Accident Analysis and Prevention 50 (2013) 312–322

Contents lists available at SciVerse ScienceDirect

Accident Analysis and Prevention

journal homepage: www.elsevier.com/locate/aap

Safety countermeasures and crash reduction in New York City—Experience and lessons learned

Li Chen[a,*], Cynthia Chen[b], Reid Ewing[c], Claire E. McKnight[a], Raghavan Srinivasan[d], Matthew Roe[e]

[a] Department of Civil Engineering, Steinman Hall, City College of New York, New York, NY 10031, USA
[b] Department of Civil and Environmental Engineering, University of Washington, Seattle, WA 98195, USA
[c] Department of City and Metropolitan Planning, University of Utah, Salt Lake City, UT 84112, USA
[d] Highway Safety Research Center, University of North Carolina, Chapel Hill, NC 27599, USA
[e] Division of Traffic Operations, New York City Department of Transportation, New York, NY 10041, USA

ARTICLE INFO

Article history:
Received 3 October 2011
Received in revised form 21 April 2012
Accepted 2 May 2012

Keywords:
Traffic safety
Safety countermeasures
Quasi-experimental design
Before-after study
Comparison group

ABSTRACT

Traffic fatalities and injuries constitute a major global public health problem and the United States has fallen behind other developed countries in traffic safety. Yet, New York City stands out as a traffic safety model in the nation with its low fatality rate and its significant reductions in various types of crashes. This study develops a safety framework that considers three principal axes that affect crashes: why, who, and where. While "why" concerns exposure, conflict, and speed, "who" and "where" consider the unique characteristics of the road users and the surrounding built environment. Grounded in this safety framework, the effectiveness of 13 safety countermeasures and street designs installed in New York City between 1990 and 2008 are evaluated using a two group pretest–posttest design. The potential regression-to-the-mean problem is addressed by applying the ANCOVA regression approach. The results show that signal related countermeasures that are designed to reduce conflicts: split phase timing, signal installations, all pedestrian phase, and increasing pedestrian crossing time, reduce crashes. Traffic calming measures, including road diets, are also found to have significant safety benefits. Countermeasures that are designed to alert drivers' cognitive attention, such as high visibility crosswalks and posted speed limit reduction signs, appear to have a lesser effect. The various safety countermeasures implemented in New York City considered all three important dimensions in the safety framework: why, who, and where. The study suggests these strategies are likely to contribute to the large reductions in crashes in New York City. We also demonstrate that a rigorous quasi-experimental design can be readily deployed in transportation safety evaluation studies.

1. Introduction

Road traffic fatalities and injuries constitute a major global public health problem—each year nearly 1.2 million people die from road collisions and as many as 50 million are injured on roads worldwide (Peden et al., 2004). Despite a continuing trend of declining crashes over the last decade (National Highway Traffic Safety Administration, 2010), the United States lags behind Northern Europe and such auto-reliant countries as Australia in traffic safety, both in terms of traffic fatalities per capita and per vehicle miles traveled (Peden et al., 2004).

Among the major cities in the U.S. with a population exceeding 250,000, New York City stands out as a traffic safety model. New York City has a lower traffic fatality rate than the national average (see Fig. 1) and other large American cities—in 2007, the number of traffic fatalities per 100,000 persons is 3.3, which is a quarter of the national rate and less than half of those of other big cities such as Chicago (6.85) and Los Angeles (7.74) (New York City Department of Transportation, 2008b).

Between 1990 and 2009, the traffic fatality rate in New York City declined much faster than the national rate (Fig. 1). Crashes of all types and severity levels, including total crashes, vehicle crashes, pedestrian crashes, bicycle crashes, and crashes with injuries and fatalities, have been decreasing (Chen et al., 2011). During the same 20-year period, the population in New York City increased by about 15% (U.S. Census Bureau, 2009), accompanied by increases in total transit ridership, subway ridership, and bus ridership (The City of New York, 2011). During the same time period, dozens of distinct traffic safety treatments have also been implemented throughout the city.

What experience and lessons can be learned from New York City's safety program? Did the implementation of those traffic

* Corresponding author at: Department of Civil Engineering, Steinman Hall, City College of New York, 160 Convent Avenue, New York, NY 10031, USA.
Tel.: +1 646 2865387.
E-mail address: lichen.cuny@gmail.com (L. Chen).

0001-4575/$ – see front matter
http://dx.doi.org/10.1016/j.aap.2012.05.009

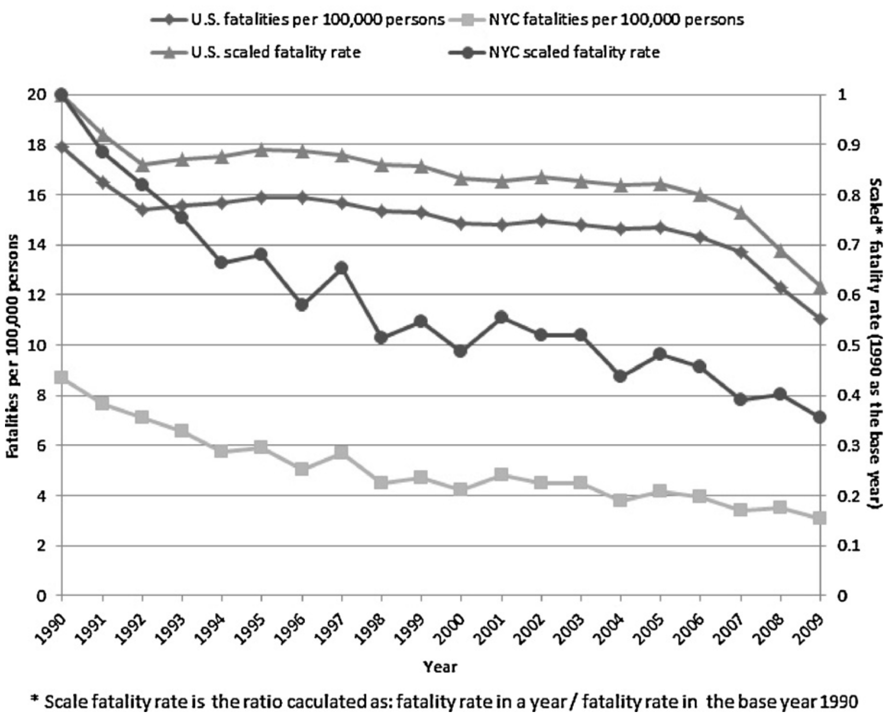

Fig. 1. Fatality rates in the U.S. and NYC between 1990 and 2009.

safety measures play an important role in crash reduction? To answer these questions, we first describe the unique features that characterize New York City's transportation system and its road users. This is followed by a presentation of a safety framework under which we evaluated 13 safety countermeasures implemented in the city during the past two decades. Drawing upon this framework and our findings about the effectiveness of these 13 countermeasures, we discuss New York City's experience with traffic safety countermeasures and some lessons that can be learned.

2. Safety countermeasures in New York City

2.1. Multi-modal transportation system in New York City

Four of the five boroughs in New York City have been rated the most compact counties in the United States, with the exception of Staten Island (Ewing et al., 2003a). These counties are more compact than the central counties of San Francisco, Philadelphia, Chicago, and all other metropolitan areas in the U.S. Compactness, and its antithesis, sprawl, can be defined in terms of various density measures and street connectivity measures. Compactness has been linked to travel, health, and other positive outcomes in many studies (Ewing et al., 2003b, 2008; Doyle et al., 2006; Joshu et al., 2008; Ewing and Dumbaugh, 2009; Lee, 2009).

New York City's transportation system is truly multi-modal, comprising a large road network of different functional classes (expressways, arterials, collectors and local streets), bridges and tunnels, an extensive public transportation network of subway, commuter rail, bus and ferry, and an ever-expanding bicycle network and facilities (on-street bike lanes, separated bike paths, shared-use paths, bike racks and other bicycle facilities). Travel in New York City is characterized by high shares of public transit, taxi, and non-motorized modes: close to 70% of commuting trips are made by public transit, walking or bicycling. New York City's street network is substantially finer-grained than many cities that were developed later, and are used by high volumes of mixed traffic, including private automobiles, taxis, trucks, buses, bicycles, motorcycles, and emergency vehicles. Furthermore, the high density and diversity of population and land use in New York City add to the complexity of street traffic, as people from different cultures may behave differently in driving, bicycling or walking (Lawson and Edwards, 1991; Haworth et al., 2000; Dobson et al., 2004; Chen et al., 2012). In addition to approximately 8.3 million residents and hundreds of thousands of commuters, New York City also attracts almost 50 million foreign and American tourists each year (NYC & Company, 2011). These tourists bring with them their own travel habits, as drivers, transit riders, pedestrians, and bicyclists. Surprisingly, such complexity did not lead to more crashes in the city; rather, as noted earlier, crashes have been declining. It is our hypothesis that the various safety countermeasures implemented in the city play an important role in the declining trend of crashes. More importantly, the selection of the safety countermeasures takes into account the causes of a crash as well as its surrounding environment and road users.

2.2. Safety countermeasures in New York City

During the past 20 years, New York City Department of Transportation (NYCDOT) has installed different types of safety countermeasures and design treatments at more than 10,000 locations (either roadway segments or intersections) to improve the safety of motorists, cyclists, transit passengers and pedestrians of all ages. The countermeasures evaluated in this paper are distributed throughout the city: Queens tops the list with 56%, followed by Brooklyn (17.5%), Manhattan (10.8%), Bronx (10.2%), and Staten Island (5.5%). The *Street Design Manual* (New York City Department of Transportation, 2009b) developed by NYCDOT provides a conceptual guide for planning many types of safety countermeasures.

In this study we evaluated 13 safety countermeasures in New York City. Table 1 shows detailed descriptions of the 13 selected safety countermeasures: seven are intersection-based and six are segment-based. The 13 countermeasures were selected because they had adequate sample sizes (Chen et al., 2011). Some measures