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Research Article

Demographic Analysis of Traffic Accidents in Tehran from 2001 to 2011

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ABSTRACT

The World Health Organization has identified 100 factors contributing to road accidents and predicts that injuries from accidents will increase by about 65% between 2000 and 2020. According to Article 163 of Iran's Five-Year Development Plan, traffic fatalities on the country's roads should decrease by 10% annually. However, this study shows that urban traffic fatalities have increased from 800 in 2001 to 1,400 in 2007, with an estimated 4,000 fatalities projected for 2021. Given the recent increase in urban vehicle accidents in Iran, the main objective of this research was to conduct a demographic analysis of accidents in Tehran during the 2000s. Data collection methods utilized demographic techniques and multiple levels of population refinement to extract relevant tables. Over 2,000 documents were examined over 10 years in a panel study format. Information was gathered through comprehensive review and analysis of all documents and statistics, which were then summarized and indexed. Findings indicate that Tehran's urban accidents account for over 40% of all urban accidents nationwide across various categories including fatalities, injuries, and property damage. With increasing vehicle traffic and daily urban travel, the number of accidents in this city is likely to double in the next decade. If current accident trends continue, considering the growth rate of fatal accidents, we will see an increase from 900 accidents in 2009 to 2,000 in 2021. Meanwhile, injury-causing accidents are projected to rise from 23,000 in 2009 to over 100,000 during the 2010s.

Keywords: Population, Demographic Index, Urban Accidents, Injury-Causing Accidents, Accident Ratio

INTRODUCTION

According to official statistics, 1.2 million people worldwide die annually in traffic accidents, with 50 million injured. The World Health Organization and World Bank have identified 100 factors contributing to road accidents and predict injuries from accidents will increase by about 65% between 2000 and 2020. While fatality rates from traffic incidents have stabilized or decreased in many populous countries, data indicates the global prevalence of traffic-related injuries is rising in most regions. Estimates suggest that without serious intervention, traffic-related deaths will become the fifth leading cause of death globally by 2030, accounting for 2.4 million annual fatalities.

Pedestrians, cyclists, and riders of two or three-wheeled vehicles comprise about half of road fatalities worldwide. Studies show that three-quarters of traffic-related deaths occur among men of economically active age. In Iran, 92 people lose their lives daily due to traffic incidents, with an average age of 36.8 years. For every 10,000 vehicles in Iran, 120 traffic accidents occur, compared to 12 in France and Japan. This research finds that in Tehran, this figure is 315 accidents, indicating a high accident rate compared to global benchmarks. The lower accident rates in France and Japan likely stem from their public transportation systems, particularly rail networks accessible throughout both countries.

This study aims to analyze demographic trends related to urban accidents in Tehran during the 2000s and project estimates for 2021. The research method is documentary, utilizing census results, national statistical yearbooks, and reports from Tehran's Traffic Studies Center. The statistical population includes Tehran residents involved in accidents. Data analysis employed Excel and Access software, along with algebraic coefficients, variance, and univariate, bivariate, and multivariate tables.

The research first reconstructed Tehran's urban accident statistics for 2001-2009, then calculated demographic indices and projected estimates for 2021 based on objectives.

1. Accident Approaches

1.2. Urbanization as a Lifestyle

Mere physical presence in a city does not equate to citizenship. Citizens should play active roles and bear responsibilities in the optimal management of the city.

In cities, vast numbers of people live alongside one another without knowing each other. Most interactions among urban residents are limited, fleeting, and merely instrumental rather than inherently satisfying relationships. The density and intensity of social life in cities leads to the formation of neighborhoods with distinct characteristics, some of which may retain small community features.

1.3. Urban Economy and Accidents

According to a 2006 World Health Organization report, motor vehicle accidents have a disproportionately negative impact on the poor and vulnerable segments of society. A large number of road accident victims in poor and vulnerable countries are pedestrians and cyclists. These groups benefit less from advanced transportation policies and programs.

Studies have shown that motor vehicle accidents have a more detrimental effect on the poor and vulnerable. Impoverished people often suffer more severe injuries and complications, with limited support from relevant organizations for long-term treatments due to resource constraints. Moreover, in many developing countries, the costs of prolonged medical care, loss of the family breadwinner, funeral expenses, and loss of income due to disability can easily push a family into poverty. Many road accident victims in poor and vulnerable countries are pedestrians and cyclists who benefit less from advanced transportation policies but bear a disproportionate share of the negative impacts of modernized transport systems, such as injuries, damages, pollution, and social isolation.

It is essential that all individuals be equally protected against road deficiencies, preventing injustices, especially towards the poorer and more vulnerable. Social justice is fundamental, aiming to establish uniform laws for everyone worldwide to reduce accident rates, injuries, and fatalities while creating equal support systems.

The prevalence of traffic-related injuries significantly impacts national economies. The global cost of traffic-related injuries is estimated at 518 billion US dollars.

1.4. Social Behavior, Civic Ethics, and Accidents

Urban ethics is recognized as a crucial domain in every individual's social and cognitive life, often considered a regulatory mechanism in human social relations. Ethics in its social form is a necessity.

Driving behavior reflects a person's social ethics. Observing laws, respecting others' rights, controlling one's temper in traffic, maintaining a clean and healthy vehicle, and creating a calm environment for passengers and other drivers are examples of a driver's social behavior, unconsciously displayed while driving. In 90-95% of accidents, human behavior is the determining factor. Antisocial behaviors are directly related to aggressive driving and accident occurrence.

Dangerous driving includes competitive driving (enjoying maneuvering among other drivers), risk-taking driving (accepting risks for excitement), high-risk driving (speeding and sudden overtaking), and aggressive driving (tailgating often to punish other drivers, angry accelerating, and hostile gestures). These are linked to the driver's personality traits. Such driving seriously threatens safety, but many young people engage in dangerous driving, resulting in higher accident rates.

To develop and expand traffic safety policies, these behaviors require further explanation and investigation to find solutions for reducing accident rates and resulting fatalities.

Studies show that the highest accident rates are among drivers who fall into these categories:

1. People in life transitions who have distanced themselves from traditional societal values (such as courtesy, respect, and consideration for others' rights) but are also unfamiliar with modern life skills and human rights. They exist in an identity vacuum.
2. Individuals who don't feel a strong connection to any particular culture, nationality, or ethnicity, and whose social class is unclear. This spans educated and uneducated, rich and poor alike. They often feel they have nothing to lose.
3. Those with mental health issues tend to be poor drivers and cause many accidents.
4. Men and women with borderline personality disorder who struggle to control their emotions and anger.

1.5. Migration and Its Various Dimensions

Uncontrolled migration to cities and rapid urbanization, occurring even faster than in industrialized countries, has left many citizens unprepared for urban life. Recent unemployment has pushed migrants from small towns with minimal legal friction into major metropolitan areas where life is more regulated. This migration, along with urban sprawl and the growth of slums, increases the distance between the city center and outskirts daily. Intra-city travel consumes citizens' time, leading them to disregard laws to save minutes, endangering themselves and others.

1.6. Population Movements and Urban Planning

Principles of sustainable urban planning include:

First Principle: Creating Suitable Pedestrian Spaces

Walking is the most natural, economical, and healthy mode of transport, being more environmentally friendly than other methods. Besides feet, it requires streets conducive to walking, which are fundamental to sustainable cities. Large pedestrian areas necessitate protecting walkers from motorized vehicle dangers. Vehicle speed limits in these areas should be low. Sidewalks should be continuous, shaded, and well-lit. Vehicle speeds should be reduced where pedestrian crossings exist.

Motorcycles, bicycles, and other human-powered vehicles occupy little space and require minimal energy beyond human power. They also offer door-to-door travel capability.

Studies show that only one-third (32%) of countries have national and local policies promoting walking and cycling as alternatives to motorized transport. 44% of countries lack policies (even at national or local levels) encouraging public transport as an alternative to personal cars, indicating neglect of non-motorized road users'

needs. These figures may be surprising, as reducing individual use of personal vehicles could positively impact respiratory health (due to less vehicle-related air pollution) and reduce obesity rates (due to increased physical activity from walking or cycling).

Second Principle: Affordable and Extensive Public Transportation

Some journeys are too long for cycling or walking. As high personal vehicle traffic slows public transport and buses, cities must address this issue. Mass public transit can quickly and comfortably move millions of passengers. Given that Bus Rapid Transit (BRT) systems can compete with metros while being cost-effective and fast, their use is recommended. Like metros, BRT has high-quality stations, level boarding, real-time information systems, dedicated lanes, and clean, comfortable, high-capacity buses.

Third Principle: Trip Management by Creating Access for Clean Walking with Fewer Vehicles at Safe Speeds

City structure and design have changed in the last century. By 2030, car travel will remain an option, especially where affordable and effective public transport is unavailable. Cars should be environmentally friendly, fuel-efficient, noise-free, and safe for both occupants and others. Widening or building new roads in cities causes significant damage by attracting more cars, subsequently increasing traffic, air pollution, fuel consumption, and greenhouse gas emissions. Personal car use should be controlled through parking policies, road pricing, and promotion of public transport and cycling. These policies should also encourage the use of fuel-efficient, eco-friendly vehicles. Optimal travel demand management is essential for any city designed for people, not cars.

Bogotá, Colombia's capital, focused on the city's need for non-motorized transport and promoted public transit between 1995-2001. This included building separate pedestrian and bicycle paths away from car traffic (excluding morning and evening rush hours), and creating dedicated bus lanes costing about $300 million, moving 700,000 people daily. These measures reduced traffic-related deaths from 1,387 in 1995 to 697 in 2002. They also improved job accessibility and created a more livable urban environment.

India recently completed its first phase, creating separate paths for pedestrians and cyclists, and designing bus lanes on city highways. Pedestrian lanes are designed with consideration for the elderly, children, and disabled individuals. As street vendors are part of Delhi's urban areas, special attention was given to allocating space for them without interfering with cyclists and pedestrians. In the first ten months of implementation, no deaths from cars, motorcycles, or bicycles were observed on these routes.

Fourth Principle: Cleanest and Safest Freight Transport in Cities via Trucks

Urban life is sustained by the movement of goods. Food, fuel, clothing, and waste are typically transported. Freight transport accounts for 40-50% of air and noise pollution, while average vehicle movement contributes 10-15%. Sustainable cities must ensure goods delivery with minimal community impact.

2. Analysis of Urban Accident Trends

Urban accident trends in the country and Tehran specifically include: examining accident rates, fatal accidents, injury accidents, property damage accidents, fatalities, and injuries in the 2000s, with projections for 2021. The impact of factors such as population, road and highway length, traffic signs, vehicles, and registered vehicles on accidents will be analyzed. To calculate indicators, we first identified factors that could influence urban accident rates, obtained recent statistics, and used growth formulas to estimate values for 2021. We also projected the ratio of these indicators to various accident types for the 2000s and 2021.

On average, over 490,000 urban accidents occur annually in Iran (2001-2007), including more than 1,000 fatal accidents, 7,300 injury accidents, and 40,000 property damage accidents. Estimates for 2021 suggest urban accidents nationwide will exceed 3 million, with over 4,000 fatal accidents, 500,000 injury accidents, and over 2 million property damage accidents. Tehran accounts for 40% of all urban accidents in the country, 26% of urban injury accidents, 35% of urban fatal accidents, and 43% of urban property damage accidents. For 2021, it's estimated that Tehran's urban accidents compared to the whole country will be 11% property damage, 58% fatal, and 19% injury accidents. Among urban accidents nationwide (2001-2007), 84% were property damage, 14% injuries, and 0.22% fatal. Annually, over 1,200 people die and 90,000 are injured in accidents nationwide, projected to reach 4,538 deaths and 652,803 injuries in 2021. For 2021, it's estimated that 82% of urban accidents nationwide will be property damage, 18% injuries, and 0.14% fatal.

Table 1: Urban Traffic Accidents Resulting in Death, Injury, and Property Damage Nationwide - 2001s and 2021

Types of Accidents	2001	2002	2003	2004	2005	2006	2007	2001-2007 Average	2021	r
Total Accidents (Cases)	263,354	351,855	445,826	509,359	642,163	646,851	601,896	494,472	3,142,519	0.1253
Fatal Accidents	742	902	1,051	987	1,318	1,307	1,348	1,088	4,447	0.0890
Fatalities	837	1,091	1,168	1,115	1,478	1,427	1,471	1,226	4,538	0.838
Injury Accidents	38,731	54,948	70,021	72,473	89,413	93,789	94,943	73,474	570,124	0.1366
Injuries	47,154	67,954	89,157	91,033	111,525	115,378	113,228	90,775	652,803	0.1333
Property Damage Accidents (Cases)	223,881	296,005	374,790	435,899	551,432	551,755	505,605	419,909	2,578,061	0.1234

The estimation for various types of accidents in 2021 is based on the average accident rates from 2001-2007, disregarding population shocks and dramatic fluctuations in vehicle numbers. This data is sourced from the Statistical Yearbook of Iran, published by the Iran Statistics Center. Registered vehicles include motorcycles, cars, buses, minibuses, vans, light trucks, trucks, and tractor-trailers.

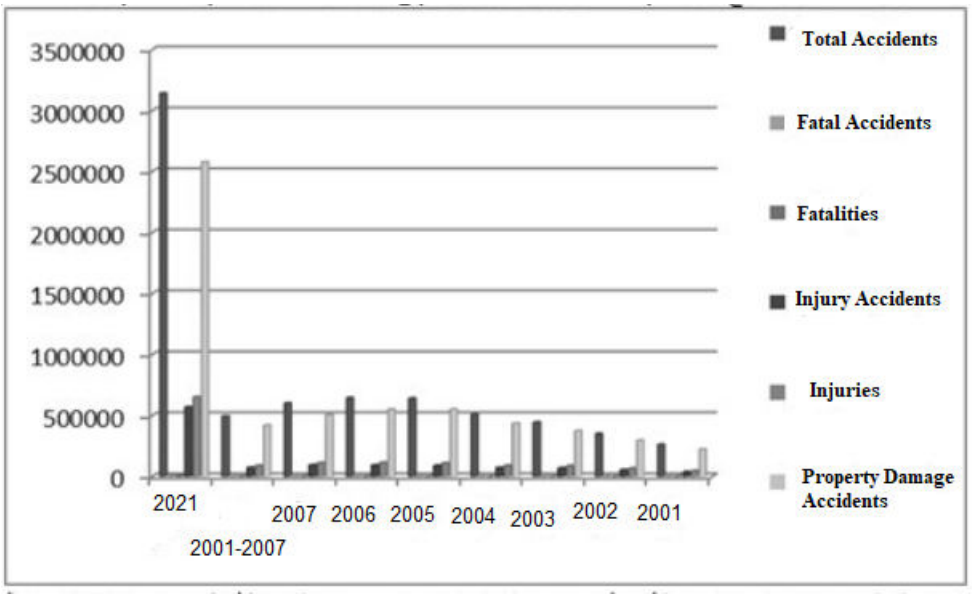

Chart 1: Urban vehicle accidents resulting in death, injury, and damage for the entire country - (2001-2011) and (2021-2022)

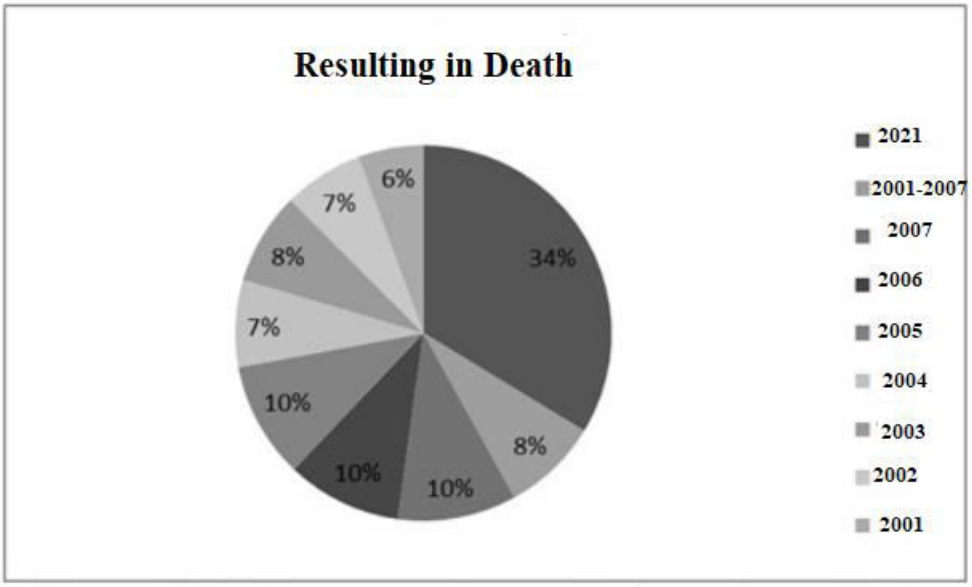

Chart 2: Percentage of urban vehicle accidents resulting in death, injury, and damage for the entire country - (2001-2011) and (2021-2022)

2.1. Tehran Urban Accidents

On average annually (2001-2009), 200,913 accidents occur in Tehran, of which more than 330 result in death, over 19,000 result in injury, and over 180,000 result in property damage. Additionally, for the year 2021, it is estimated that more than 370,000 accidents will occur in Tehran, of which over 2,000 will result in death, more than 100,000 will result in injury, and less than 300,000 will result in property damage.

Among the types of urban accidents in Tehran, 90% involve property damage, 12% involve injuries, and 0.19% involve fatalities. Annually in Tehran, 429 people die due to accidents, and more than 24,000 are injured. Furthermore, among the types of urban accidents in Tehran in the year 2021, it is estimated that 79% will involve property damage, 29% will involve injuries, and 0.76% will result in fatalities.

Table 2: Urban Vehicle Accidents Resulting in Death, Injury, and Property Damage in Tehran - 2000s Decade and the Year 2021

Types of Accidents	2001	2002	2003	2004	2005	2006	2007	2008	2009	2001-2009 Average	2021 Estimate	r
Total Accidents (Cases)	105,999	146,803	188,214	217,017	269,816	256,777	219,866	221,731	181,997	200,913	374,168	0.0619
Fatal Accidents	215	292	374	297	383	329	314	346	927	386	2,853	0.1762
Fatalities	234	362	404	325	429	367	343	402	995	429	3,249	0.1744
Injury Accidents	7,163	12,999	18,840	19,145	22,108	22,813	21,450	24,476	23,035	19,114	109,240	0.1385
Injuries	8,858	16,315	26,076	25,938	29,456	29,505	26,941	30,451	26,994	24,503	119,136	0.1317
Property Damage	98,621	133,512	169,000	197,575	247,325	233,635	198,102	196,909	158,035	181,412	296,044	0.0537

Accidents (Cases)												

For estimating the number of various accidents in the year 2021, the average accident rates from (2001-2009) were used, without considering population shocks and extreme fluctuations. Source: Statistical Yearbook of the country, Statistical Center of Iran.

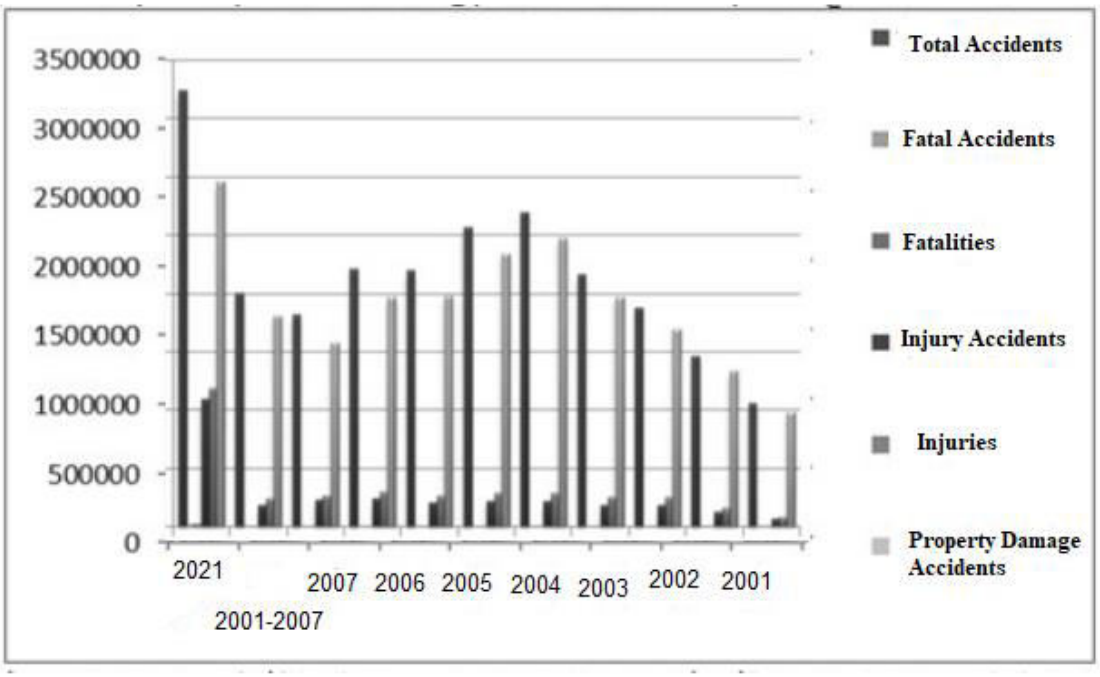

Chart 4: Urban vehicle accidents resulting in death, injury, and property damage in Tehran - (2001-2011) and the year 2021

Chart 5: Percentage of urban vehicle accidents resulting in death, injury, and property damage in Tehran - (2001-2011) and the year 2021

Based on Chart 5, the highest number of accidents during the 2001s decade occurred in the years (2005 and 2006), while the lowest number of accidents happened in 2001. From 2006 onwards, we have gradually seen a decrease in urban accidents in Tehran. However, according to the calculated growth rate of accidents during the years (2001-2009) and considering the number of accidents in 2009 as the base population, the number of accidents in 2021 is expected to approximately double. This estimate seems to be realistic, given the growth in the number of licensed drivers and the increase in the number of vehicles expected by 2021.

Table 3: Ratio of Tehran inner-city accidents to nationwide inner-city accidents in the (2001-2011) and 2021

Accidents	Fatalities	Injuries	Property Damage	Injured	Fatal
p = Number of inner-city accidents in the years (2001-2009)	734,741,226	108,849	447,280	90,775	419,909
Nationwide in the years (2001-2009)	200,913	386,429	19,114	24,503	181,412
Tehran city in 2021	3,142,519	4,447	4,538	570,124	652,803

Nationwide in 2021	374,168	2,853	3,249	109,240	296,044
Tehran city ratio to types of accidents in the years (2001-2009)	99.26%	26.01%	99.34%	47.35%	48.40%
Tehran city ratio to types of accidents in 2021	11.90%	64.15%	71.59%	19.16%	18.24%

2.2. Ratio of Indicators to Inner-city Vehicle Accidents in Tehran for 2007-2009 and 2021

Demographic Dimensions of Accidents include several aspects or indicators, such as: driver population, number of vehicles, roads and highways, traffic signs and signals, etc. In this regard, 4 issues should be considered:

1. Ratio of accidents to vehicles
2. Ratio of accidents to total population
3. Ratio of total accidents to injury-causing accidents
4. The purest indicator, i.e., the percentage of fatalities resulting from accidents

In this study, the indicators are: population, vehicles, passenger cars, daily urban trips, roads and highways, registered vehicles, licensed individuals, day, traffic lights, signs and surveillance cameras, and the number of traffic and technical signs.

Population:

For every 10,000 residents of Tehran, 243 accidents occur, which is estimated to reach 466 by 2021. Considering that Tehran's population growth in 2021 will be 0.0065, we will witness a doubling of the accident-to-resident ratio in Tehran over the next 10 years. This is while the population in 2021 compared to the 2000s will increase by only 7%, thus these results indicate that population growth in the coming years will not have much effect on the increase in accidents.

Vehicles:

For every 10,000 vehicles in Tehran, 315 accidents occur annually, of which 30 are injury accidents and 284 are property damage accidents. Based on predicted statistics for 2021, this number will reach 288 accidents per 10,000 vehicles, of which 91 and 228 will be injury and property damage accidents, respectively. Also, if we assume that 7.5% is added to the number of existing vehicles in Tehran annually (considering that no vehicle is retired), more than 313 accidents per 10,000 vehicles will be added to the total accidents in Tehran annually.

Passenger cars:

For every 10,000 passenger cars in Tehran, 556 accidents occur annually. Based on predicted statistics for 2021, this number will reach 718 accidents per 10,000 vehicles, of which 228, 568, and 5 will be injury, property damage, and fatal accidents, respectively. Additionally, there are 3 cars for every 5 residents in Tehran, which is expected to change to 2 cars for every 4 people by 2021. Assuming an 8% annual increase in the number of cars in Tehran (considering no vehicles are retired), and given that passenger cars make up half of all vehicles in the city, 257 accidents will be added annually to Tehran's total accidents for every 10,000 vehicles.

Daily urban trips:

For every 10,000 daily trips in Tehran, 128 accidents occur, of which 12 result in injuries. This figure is expected to reach 206 by 2021, with 65 resulting in injuries. While the ratio of accidents to daily urban trips will approximately double by 2021, the number of inner-city trips will only grow by 14% over the next 10 years.

Roads and highways:

For every 1 kilometer of existing roads in Tehran, more than 70 accidents occur, of which 6 result in injuries. By 2021, this number is expected to reach 93 accidents, with 27 resulting in injuries. According to reports, in 2009 (from March 21 to December 20), 70% of Tehran's inner-city accidents occurred on highways, and 53% of injury accidents also happened on highways. For every 1 kilometer of highway in Tehran, 477 accidents occur, of which 45 are injury accidents. With this assumption, it can be said that more than 140,000 accidents occur annually on Tehran's highways, which is estimated to reach 676 accidents by 2021.

Registered vehicles:

Assuming a 7.5% annual increase in the number of existing vehicles in Tehran (considering no vehicles are retired), more than 313 accidents will be added to Tehran's total accidents annually for every 10,000 vehicles.

Licensed individuals:

For each person who obtains a driver's license in a year, there is a probability of one accident, which is also estimated to be 1.01 in 2021.

Day:

Daily, 550 accidents occur in Tehran, of which 1 results in death, 52 in injuries, and 497 in property damage. Based on accident statistics projections for 2021 in Tehran, this figure will reach 1,025 accidents daily. Additionally, fatal accidents will increase to 7, injury accidents to 299, and property damage accidents to 811.

Traffic lights, signs, and surveillance cameras:

For each traffic light, sign, and surveillance camera, 59 accidents occur in Tehran. This figure is expected to decrease to 49 accidents by 2021.

Number of traffic and technical signs:

For each traffic and technical sign, 11 accidents occur in Tehran. This figure is expected to increase to 21 accidents by 2021.

CONCLUSION

1. Data indicates that the global incidence of traffic-related injuries is increasing in most regions. According to estimates, without serious interventions, traffic-related deaths will become the fifth leading cause of death globally by 2030, equivalent to 2.4 million deaths annually. Pedestrians, cyclists, and two or three-wheeled vehicle riders account for about half of all road fatalities worldwide. Studies show that three-quarters of traffic-related deaths occur among men in their economically active age range.

2. In Iran, 92 people lose their lives daily due to traffic incidents, with an average age of 36 years for the deceased. In this country, there are 120 traffic accidents per 10,000 vehicles, while this figure is 12 in France and Japan. Meanwhile, according to this study, this figure in Tehran is 315 accidents, indicating a high rate of accidents in this metropolis compared to global standards.

3. Considering the theories presented, traffic accidents in Tehran result in irreparable damages. The research results show that nearly 40% of all urban accidents in the country occur in Tehran. With the annual increase in registered vehicles in Tehran and consequently daily inner-city trips, it is estimated that the number of accidents in this city will double by 2021. Meanwhile, considering the growth rate of fatal and injury accidents, this rate will increase sevenfold in the next 10 years, while property damage accidents will double.

4. According to the results of this research, there are 2 passenger cars for every 5 residents in Tehran. The daily traffic of these vehicles in the city will have consequences that, in addition to air pollution in Tehran, have also increased the number of accidents in the city. Some calculated indicators can be used to analyze the impact of

these factors on Tehran's accidents and be utilized in metropolitan planning.

5. Based on studies conducted in the Fifth Economic, Social, and Cultural Development Plan of the country, given the low age of death in accidents (33 years), traffic accidents are the most common cause of death based on years of life lost. Also, by age groups, traffic accidents are the most common cause of death in children over 4 years and adults under 60 years. According to this plan, based on studies conducted in 13 medical universities in 2006, the incidence ratio of traffic accidents by location was as follows: streets inside cities and villages (46.8%), intercity roads (21.5%), rural roads (19%), highways (8.5%).

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