Exploring the Impacts of Safety Culture on Immigrants' Vulnerability in Non-motorized Crashes: A Cross-sectional Study

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ABSTRACT *Pedestrians and cyclists are a vulnerable group of road users. Immigrants are disproportionately represented in pedestrian and cyclist crashes. We postulate that the mismatch in safety culture between countries of their origin and the USA contribute to their vulnerability in pedestrian and cyclist crashes. Over time, the differences may disappear and immigrants' traffic behavior gravitates toward those of native-borns. We describe this process as safety assimilation. Using the pedestrian and cyclist crash database in New York City between 2001 and 2003, we examined the effects of foreign-born population, their countries of origin, and time of entry into the USA on census tract-level pedestrian and cyclist crashes. We find that neighborhoods with a higher concentration of immigrants, especially those from Latin America, Eastern Europe, and Asia, have more crashes. Our results also exhibit a pattern of the hypothesized safety assimilation process. The study suggests a higher level of vulnerability of immigrants to pedestrian and cyclist crashes. We propose that targeted policies and programs need to be developed for immigrants of different countries of origin.*

KEYWORDS *Pedestrian and cyclist crash, Immigrants, Safety assimilation, Safety culture*

INTRODUCTION

Walking and cycling are healthy and environmentally friendly modes of transportation compared to automobile usage. Yet, it is undebatable that pedestrians and cyclists are more vulnerable than motorists in traffic collisions. Nationwide, a total of 4,378 pedestrian and 716 cyclist deaths were reported in 2008,^{1,2} accounting for 13.7% of motor vehicle collision fatalities. Another 69,000 pedestrians and 52,000 cyclists were injured in traffic crashes in 2008.³

Minorities are disproportionately represented in traffic fatalities and injuries. In 2001, 69% of the nation's population were non-Hispanic whites, and yet only 60% of the pedestrian deaths for which ethnicity was known were non-Hispanic whites.⁴ In contrast, African-Americans were involved in more than 20% of the total pedestrian deaths, though they represented only 12% of the population. Likewise, 13.5% of the pedestrian deaths involved one or more Latinos, while they accounted

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for 12.5% of the total US population.⁴ The existing literature shows even after other confounding factors such as income and exposure are accounted for, the disproportional representation of minorities in crashes remains.

The population of minorities has been on the rise for the past decade. In some cities such as San Francisco, the previous minority population has now become the majority. Immigrants are a major source of the minority and general population growth in this country. The population of first-generation immigrants living in the USA has increased from 9.6 million in 1970 to about 38 million in 2007.⁵ A 2008 report from the Pew Research Center projects that due to immigration, the Hispanic population will rise from 14% in 2005 to 29% by 2050; the Asian population is expected to more than triple by 2050.⁶ The combination of a higher level of risk of immigrants to be crash victims when walking and cycling and the projected growth in immigrant population could lead to an elevated level of non-motorized crashes involving immigrants in the future.

When immigrants came to this country, they brought with them the attitudes and perceived social norms of their countries of origin toward risky traffic behavior as pedestrians and cyclists, as well as habits and expectations of behavior when driving. These "attitudes, beliefs, perceptions, and values that (people) share in relation to traffic safety" are broadly referred to as (traffic) safety culture.⁷⁻¹⁰

The mismatch in safety culture between immigrants and native-borns is hypothesized to explain the differential in crash risk between the two groups both as pedestrians/cyclists and drivers. As pedestrians and cyclists, immigrants may be more likely to engage in risky traffic behavior, such as jaywalking, than the native-borns, if the society in which they resided prior to the arrival in the USA approves such behavior, which in turn reinforces their attitude that behavior like jaywalking is fine. As drivers, immigrants can be either more or less likely to watch for or yield to pedestrians and bicyclists than the native-born drivers.

In this study, we explore the role of safety culture in census tract-level pedestrian and cyclist crashes in New York City. In New York City, there has been a long-time suspicion that immigrants are particularly vulnerable in non-motorized crashes because of the different safety cultures they brought with them.¹¹⁻¹³ Two of the five most dangerous locations for pedestrians are in Chinatown and these two locations consistently have high pedestrian fatality rates. In contrast, Yorkville, a historic German immigrants' neighborhood, where there is still a substantial number of immigrants coming from Germany, has fewer non-motorized crashes than the city-wide average and this observation appears to be consistent with the finding that US pedestrians and cyclists are two to three times more likely to be killed in traffic crashes than their German counterparts.¹⁴

We evaluate three hypotheses: first, census tracts with more immigrants experience more pedestrian and cyclist crashes; second, census tracts with immigrants of different countries of origin may experience different degrees of pedestrian and cyclist crashes, due to the differences in the safety culture brought from countries of origin; and third, over time, immigrants undergo a safety assimilation process, as they become more exposed to the attitudes and the social norms in this country. Thus, everything else being equal, census tracts with more early immigrants will have fewer crashes than those with more new arrivals.

BACKGROUND

Most of the safety literature pertinent to immigrants relate to the relatively high level of vulnerability for minorities as pedestrians. Kim and Palmisano showed that the risk of injury was significantly higher among African-American children than other

children;¹⁵ other studies concluded that more crashes occurred in census tracts with higher percentages of non-White residents.^{16,17} Lawson and Edwards reported that young Asian pedestrians in Birmingham, UK, were twice as likely as young non-Asian pedestrians to be seriously injured.¹⁸ Dobson et al. found that although immigrant drivers were in general no different from native-borns in their risk of being involved in crashes, immigrant pedestrians were definitely more likely to be involved in crashes as well as to be severely injured.¹⁹

The association between ethnicity and crash rate is commonly considered as being related to their relatively low socio-economic status (SES), risky traffic behavior as pedestrians/cyclists, or substance usage: minorities are more likely to have low SES or live in a deprived area; use transit and non-motorized modes more than native-borns; and are more likely to be involved in injury or death due to the use of alcohol or illegal drugs.^{20–23} Yet, the effect of ethnicity remains after controlling these factors. Cottrill and Thakuriah explored the relationship between pedestrian–vehicle crashes and areas with high low-income and minority populations.²⁴ A significant area effect remained after controlling a variety of environmental factors including socio-economic and demographic attributes (e.g., income, percent of population who speak no or little English), exposure to vehicle traffic (e.g., traffic volume and road length), land use diversity, accessibility by transit, school quality, and crime rate. Steinbach et al. studied road injuries in London, and found that Black children had higher injury rates as pedestrians than White or Asian children, and living in a less-deprived area did not “protect” them from being exposed to a higher level of risk.²⁵ They discussed that ethnic differences in injury rates were likely to result from having different attitudes toward risky traffic behavior. Our first two hypotheses are based on the differential roles that safety cultures of countries of different origins play in census tract-level non-motorized crashes.

Although the traffic safety literature has not paid much attention to immigrants, there exist a number of studies on immigrants’ travel behavior. Smart found that immigrants were twice as likely to cycle as native-borns.²⁶ He pointed out that even after controlling for income, neighborhood characteristics, and other factors, a large and significant “immigrant effect” remained. Other research suggests that new immigrants were more likely to carpool, ride public transportation, and walk,^{27–30} however this difference diminished over time. A process of “transportation assimilation” characterizes this phenomenon—immigrants’ travel behavior gravitates toward those of native-borns until eventually they are no different from each other.²⁷ In this study, we hypothesize a “safety assimilation” process, during which immigrants’ traffic safety behavior gradually assimilates to that of native-borns over time, and eventually the two groups behave similarly on the road and are associated with a similar level of crash risk.

METHODOLOGY

Dependent and Independent Variables

The dataset used in this study contains all reported pedestrian- and cyclist-involved crashes that occurred between 2001 and 2003 in New York City. New York City comprises five boroughs: Manhattan, Bronx, Brooklyn, Queens, and Staten Island. It has 2,216 census tracts. In total, there are 31,931 pedestrian crashes and 8,941 cyclist crashes during the study period. The census tract-level correlation coefficient between pedestrian crashes per tract and cycle crashes per tract is 0.75, which indicates a high level of consistency of crash patterns between the two types of crashes.

Our dependent variable is the number of pedestrian and cyclist crashes per census tract.* All crash locations were geo-coded to either intersections or mid-blocks and matched to a roadbed street map. Most crashes were identified as occurring in a single census tract and about 6% of them happened on boundaries between two census tracts. These crashes were assigned equally to both tracts.

We construct nine independent variables corresponding to the three hypotheses. We refer those variables as *immigrant population characteristics*. The variable, the percentage of foreign-born population, is used to test the first hypothesis, which states that everything else being equal, census tracts with more immigrants have more pedestrian and cyclist crashes. Four variables are constructed for the second hypothesis: the percentages of foreign-born population that came from East Europe,[†] the rest of Europe, Asia, and Latin America.^{31,32} We expect that tracts with immigrants from different countries experience different levels of crashes. For the third hypothesis, we test five categories of years of stay since first entry in this country: 0–5 years, 6–10 years, 11–15 years, 16–20 years, and 21 or more years, where the last category serves as the reference. We expect that the magnitude and the significance of the estimates associated with these variables decline as the number of years of stay increases.

In addition, we include three categories of independent variables—exposure, roadway design, and socio-economic status—to account for confounding factors.[‡] Under the “exposure” category, we capture daytime population density, land use mix and service attraction, transit facilities, traffic characteristics, and special locations (e.g., Central Park). Daytime population density is calculated as the sum of employment and residential population minus the number of residents who live and work in the same census tract (to avoid double counting) divided by the area size of the census tract. In general, we expect a positive effect for these variables and some (e.g., daytime population density) may have a nonlinear effect, which is accounted for by including a squared term. Under the “roadway design” category, we account for the share of one-way streets and density of intersections with four or more legs. Under the “socio-economic status” category, we include variables related to poverty status, age, marital status, and minority status of the population in the census tract.

Data of different sources were used to calculate the above variables. Crash data was provided by the New York State Department of Motor Vehicles (NYS DMV) based on police reports. Land use information was calculated based on the MapPluto shapefile provided by the New York City Department of City Planning (NYC DCP).³³ Roadway information was calculated from NYC DCP's LION Street shapefile. New York Metropolitan Transit Authority (NYMTA) provided information on transit facilities and ridership data. Data on socio-demographics and employment was obtained from the Census.³² Table 1 lists each of the independent variables used in the study and the corresponding data source.

*Some studies use crash rate, i.e., number of crashes per population as the dependent variable. This specification indirectly assumes a linear relationship between number of crashes and population size, which may not be necessarily true. Instead, we use the number of crashes as the dependent variable—and control the impact from population by having daytime population density and its quadratic term as independent variables in the regression models.

[†]The US Census 2000 divided Europe into four parts: northern, western, southern, and eastern. The eastern part used by Census appears to comprise that section commonly referred to as “Eastern Europe.” We refer to the other three parts as “the rest of Europe.”

[‡]These variables were selected to minimize multiple correlations among them. Only those with variance inflation factor less than 10 were chosen.

TABLE 1 List of variables and corresponding data sources

Name	Label	Sub-category	Category	Data source
Num_Crash	Number of crashes at census tract level			
DaytimePopDen	Daytime population density (in 10 ³ /mile ²)	Daytime population density	Dependent Exposure	NYS DMV Census
DayPopDenSq	Square of the above			
SumRes	Residential land use floor area (in mile ²)	Land use mix and service attraction		NYC DCP
ResSq	Square of the above			
SumRetail	Retail land use floor area (in mile ²)			MapPluto 2005
RetailSq	Square of the above			
EmpAttr	Percentage of employment in occupation categories that attract visitors			Census
EmpAttrSq	Square of the above			
NumBusStop	Number of bus stops	Transit facilities		MTA 2005
BusStopSq	Square of the above			
Per4Lane	Percentage of street miles that have four or more lanes	Traffic characteristics		NYC DCP LION 2006
CentralPark	Indicator for Central Park (=1 if the census tract contains part of the Central Park and 0 otherwise)	Special locations		NYC DCP MapPluto 2005
Schools	Number of schools			
PerOneWay	Percentage of street miles that are one-way		Roadway design	NYC DCP LION 2006
DenInt4more	Density of intersections with 4 or more legs (over total street miles) (1/mile)			
PerPoverty	Percentage of population in poverty status	Poverty status and other demographic factors	SES	Census 2000
ChildBearing	Percentage of households with children younger than 18 years old			
PerAge1821	Percentage of population aged 18 to 21			
PerAge70	Percentage of population aged 70 or more			

TABLE 1 Continued

Name	Label	Sub-category	Category	Data source
PerNavNonWhite	Percentage of population who are native-born minorities (non-white)	Minority		
ForeignPercent	Percentage of population who are immigrants (foreign born)	Total immigrants	Immigrant population	Census 2000
PerEastEurope	Percentage of population who are immigrants from East Europe	Immigrants by regions of origin		
PerOtherEurope	Percentage of population who are immigrants from rest of the Europe			
PerAsia	Percentage of population who are immigrants from Asia			
PerLatinAmerica	Percentage of population who are immigrants from Latin America			
PerEntry95_00	Percentage of population who are immigrants entered USA during 1995 to 2000	Immigrants by entering USA time periods		
PerEntry90_94	Percentage of population who are immigrants entered USA during 1990 to 1994			
PerEntry85_89	Percentage of population who are immigrants entered USA during 1985 to 1989			
PerEntry80_84	Percentage of population who are immigrants entered USA during 1980 to 1984			

Negative Binomial Model

The negative binomial model was applied in the analysis because crashes in this study are over-dispersed. Shown in Table 2, the average crash incidences per census tract is 18.45, with a variance of 357.97, which is much larger than the mean, exhibiting the property of over-dispersion. We express the model as follows:

$$P = (Y = y_i) = \left(\frac{\gamma}{\gamma + \lambda}\right)^{\gamma} \frac{\Gamma(\gamma + y_i)}{\Gamma(y_i + 1)\Gamma(\gamma)} \left(\frac{\lambda}{\gamma + \lambda}\right)^{y_i}, \tag{1}$$

where y_i is the number of pedestrian and cyclist crashes in i th census tract, Γ is the gamma function, and γ is the dispersion parameter, and λ is the expected value of y_i . If γ is very large, Eq. 1 converges to a Poisson model, which requires that mean is equal to the variance.

In this study, we express λ as a function of census tract-level immigrant population characteristics, exposure, roadway design, and SES factors:

$$\lambda = E[\alpha + \beta_1 \cdot x_{\text{exposure},i} + \beta_2 \cdot x_{\text{roadway design},i} + \beta_3 \cdot x_{\text{SES},i} + \mu \cdot x_{\text{ipc},i}]. \tag{2}$$

The parameters of interest is μ . Examination of the estimated values of μ allows us to evaluate the three hypotheses laid out earlier.

RESULTS AND DISCUSSION

We first present results from the descriptive and spatial analyses, followed by the results from the models. We estimated two models: model 1 to test the first

TABLE 2 Descriptive statistics on immigrant population percentages and number of crashes in census tracts with a large number of immigrants

	No.	Mean	Variance	Min	Max
Immigrant population percentages in census tracts					
Asia	2,216	8.01	111.94	0	75.96
Latin America	2,216	14.85	236.24	0	71.18
East Europe	2,216	4.01	56.10	0	69.22
Rest of Europe	2,216	4.97	12.89	0	71.38
Total% Foreign-Born	2,216	34.18	293.44	0	93.19
Number of crashes in tracts with a large number of immigrants by regions of origin					
Asia	30	55.23	1,325.69	15	119
Latin America	75	59.61	839.84	11	103
Eastern Europe	91	43.49	446.90	11	96
Rest of Europe	55	6.11	32.15	0	47
Number of crashes in tracts with a large number of immigrants by entering US time periods					
1995–3/2000	38	39.95	1,064.72	0	134
1990–1994	31	33.35	483.56	0	148
1985–1989	48	22.34	516.65	0	78
1980–1984	27	9.63	73.27	0	35
All census tracts in NYC	2216	18.45	357.97	0	154

hypothesis—the overall impact of immigrant population on census tract-level crashes—and model 2 to test the second and third hypotheses—the effects of countries of origin and the existence of a safety assimilation process.

Descriptive Statistical and Spatial Analysis

Before modeling, we created kernel density maps identifying hotspots (areas of high pedestrian and cyclist crash densities) with deeper red (Figures 1 and 2). In Figure 1, the census tracts with high concentrations of immigrants from Asia, Latin America, East Europe, and the rest of Europe are marked with dots, triangles, crosses, and

FIGURE 1. Kernel density map of pedestrian and cyclist crashes in NYC and neighborhoods with a large number of immigrants who came from different countries of origin.

FIGURE 2. Kernel density map of pedestrian and cyclist crashes in NYC and neighborhoods with a large number of immigrants who entered USA during different time periods.

pentagrams, respectively. The percentages of immigrants from the respective regions in these census tracts are at least several times greater (Table 3) than the city-wide average percentages (shown in Table 2). Visual inspection of Figure 1 highlights a few points: The local hot spots in Chinatown (in Manhattan) and Flushing (in Queens)—the two Chinese immigrant enclaves appear to support our hypothesized safety culture effects for Asian immigrants; census tracts with more Latin America immigrants (marked with triangles) also appear to have more crashes than others; census tracts with more immigrants from the rest of Europe (marked with pentagrams) in general have fewer crashes.

TABLE 3 Percentages of the total population with a large number of immigrants who came from Asia, Latin America, East Europe, and the rest of Europe

Immigrants from	Mean (%)	Minimum (%)	Maximum (%)	No.
Asia	53.5	45.1	76.0	30
Latin America	56.0	50.4	71.2	75
East Europe	40.8	30.2	69.2	91
Rest of Europe	45.3	30.3	71.4	55

Figure 2 is a kernel density map of crash hotspots overlaid with census tracts with a high concentration of immigrants who arrived in this country during different time periods: between 1996 to March 2000, between 1990 and 1994, between 1985 and 1989, and between 1980 and 1984. One hundred and thirty-seven census tracts were selected as those with a large number of early or newer immigrants (Table 4). These four periods are outlined in black, dark gray, light gray, and white. Figure 2 shows that census tracts with more recent immigrants (those outlined in black and dark gray) appear to be located inside or near some of the crash hotspots, like lower Manhattan, Flushing in Queens, and Southwestern Bronx, whereas those with early immigrants (outlined in light gray and white) appear to be close to areas where there are few hotspots.

The descriptive statistics of the data also show a similar pattern—the crashes in the immigrant neighborhoods appear to differ significantly from the city-wide average (Table 2). During the study period (2001–2003), the 2,216 census tracts have an average of 18.45 pedestrian and cyclist crashes per census tract. Those census tracts with a high concentration of Asian immigrants have an average of 55.23 crashes, nearly three times of city-wide average. Those with more Latin American immigrants have an average of 59.61 crashes. Tracts with more Eastern European immigrants have an average of 43.49 crashes, 2.4 times of city-wide average, while the average number of crashes in those tracts with immigrants from the rest of Europe is 6.11, only 33% of the city-wide average. There also exhibits a declining trend in crashes when observing from crashes in census tracts with early immigrants to crashes in tracts with new arrivals.

Model Results

Table 5 presents the results of the two negative binomial models.* The null hypothesis: $1/\gamma=0$, is rejected, indicating the over-dispersion property of the crash data and supporting the use of negative binomial model. For each model, we reported the estimated coefficients (Coef.), the pseudo *t* value for maximum likelihood estimators (Z Value), and the elasticities (the percentage change in crashes in response to 1% increase in a factor; Elas. [in %]) at the mean of each factor. We first discuss the findings on the confounding variables constructed under the “exposure,” “roadway design,” and “SES” categories, and then present the results on the immigrant population characteristics constructed for the three hypotheses.

*We tested running regression models separately using pedestrian-only crashes and cyclist-only crashes. The estimates are similar to each other, thus we combined pedestrian crashes and cyclist crashes together in a single dependent variable.

TABLE 4 Percentages of the total population with a large number of immigrants who entered the USA during different time periods

Entry periods	Mean (%)	Minimum (%)	Maximum (%)	No.
1995–3/2000	53.6	42.4	74.0	38
1990–1994	46.6	40.5	77.9	31
1985–1989	42.6	33.4	87.8	41
1980–1984	42.2	30.6	64.5	27

Confounding Factors As expected, higher daytime population density is associated with more crashes. More residential or retail floor area, as well as more employment in businesses that attract visitors, are also correlated with more crashes. Bus stops near intersections are potentially a hazard, as the body of the bus will block the vision of the pedestrian who wants to cross the street or the vision of the driver coming from the crossing street of the intersection. Census tracts with a higher percentage of streets with four or more lanes have more crashes and census tracts containing the Central Park or schools have more crashes due to the large number of visitors they attract or the vulnerable population they house.

In terms of roadway characteristics, census tracts containing more one-way streets have more crashes. This may be due to that the higher speed of vehicles on one-way streets may leave drivers insufficient time to react when a potential conflict with pedestrians or cyclists arises. Census tracts with more intersections with four or more legs also have more crashes, probably because of the different kinds of conflicts in these intersections.

Census tracts with a high percentage of population aged between 18 and 21 are associated with more crashes. These findings seem to support the argument that young and single people are more likely to be risk-seeking than others. In addition, census tracts with a high percentage of households with children tend to have fewer crashes. While children are more vulnerable since they lack the skills of avoiding dangers on roadway, this finding likely explains that parents of young children are less likely to be risk-seeking when driving or walking. The effect resulting from the vulnerability of the young children on roads is probably already accounted for by the “schools” variable in the model, which is positive, indicating that census tracts with more schools (and therefore young children) have more crashes. Census tracts with more elderly people have fewer crashes, probably due to that elderly people make fewer trips. Census tracts with a higher percentage of residents in poverty status also have more crashes, though the effect in model 2 (after immigrant population characteristics were entered) is only significant at 10%. Lastly, census tracts with a higher percentage of native-born minorities* tend to have more crashes, which is consistent with others’ findings that they are more vulnerable as pedestrians.

Immigrants and Safety Culture As shown in model 1 in Table 4, the estimate for the percentage of foreign-born population is significant and positive—supporting our first hypothesis that census tracts with more foreign-born population are likely

*This variable is included in the model to distinguish between “minority” effect and “immigrant” effect. The latter is what we are interested in the paper.

TABLE 5 Model estimation results for pedestrian and cyclist crashes

Variables		Model 1			Model 2		
Variable name	Category	Coef.	Z Value ^a	Elas. (in %)	Coef.	Z Value ^a	Elas. (in %)
DayTimeDen	Exposure	0.004	6.36	1.95	0.004	6.09	1.85
DayPopDenSq		-4.23E-06	-5.57		-3.97E-06	-5.24	
SumRes		6.635	8.68	4.48	6.564	8.65	3.61
ResSq		-14.749	-5.35		-14.514	-5.33	
SumRetail		27.584	8.79	1.17	28.190	9.07	1.22
RetailSq		-33.474	-8.58		-34.259	-8.88	
EmpAttr		0.017	5.95	4.82	0.017	6.15	5.14
EmpAttrSq		-1.51E-04	-5.51		-1.55E-04	-5.75	
NumBusStop		0.084	15.53	5.67	0.083	15.56	5.01
BusStopSq		-0.001	-8.83		-0.001	-9.01	
Per4Lane		0.006	7.00	1.31	0.006	7.02	1.83
CentralPark		2.872	4.40	0.01	2.848	4.42	0.01
Schools	Roadway design	0.042	4.20	0.04	0.041	4.18	0.04
PerOneWay		0.007	9.80	2.28	0.006	9.43	2.84
DenInt4more		0.056	6.20	3.29	0.059	6.61	3.37
PerPoverty		0.005	3.75	0.74	0.003 ^b	1.74	0.62
ChildBearing	SES	-0.009	-5.31	-1.39	-0.011	-6.25	-2.10
PerAge1821		0.016	4.03	0.94	0.014	3.49	0.73
PerAge70		-0.011	-3.90	-0.89	-0.008	-2.47	-0.65
PerNavNonWhite		0.004	5.87	1.83	0.002	2.30	1.55
ForeignPercent	Immigrant population	0.011	12.31	4.16	0.010	4.20	1.04
PerEastEurope					-0.029	-5.46	-1.09
PerOtherEurope					0.007	4.28	1.05
PerAsia					0.010	8.67	1.79
PerLatinAmerica					0.005	3.34	0.98
PerEntry95_00					0.001 ^b	0.53	0.17
PerEntry90_94					0.003 ^b	1.54	0.45
PerEntry85_89					-0.001 ^b	-0.66	-0.01
PerEntry80_84					0.149 ^b	1.32	
Constant		-0.044 ^b	-0.41		-7.663.8		
Log-likelihood		-7,704.9			0.121		
Pseudo R ²		0.116					

^aZ value is the pseudo T value for maximum log-likelihood estimators in STATA
^bCoefficients not significant at 5% level

to have more crashes. The elasticity estimation for foreign-born population is 5.63, predicting a 5.63% increase in the number of crashes in response to a 1% increase in foreign-born population.

Table 5 also shows that census tracts with more immigrants from Asia, Latin America, and Eastern Europe tend to have more pedestrian and cyclist crashes while tracts with more immigrants from the rest of European countries tend to have fewer crashes, everything else being equal. The latter finding accords with the hypothesis that neighborhoods with a higher concentration of residents from those European countries are safer than others.³⁴ The risk for pedestrian and cyclists crashes is the highest for Latin Americans.

The model results also show support for the safety assimilation hypothesis. As the duration of stay in this country lengthens, we expect that immigrants undergo a safety assimilation process in terms of their attitudes, perceptions of the social norms toward risky traffic behavior, and their own on-road behavior. Consequently, we expect to observe a declining trend in the significance and magnitude of the coefficients associated with longer years of stay and eventually, the estimate becomes insignificant. As shown in Table 5, the estimate for the percentage of entry within 5 years is positive and significant. Five years appear to be a sufficient period for the safety assimilation to take place for immigrants, as after 5 years, *ceteris paribus*, the risk of immigrants' being involved in pedestrian and cyclist risks appears to be similar to that of native-borns.

CONCLUSIONS

The current study analyzes pedestrian and cyclist crashes in New York City at the census tract level. The hypothesized relationships between higher immigrant population and higher incidences of crashes are confirmed. The safety assimilation process we hypothesized is validated.

The current study provides support to the long-standing suspicion in New York City that "immigrants" play a role in the high crash incidences observed in some immigrant neighborhoods. We found that areas with a higher concentration of Latin American, Eastern European, or Asian immigrants tend to have more pedestrian and cycle crashes after controlling for other factors including native-born minorities. It is also worth noticing that the pedestrian and cyclist crashes used in the study are police-reported ones. In reality, many pedestrian and cyclist crashes, especially when involving immigrants, are not reported. Therefore, the number of crashes summarized from police reports is likely to be an underestimation of the actual incidences of pedestrian and bicyclist crashes. In other words, the actual effect of "foreign-born" is likely to be higher than the effect estimated from the current study. Our results indirectly suggest a higher level of vulnerability of immigrants of being crash victims and support the hypothesis that the safety culture of the immigrants' home countries plays an important role in traffic safety.

Studies of immigrants' travel behavior show that immigrants are more likely to walk and cycle compared to native-borns;^{26,28} our results suggest they appear to have a higher level of vulnerability when walking and cycling. These statistics indicate that policy makers and planners need to learn more about the walking and cycling behavior of immigrants. Yet, immigrants are largely ignored in current data collection efforts designed to learn about cyclists' behavior and attitudes. For example, 55% of the respondents in the 2007 NYC-wide survey designed to "promote bicycling as a viable, healthy, and affordable form of transportation" and

to “generate data and solicit feedback from the public on bicycling issues in the city” are members of bicycle advocacy groups, probably because the survey was conducted via internet, and in English only.³⁵

Existing programs promoting walking and cycling safety need to be targeted more toward certain immigrant neighborhoods, because of their vulnerability on the road. A range of programs can be considered, including traditional engineering programs such as pedestrian barriers and bike lanes as well as education outreach programs. Many ethnic neighborhoods have vibrant community centers, which should be involved to establish trust between safety policy makers and immigrants.

Our study is at the neighborhood level. Thus, while it demonstrates that areas with more immigrants tend to have more crashes—supporting our hypothesis that the safety culture of immigrants’ home countries plays an important role, it does not inform us the kinds of behavior that immigrants are likely to engage in on the road. Thus, in the end, the term “safety culture” remains vague and needs to be explored in future research. We call for more attention to be paid to immigrants in traffic safety studies and programs promoting traffic safety, especially the safety of pedestrians and cyclists. Potential efforts should include surveys that learn about immigrants’ behavior on the roadway and their attitudes and perceptions toward various kinds of behavior on roadway and community-based programs that promote safety, and interventions that aim to reduce crashes in immigrant enclaves.

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