPS

Think about people on bicycles when you are driving

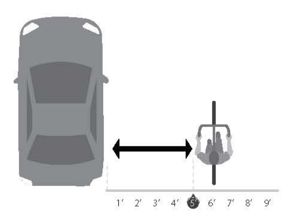
Give bicyclists at least 5 feet when passing them – move over when it's safe to do so, even if you have to cross the center line.

When you look for traffic, **think "bicycle."** You are more likely to see people on bicycles if you look for them.

When turning right, watch for bicyclists coming from behind – **look over your shoulder before turning** on red or green signals.

Obey the speed limit. You'll have more time to see and react to bicyclists.

Remember ... the law in Grand Rapids **requires drivers to leave at least 5 feet of space** when passing bicyclists.



Please help make Grand Rapids safer for every road user. Share this information with your friends, family and neighbors so we can make our streets safer for all of us.

Avoid a ticket and save a life!

GRDrivingChange.org

18-GRTS-0221-NHTSAEnforcementCard-010.indd 2 7/31/18 10:53 AM

(Back)

Knoxville Police Flyer

FRONT

City Ordinance 17-443 states "...a bicycle shall have all the rights and all the duties applicable to the driver of any other vehicle..."

City Ordinance 17-446 (State Law reference T.C.A. § 55-8-175) requires "the operator of a motor vehicle, when overtaking and passing a bicycle proceeding in the same direction on the roadway, shall leave a safe distance between the motor vehicle and the bicycle of not less than three (3) feet and shall maintain the clearance until safely past the overtaken bicycle."

City Ordinance 17-446 also states that cyclists shall ride as close as practical to the right hand edge except for several situations such as "...surface hazards or substandard width lanes that make it unsafe to continue along the righthand curb or edge."

BACK

KNOXVILLE
1791
POLICE

When you look for traffic, think bicycle. You're more likely to see bicycles if you actually look for them.

Avoid a citation and save a life!

Being courteous, alert, and patient will help ensure safe travels on our roadways.

Appendix B: Publicity Examples From Grand Rapids

This appendix contains examples of the messages and media stories from Grand Rapids.

TV Coverage of Police Training

(Video accessible as of September 8, 2021, at wwmt.com/news/local/west-michigan-police-train-on-distance-measuring-radar-to-enforce-bike-passing-laws)

WWMT WEST MICHIGAN NEWS WEATHER SPORTS I-TEAM CHIME IN WATCH

West Michigan police train on distance measuring radar to enforce bike passing laws

by Michael Krafcik | Newschannel 3 | Tuesday, July 10th 2018

PassingRadardevice.PNG

GRAND RAPIDS, Mich. — A local police department is one of two departments in the country using new technology to protect bicyclists on the road.

Cities like Kalamazoo, Portage and Grand Rapids have a 5-foot passing law and Michigan passed a 3-feet law. A new technology can show how far the distance is between a vehicle and a bicyclist.

Police officers spent the day circling several Grand Rapids corridors riding bicycles mounted with an ultrasonic radar with the capability to capture and display the passing distance between vehicles and bicyclists.

City of Grand Rapids Traffic Safety Manager Chris Zull said, "We've actually been riding around the city for about a month collecting pre-data with some of our incognito riders and now we're moving towards the police officers."

The officers are collecting the data in hopes of figuring out enforcement strategies and to help with a federally funded study. The researchers are looking at cities with 5-feet passing laws versus cities with a 3-feet passing law.

Dunlap and Associates President Richard Blomberg said, "We want to see what differences does the 5-foot law really move people farther away from the bicycle and will the enforcement get people in greater compliance."

Paul Selden, founder of Bike Friendly Kalamazoo, said, "By in large, Drivers are respectful of the new ordinances, but not everyone}

Selden said radar devices, which have been in use in cities like Chattanooga and Austin, could be beneficial in Kalamazoo.

He said, "It's got to be a goal that we all understand we're all into it together as a community and we're working together to make it safer for everyone."

The researchers in Grand Rapids believe their work analyzing driving behavior in West Michigan could one day impact national policy.

Blomberg said, "That's how a lot of our laws, like school bus stop laws and others have come into being, they got tested somewhere and worked well."

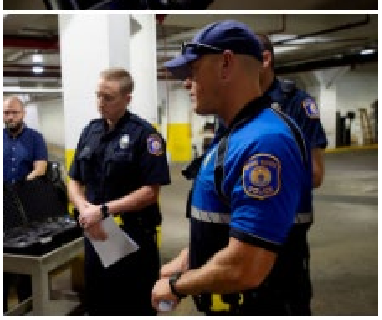
Newspaper Coverage of Police Training

(Story accessible as of September 8, 2021, at https://www.mlive.com/news/grand-rapids/2018/07/post_651.html)

Grand Rapids

Police using new devices to gauge distance between cars and bicycles

Updated Jan 30, 2019; Posted Jul 10, 2018



In Grand Rapids, there is a 5-feet wide ordinance for safe-passing standard for motorists. Knoxville, Tennessee, the other city picked for the research study, enforces a 3-feet ordinance.

However, Grand Rapids and Knoxville will be collecting data to help determine the effectiveness between the difference of 5-feet to 3-feet ordinances. The data collection for the research runs the length of the training period through October.

In the next several months, the Grand Rapids Police Department expects to have police officers out twice a week using the new devices. During that period through October, the study will be for educating the officers on the new technology and focusing on areas in Grand Rapids that need to enforce bicycle safety efforts, Noles said.

Twice a week, one officer will be on the bicycle with the device and another officer will be in a marked patrol car or a police motorcycle riding in designated areas through the city.

After the training and data collection through October, the plan is to use the devices to help encourage and enforce motorist-bicyclist safety in the city.

"It's more than just enforcement, it's more than just bicycle safety, it's actually a research project as well," Noles said. "We're going to make sure people know what the rule is before we start issuing too many tickets. Not to say they can't if there is a egregious violation for something that is reckless, they will issue a citation."

The intent is to have the bicycle officer, when there is a violation, call it out to the patrol car that is going to stop the driver. Police will be asking some questions for the research project and will be documenting the information, Noles said.

Violating the law will result in a city ordinance violation.

Noles said the goal of using the device is to continue to decrease the amount of bicycle-related crashes.

"One of the ways we can do that now is by doing some enforcement with a device that will actually be more than just the officer guessing how far away the car was from the bicycle," Noles said.

Lawn Sign

GIVE THEM 5-KEEP THEM ALIVE
FIVE
5
FEET
GRAND RAPIDS
POLICE
IT'S THE LAW
visionzerø
GRAND RAPIDS

Radio Coverage of Campaign Conclusion Press Conference

(Audio accessible as of September 8, 2021, at www.wgvunews.org/post/city-grand-rapids-praises-bike-safety-campaign-reducing-accidents)

WGVU Public Media PBS npr 88.5 FM Grand Rapids and 95.3 FM Muskegon ▶ Listen Live Donate

City of Grand Rapids praises bike safety campaign for reducing accidents

By DANIEL BOOTHE • NOV 19, 2018

Share
Tweet
Email

The City of Grand Rapids is praising its public education campaign for dramatically reducing the amount of accidents involving a bicycle and automobiles.

Named the Vision Zero campaign, city officials have made a concerted effort to educate drivers on two new ordinances in Grand Rapids. One requires drivers to stop for pedestrians at all crosswalks, the other mandates that motorists keep at least 5 feet between the right side of their vehicle and the bicyclist they are passing.

City officials say the new laws are making a difference. While just a few years ago Grand Rapids had Michigan's second-highest crash rate 2014, data released Monday showed zero bicycle-related fatalities were recorded in Grand Rapids from April 2018 through September 2018, while the 40 vehicle-bicycle crashes recorded during that six-month span were the City's lowest total since 2008.

Grand Rapids Mayor Rosalynn Bliss joined other to discuss the results at City Hall. A bicyclist herself, Mayor Bliss says the city is making significant progress when it comes to bike safety.

"I'm beyond pleased with the results," Bliss said.

According to results from a new City-commissioned survey, more than 9 in 10 people in Grand Rapids now know they must leave a minimum amount of space – 5 feet – between their vehicle and a bicyclist when passing.

Appendix C: Publicity Examples From Knoxville

This appendix contains examples of the messages and media stories from Knoxville.

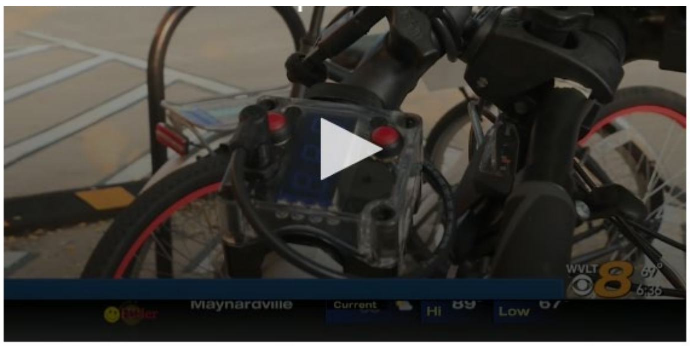
TV Coverage of Campaign Introductory Press Conference

(Video accessible as of September 8, 2021, at www.wvlt.tv/content/news/KPD-implements-new-device-to-enforce-Three-foot-493831211.html)

WVLT 8 KNOXVILLE, TN

News | Weather | Sports | As Seen on WVLT | Watch WVLT News

KPD implements new device to enforce Three Foot Law



By Sarah Jane Cobb | Posted: Thu 8:59 AM, Sep 20, 2018 | Updated: Thu 10:53 AM, Sep 20, 2018

KNOXVILLE, Tenn. (WVLT) -- Knoxville Police Chief Eve Thomas is implementing some new equipment the department hopes will keep bicyclists safe.

The "Minimum Three in Tennessee" campaign is designed to bring awareness to the Three Foot Law, which came into play back in 2007.

KPD bicycle riders will start using an ultrasonic radar, "C3FT," which helps officers "see three feet" between cars and bikes.

Amy Johnson is the founding officer for Bike Walk Knoxville and played a large roll in bringing the devices to law enforcement in the city. She explained it's against the law to drive too closely to a bike, but it's also hard for officers to enforce.

The department asked Johnson and a few other bike advocates to try the new equipment out, along with a GoPro camera and a tool to collect data.

"I've also captured, since I've been riding with this, a few verbal attacks that have been caught on camera. While the driver may have given three feet, the driver or passenger had some choice words for me and it all got caught on camera," she said, pointing to the GoPro on her handle bar.

According to the National Highway Traffic Safety Administration, 30% of bicycle deaths nationwide involve a motor vehicle overtaking a bicyclist.

In Knoxville, 10% of motor vehicle crashes occurred when the bicyclist was hit from behind.

"This isn't a 'cars versus bikes' issue. This is a 'safe versus unsafe on the roadways' issue. This is a great way to make our roads safer for everyone," Johnson said.

"City streets thrive when all of its users—motorists and bicyclists alike—adhere to the law," said Knoxville Police Chief Eve Thomas. "Traffic laws are established to save lives and keep all members of the community safe, so we're happy to get behind this campaign to raise awareness of the Three Foot Law."

Knoxville has twice been certified a "Bronze Bicycle Friendly Community" by the League of American Bicyclists, a designation equivalent with cities like Miami, Los Angeles and Baltimore.

KPD is offering a two week grace period, in which officers will give warnings if driving too closely to bicyclists.

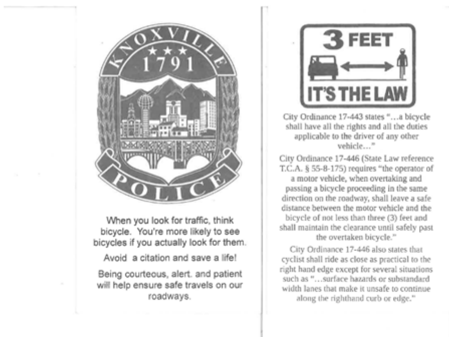
After October 4, drivers will be cited.

The three-feet law has been in place in Tennessee since 2007, a law Johnson says was passed because people are dying. Like in Kalamazoo, Michigan, in 2016 when five-bicyclists were killed and four more were injured after a pick up truck crashed into a group of them.

“A law that was passed because children are losing their fathers, wives are losing their husbands, husbands are losing their wives, workers are losing their colleagues, children are losing their parents,” says Johnson. “This is not a campaign to pit cars against bicycles, this is a campaign to educate and enforce the law that enables cars and bikes to effectively share the road.”

KPD will be using the next few weeks to promote the new campaign, after that it is a $50 ticket if you are caught violating the “Minimum 3 in Tennessee” law.

In the meantime, if you are pulled over within the next few weeks, the department is handing out these cards as a warning, complete with the entire Tennessee law code.



Newspaper Coverage of Campaign Introductory Press Conference

(Videos accessible as of September 8, 2021. at www.knoxnews.com/story/opinion/columnists/2018/09/19/dont-crowd-bicycles-its-safer-smarter-and-law-opinion/1340746002/)

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OPINION

Motorists, don't crowd bicycles — it's safer, smarter ... and the law | Opinion

Amy Johnson, Guest columnist Published 4:00 p.m. ET Sept. 19, 2018

(Photo: Submitted)

CONNECT TWEET LINKEDIN COMMENT EMAIL MORE

If you drive in Knoxville, you have no doubt noticed you are sharing the road with an increasing number of people on bicycles, and bike lanes are being added to city roads.

That's a good thing. It's good for health, good for the environment, frees up parking, saves on gas, and opens up biking as a viable option for all ages and abilities. The city has encouraged it. More bikes on the road means that drivers need education on how to safely pass bikes, so the roads can be safe for everyone and the misconception that riding bikes is unsafe can be avoided.

KPD can now enforce 3-foot law

A new interactive map from the Knoxville Regional Transportation Planning Organization shows the area's highest rate per capita of vehicle crashes that involve pedestrians or cyclists.

Fortunately, the city is taking steps to make it safer, through both education and by enforcing The Jeff Roth and Brian Brown Bicycle Protection Act, known as the three-foot law, a state statute and Knoxville ordinance that requires motorists to maintain a distance of three feet while overtaking a bicyclist. Police officers have been equipped with technology to better enforce this law, and all of us will be safer because of it.

The state statute is named in part for East Tennessean Jeff Roth. Jeff was a hard-working husband and father to three young children when he was killed in Blount County on U.S. 321 while riding his bicycle in 2006. He was killed by a driver who struck Jeff from behind.

Minimum passing distance laws are on the books in most states. Thirty states require at least three feet of passing distance when overtaking a bicycle. So it's not just common sense, it's the law and has been the law in Tennessee since 2007.

Violations frustrate bicyclists

Since these minimum passing distance laws were first enacted, the problem of actually enforcing these safety statutes has caused frustration for bicyclists and their loved ones. Violations of the law have been difficult to prove in cases where a car doesn't come into contact with a cyclist, but rather passes dangerously close in violation of the law. As a result, bicyclists have grown frustrated with law enforcement agencies who have not used the law, and motorists have remained unaware of the three-foot requirement or the safety reasons behind it. Thankfully, the city and KPD are acting to change that.

Since GoPro cameras burst onto the scene, some cyclists have been riding equipped with cameras to document any unsafe passes and capture identifying information of the offending vehicles. Wittier cyclists, who don't have aerodynamics in mind, have taken to riding with swimming pool noodles mounted on the back of their bicycles to create some space between them and passing cars. Cyclists can also invest in bicycle lights that have front- and rear-facing cameras.

But things are getting even better. Knoxville officers will now have C3FT enforcement technology on some units. This technology was actually developed by a police officer for police officers. The technology is reliable, accurate and straightforward, and it will save lives and enable officers to help keep bicyclists safe by displaying with immediate accuracy the distance between cars and bikes.

Obey law or get a ticket

KPD has presented our community with an opportunity to be an example for the rest of the country. With this new technology, the three-foot law has the potential to become as commonplace in a car driver's mind as is obeying the posted speed limit to avoid a speeding ticket. Driver education on how to safely pass a cyclist begins with educating them on and enforcing the three-foot requirement. Drivers should pass when there is no oncoming traffic.

This video is the result of a research effort by faculty and students at the University of Tennessee to document and study the hazards associated with railway grade crossings on bicycle safety (published in the Journal of Transport & Health).

Humanizing safety laws should serve as a deterrent, but having the ability to enforce safety rules with reliable technology is a comfort for those of us who are vulnerable on the roadways.

Cars and bikes can share the roadway and peacefully co-exist. It takes a little effort by all of us. There's nothing I'd like more than to stop getting calls from the families of people who've had a loved one hurt by a motorist while riding their bike.

Amy Johnson is a Knoxville native, bike rider, founding officer and secretary of Bike Walk Knoxville, and lawyer who specializes in bike-related accidents and law. Her firm is Bike Law Tennessee, and she can be reached at amy@bikelaw.com.

(Story accessible as of September 8, 2021, at www.knoxnews.com/story/news/2018/09/20/bike-cycling-dangerous-drivers-knoxville-police/1372817002/)

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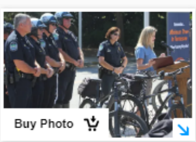
How this device could keep Knoxville cyclists safe and result in fines for motorists

Ryan Wilusz, Knoxville Published 7:27 p.m. ET Sept. 20, 2018

So you want to bike to work? Here are some rules to keep you safe while you do it.



(Photo: Ryan Wilusz/News Sentinel)

The hairs on your arms stand up and you're startled by the wind — strong enough to knock you down.

Your body vibrates, your head vibrates and you feel a sudden flash of fear.

That's what it feels like to be passed by unsafe motorists while riding a bicycle, said Amy Johnson, a Tennessee attorney for the Bike Law Network.

Now, the Knoxville Police Department is looking to crack down on these dangerous drivers more effectively thanks to some newly acquired technology.

On Thursday, KPD unveiled their new C3FT devices, which will be attached to two police bicycles to measure the distance between the bikes and passing cars.

A device to keep cyclists safe

The device is pronounced "see three feet," referring to a common bike law.

Tennessee's law has been on the books for years and requires drivers give bicycles at least three feet of space when passing.

"It's always been an important thing," said KPD Lt. Sammy Shaffer of the special services unit. "But officers often had to rely on a guesstimate."

This device, called a C3FT and prounced as "see three feet," will be used on two Knoxville Police Department bicycles to measure the distance between the bikes and passing cars. *(Photo: Ryan Wilusz/News Sentinel)*

The C3FT, which attaches to the officers' handlebars, emits a signal when a car passes, Shaffer said.

"If something breaks that signal, it gives a readout on the device of the distance," he said.

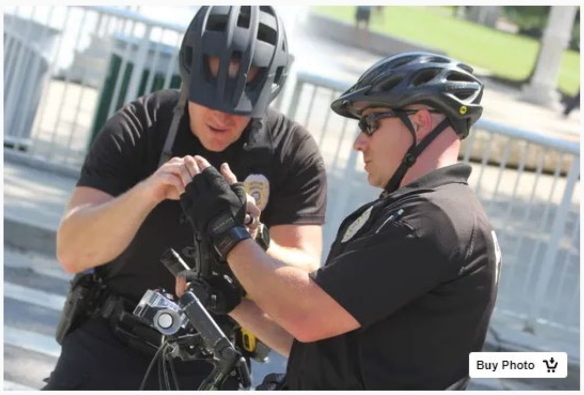
Like KPD, civilian cyclists also received two C3FT devices through a grant. They have been gathering data on popular bike routes for months now, Shaffer said.

Terry Haywood, one of the civilian cyclists, said there were a few close calls during the data gathering process.

"But I've been hit a few times before," he said. "It is scary. I've been hit from behind, I've been broadsided — both of them people that just did not see me at all."

Haywood said most drivers on the road tend to be careful. But depending on the length of the trip, Johnson said, cyclists experience one or two passes that make them fearful every time they go out.

Sometimes that fear is truly legitimate. According to National Highway Traffic Safety Administration data, 817 cyclists were killed in crashes in 2015. Roughly 45,000 people were injured.



Officer Thomas Turner (left) helps Officer Steve Kaufman get a reading from the C3FT device following a demonstration at World's Fair Park on Sept. 20, 2018. *(Photo: Ryan Wilusz/News Sentinel)*

These are the types of people Johnson represents, and she briefly shared some of their stories Thursday.

"Children are losing their fathers, wives are losing their husbands, husbands are losing their wives," she said. "I deal with this stuff day in and day out. I've become desensitized, but I had a wave of emotion hit me because I can put faces to the scenarios."

In Knoxville, 10 percent of bicycle crashes involving motor vehicles happen when the cyclist is struck from behind, according to a KPD press release.

What drivers need to know

The devices were officially put to use following the unveiling ceremony. Drivers will receive warnings for the first two weeks before getting fined, the release said.

The three-feet law has both city and state versions that drivers could face. Breaking the city law results in a $50 fine plus court costs, Shaffer said. Breaking the state law is a Class C misdemeanor.

This is the warning that will be given to drivers for not obeying the "three feet law" when passing cyclists in Knoxville. *(Photo: News Sentinel)*

Police Chief Eve Thomas said drivers should know that bicyclists do not have to travel in bike lanes.

City Ordinance 17-443 states that "a bicycle shall have all the rights and all the duties applicable to the driver of any other vehicle." Basically, they can drive in lanes just like cars.

But Haywood said cyclists face many dangers motorists might not think about.

"The biggest obstacles, in addition to traffic, are things in the road that wouldn't affect a car, like potholes and rocks," he said. "I'm hopeful that some of this publicity will make people aware we're sharing the road and can get along."

A new interactive map from the Knoxville Regional Transportation Planning Organization shows the area's highest rate per capita of vehicle crashes that involve pedestrians or cyclists.

But if you're anxiously waiting behind a cyclist and feel the urge to pass, drivers should also know that it's OK to cross the double yellow line if it looks safe, Shaffer said. It's like crossing the double yellow line to avoid hitting an obstacle in the road, he said.

Shaffer said KPD hopes these new devices will help keep existing bicyclists safe but also encourage motorists to consider cycling as an option.

"Not only is it better in health, but it's better on the environment and cuts down on our carbon footprint," he said. "It also helps a lot of time with congestion — both parking and traffic."

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