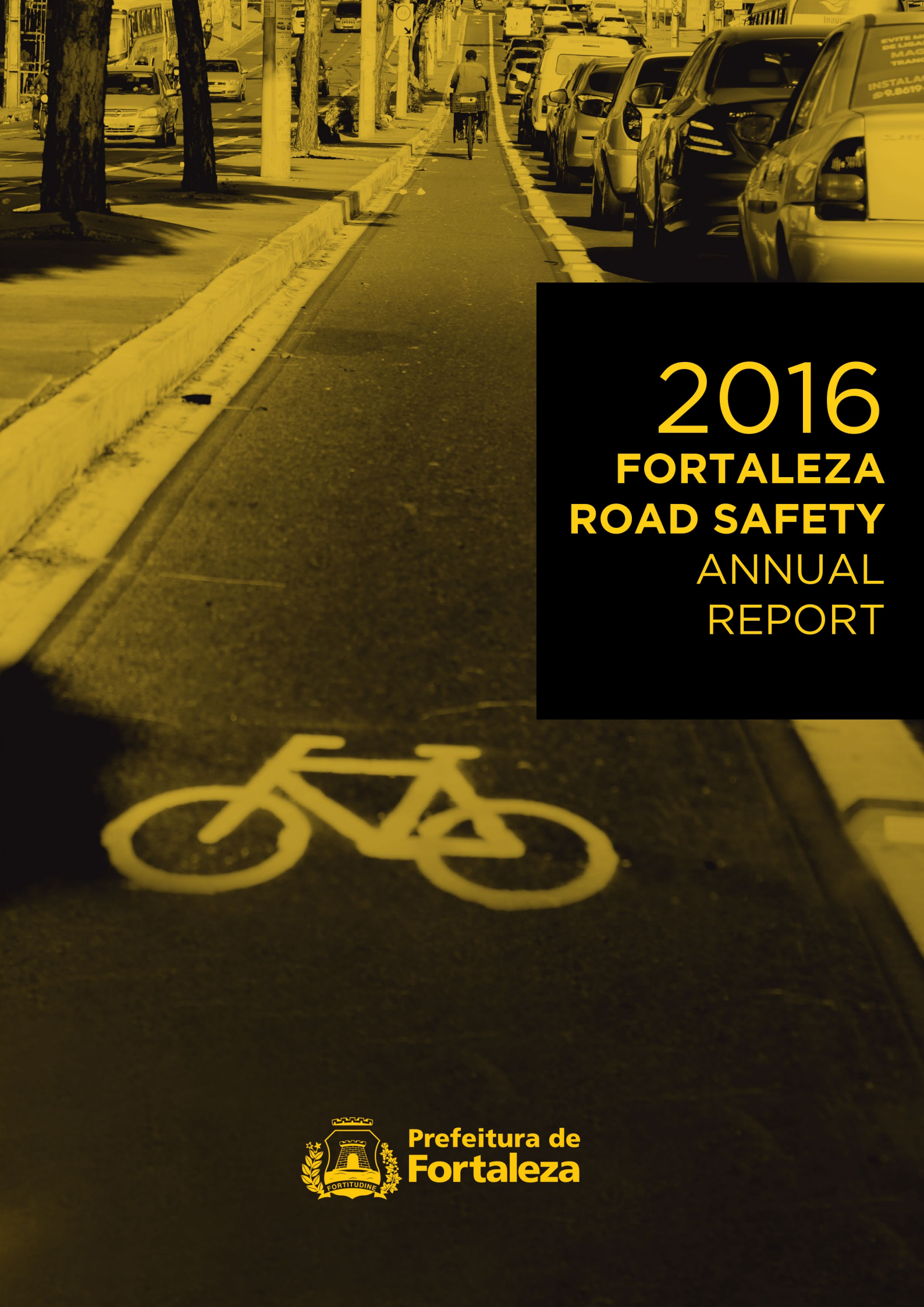

2016
FORTALEZA ROAD SAFETY ANNUAL REPORT

Prefeitura de Fortaleza

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NOVEMBER, **2017**

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Prefeitura de Fortaleza

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A WORD FROM **THE MAYOR**

Every day we seek to reduce the number of people suffering from the tragedy of road crashes, and we are on the right path. But the fight against this problem, which we now understand is a public health epidemic causing so many losses to the community, demands a state of alertness and an unrelenting improvement of our road safety. We are moving forward not only by building new road infrastructure that is safer for the most vulnerable users, but also by understanding this problem with a deeper analysis and by establishing better strategies.

As a society, we must take a new look at how we use the largest public space we have in our city, our streets, and realize that it is possible to put public transportation, cyclists and pedestrians at the top of our priorities. By providing more space, comfort and accessibility to these users we are also reducing traffic conflict and investing at the same time in the community's quality of life, in addition to a new era in road safety. Continuing to develop educational campaigns about the main risk factors involved, supported by traffic management focused on the highest crash sitescrash , is essential to achieving the ultimate goal of saving lives.

Fortaleza is committed to preventing and reducing the number of traffic deaths, as all such crashes are preventable and the loss of any one human life cannot be tolerated. We work in line with the recommendations of the General Assembly of the United Nations in this Decade of Action for Road Safety (2011-2020). Every year, our society understands even more the scale of the problem and, with the help of the international community, we have sought to apply innovative solutions to reduce risk and build opportunities. I am glad that the culture of road safety is ever increasing in our city.

ROBERTO CLAUDIO RODRIGUES BEZERRA
Mayor of Fortaleza

PREFACE BY THE MUNICIPAL **SECRETARY OF HEALTH**

Road crashes have become a serious public health problem given their magnitude and the huge impact they have on the entire healthcare system, as it has to provide treatment, recovery and rehabilitation care to the victims.

In 2016, we have recorded 281 deaths and approximately 18,295 injured due to road crashes, with motorcyclists accounting for most of them.

The analysis of the road crash victim profiles in Fortaleza shows that the highest risk is among young and adult men, corresponding to a significant portion of the economically active population, a fact that has a direct impact on the city´s economy. Furthermore, these premature and sudden deaths cause profound suffering and psychosocial distress to their families.

As these crashes are mostly predictable and preventable events, they demand systematic and permanent multilateral interventions and a constant and uninterrupted surveillance and development of health promotion and crash prevention strategies.

Fortaleza has achieved encouraging results in the fight against this problem, especially with the development of the Road Safety Program, which has positively changed the local road safety culture.

However, much still has to be done and the success of any intervention will depend, essentially, on the joint effort undertaken by different public entities and by the engagement of the whole of society, as the implementation of integrated public policies benefits the entire population in diverse ways, especially in public health.

JOANA ANGÉLICA PAIVA MACIEL
Municipal Secretary of Health

ACKNOWLEDGMENTS

Few victories are as important as those in which we are capable of saving lives. In the last 2 years, 157 lives were saved from traffic crashes in the city of Fortaleza. This means that 157 families were able to follow through with their plans and their dreams. At the same time, thousands of other people were spared from injury or other serious consequences of road crashes. We understand that our first acknowledgment must go to the citizens who, with a more careful attitude, began to properly use helmets when driving a motorcycle or avoided driving after drinking alcohol. These are simple behaviors that save lives and spare so many families the suffering of losing a loved one.

Achieving an ever smaller number of road injuries and deaths crashes is the result of the relentless work of a battalion of professionals, from the emergency call center through traffic engineering and traffic control, to the healthcare network providing first aid and medical care to the victims. Anonymous heroes who often work above and beyond their call of duty. To these professionals, our sincere gratitude for their perseverance and strength in this battle.

I would like to emphasize the fundamental role of the partnership with the different information sources of the Road Crash Information System (SIAT) at the local, state and federal levels, i.e. the Mobile Emergency Service (SAMU), the Dr. José Frota Hospital, the Municipal Health Secretariat (SMS), the Forensics of the State of Ceará (PEFOCE), the State Highway Police (PRE), the Security Operations Integrated Coordination (CIOPS) and the Federal Highway Police (PRF). It is thanks to the sharing of information that we managed to prepare this annual report in such rich detail and analysis.

I would also like to note the important support of several international institutions which, through the Bloomberg Initiative for Global Road Safety, facilitated the collection and processing of data in Fortaleza, with special thanks to Dr. Sara Whitehead, Public Health and Preventive Medicine Consultamt with Vital Strategies, an organization that has been dedicating continuous efforts to the city of Fortaleza. The road is still long but, in these first steps, the feeling is undoubtedly one of gratitude.

JOÃO AGUIAR PUPO
Municipal Secretary of Conservation
and Public Services

1. INTRODUCTION

This report brings not only a collection of key road crashes statistics for 2016 but also a more comprehensive look at Fortaleza´s road safety, including data about the behaviorals and preferences of city road users obtained from other sources and generated during the last two years. This report shows the municipal management efforts to better understand the road safety problems, identifying road crash patterns, the profile of the individuals most frequently involved in these crashes (risk groups), the incidence of high-risk behaviors such as drink driving, not wearing helmets correctly, speeding and not using seat belts, among other relevant data. The main goal of the collection, management and analysis of such data is to provide effective guidance to actions and policies for the prevention of road deaths and injuries. The final chapter of this report provides an overview of the main road safety initiatives implemented from 2013 to 2017.

A GLOBAL PUBLIC HEALTH EPIDEMIC

According to the World Health Organization, road traffic injuriescrashes are the 10th leading cause of death in the world. However, they are the leading cause of death among young people aged 15 to 29 years.

DATA AND INFORMATION SOURCES

The data used in this report were compiled by the Road Crassh Information System of Fortaleza (known as SIAT), managed by the Municipal Civics and Transit Authority of Fortaleza (AMC) since 2001. This system is being constantly improved and integrates information from different sources, allowing a quantitative and qualitative analysis of the occurrence of road crashes in the city of Fortaleza.

SIAT integrates data collected by AMC with that provided by the following bodies: The Security Operations Integrated Coordination (CIOPS);the Forensic Polices of the State of Ceará (PEFOCE); Dr. José Frota Hospital (IJF); Ceará State Highway Police (PRE); Federal Highway Police (PRF); Mobile Emergency Service (SAMU) and the Mortality Information System (SIM) managed by the Municipal Secretariat of Health (SMS).

In addition to the SIAT consolidated data, additional information sources were used as well, such as: a) Risk behavior surveysre conducted by the Johns Hopkins University in partnership with the Federal University of Ceará; b) An evaluation survey of the media campaign launched to promote correct helmet; c) Official reports of the Road Deaths Review CommitteeRoad Crashes (known as CGDMAT), which includes representatives of AMC, SAMU, IJF, PEFOCE and SMS. This Committee reviews fatal road crashes to identify preventiable contributing factors crashes.

IMPORTANT DEFINITIONS:

A road crash is defined as a collision or any impact occurring on a roadway causing death, injury or property damage (as defined by the Brazilian Association of Technical Standards, 2015). A Traffic Victim refers to any injured or deceased individual involved in a road crash. The number of road crashes involving injured or fatal victims, therefore, tends to be lower than the number of victims, given that one crash may result in more than one traffic victim.

2. BACKGROUND

IN THE WORLD

According to the World Health Organization´s 2015 Global Status Report on Road Safety, approximately 1.25 million people die as a result of road crashes annually, an average of 1 death every 25 seconds. The global mortality rate is 17.4 deaths from road crashes per 100,000 population.

IN BRAZIL

According to DATASUS (2015), in Brazil 19.4 people per 100,000 inhabitants die in road crashes. Comparing this indicator with the WHO 2015 data, Brazil is the fourth leading country in South American for traffic-related deaths.

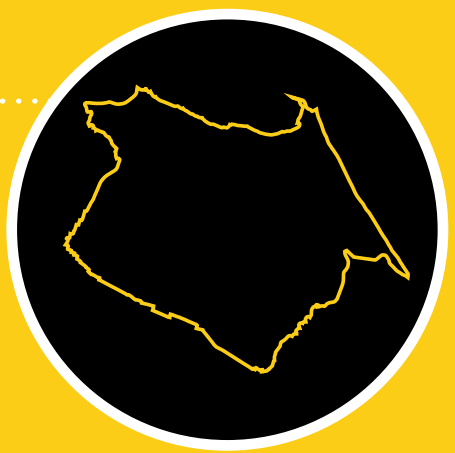
IN FORTALEZA

In 2016, the SIAT recorded 27,492 road crashes. The most common type of crash was collisions between vehicles, accounting for 82.2% of all occurrences. Among these, the most recurrent specific types were lateral (33.2%) and transversal (30.5%) collisions. In 2016, 1,812 crashes with pedestrians (6.6%) were recorded, mostly committed by motorcyclists (43.7% of all cases).

October was the month with most fatal or injury crashes , with 1,402 occurrences. The highest number of occurrences occurred on Saturdays (1st), Mondays (2nd) and Sundays (3rd). The time of day with the highest number of fatal or injury crashes was 5:00 p.m. to 7:00 p.m.

The number of fatalities was 281, 11% lower than in 2015. 90.7% of the fatal victims were vulnerable road users (motorcycle drivers and passengers, cyclists and pedestrians). In 2016, the leading road user types to die in traffic were motorcyclists (47.7%) and pedestrians (30.2%). The basic profile of a fatal victim in Fortaleza is a male motorcyclist aged 18 to 59 years. The direct and indirect costs related to road crashes in 2016 were were estimated to be approximately USD 200 million.

In 2016, the traffic mortality rate in Fortaleza was 10.7 deaths/100,000 inhabitants, showing a decrease of 11.7% compared to 2015 and of 30% compared to 2011, when the UN Decade of Action for Road safety began. This evolution shows a decreasing traffic death risk in Fortaleza. Demographic groups at highest risk of death or injury from traffic are, respectively, men aged over 60 years (pedestrians) and men aged 18 to 29 years (motorcyclists).



According to a study conducted by the Johns Hopkins University in partnership with the Federal University of Ceará, in Fortaleza 1% of drivers drive under the influence of alcohol. However, if we consider both the positive alcohol test results and the number of drivers refusing to take the test, this rate rises to 3.2% likely positives. The study on risk factors showed that 12% of motorcyclists travel without correctly buckled helmets, 20% of all vehicles exceed the speed limit and 16% of car occupants do not use seat belts.

3. FORTALEZA IN NUMBERS

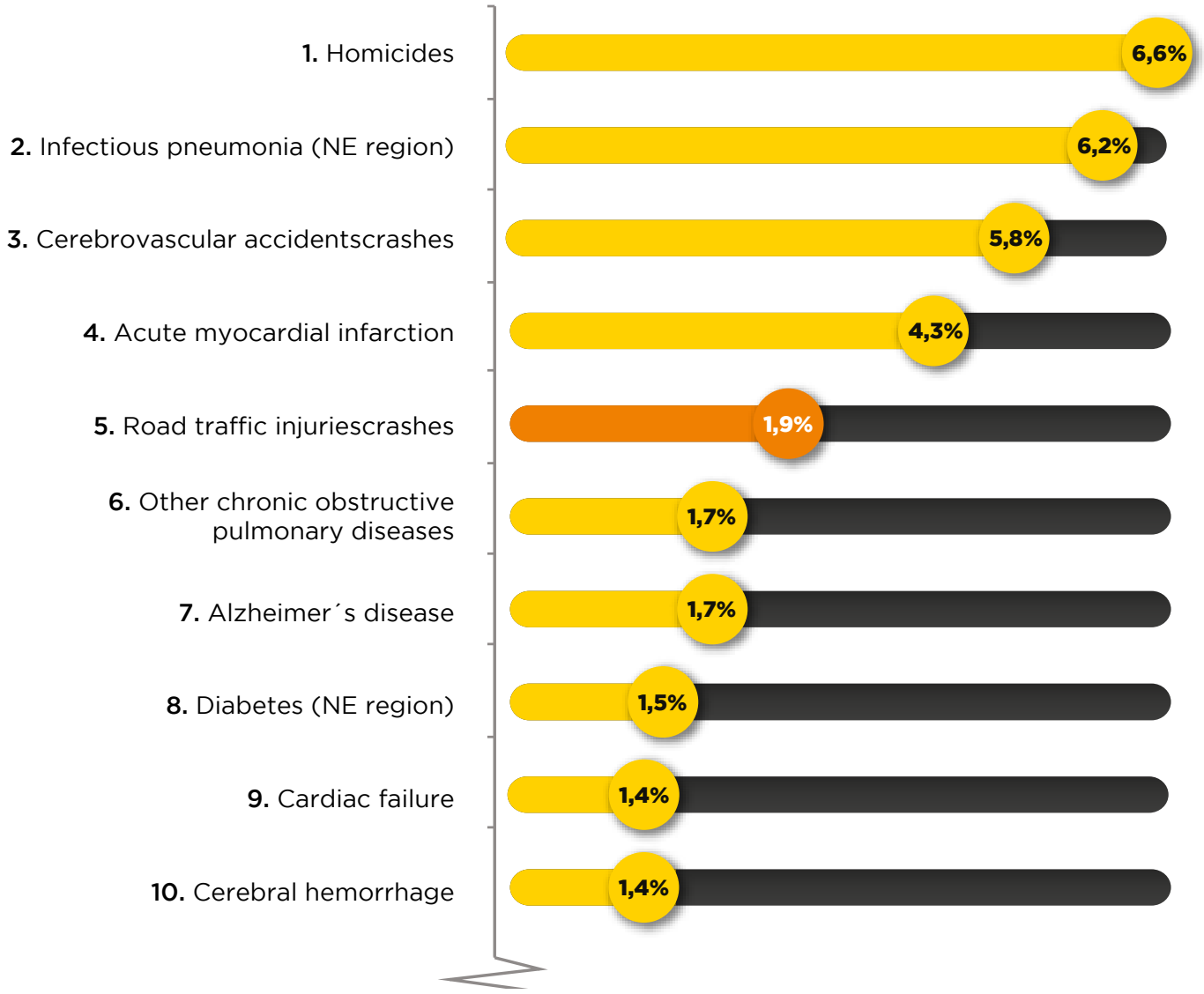
The city of Fortaleza, capital of the State of Ceará, is the 5th largest city in the country with an estimated population of 2.6 million inhabitants in 2016 (IBGE, 2016) and a total area of 314.9 km2, having a population density of approximately 8,287.4 inhabitants/ km2.

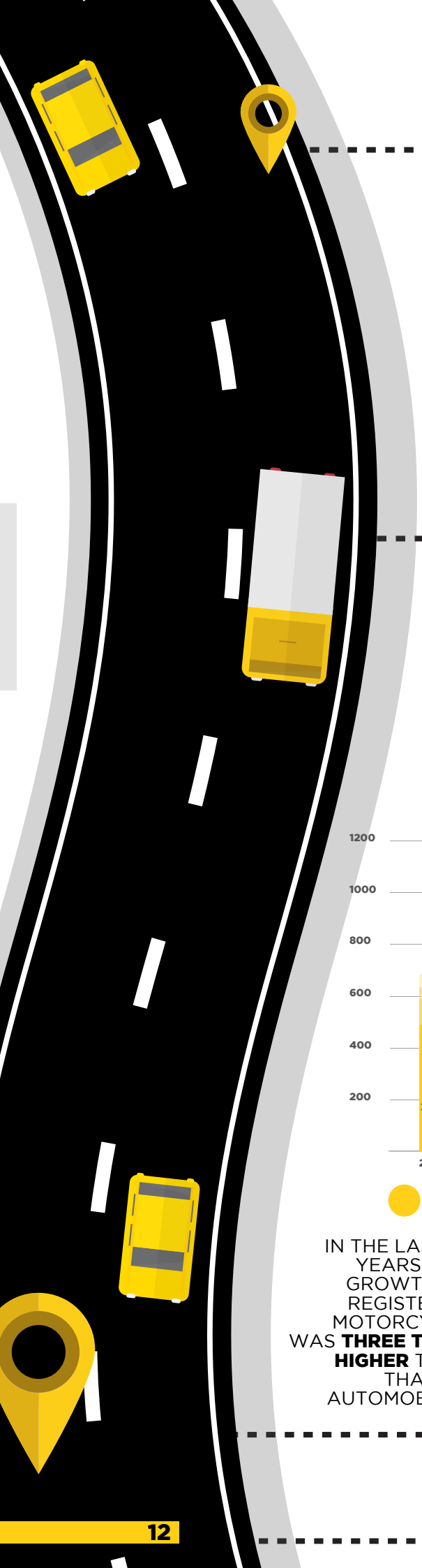
The city has a road network of approximately 4,000 km and a total of 1,039,062 registered vehicles as of December 2016. According to the State Department of Motor Vehicles (DETRAN-CE), 26.8% of all vehicles are motorcycles. The city has a motorization rate of 2.51 inhabitants/vehicle.

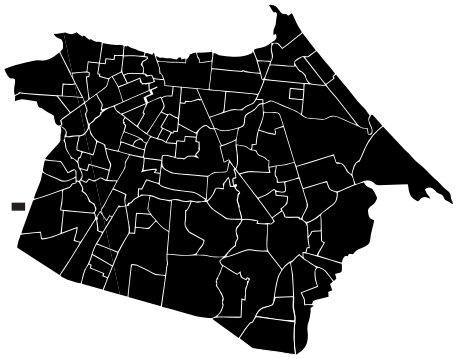
TRAFFIC MORTALITY:

According to the Municipal Health Secretariat, deaths due to road crashes are decreasing in a sustained manner, indicating that public interventions and policies have been successful. Despite the downward trend, however, road traffic injuriescrashes are the 5th leading cause of death in the city.

FIGURE 01 - MAIN CAUSES OF DEATH IN THE CITY OF FORTALEZA (SMS, 2017)





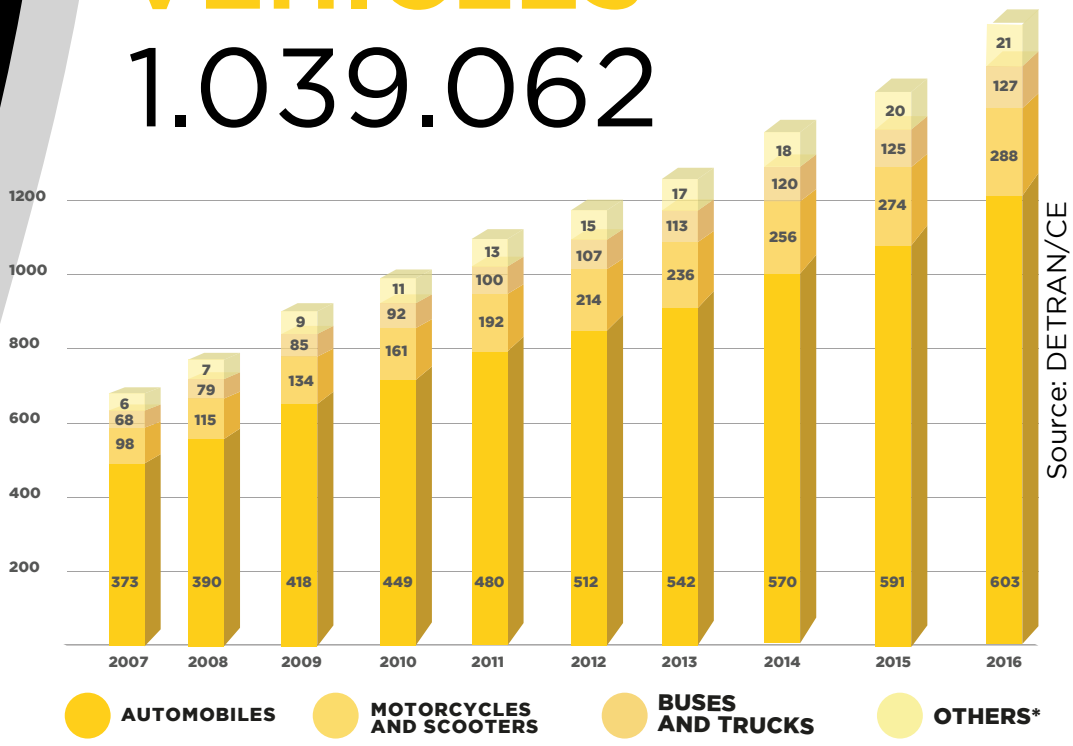


POPULATION
2.609.716
INHABITANTS

5TH LARGEST CITY IN THE COUNTRY

Source: IBGE

REGISTERED VEHICLES
1.039.062



Source: DETRAN/CE

IN THE LAST 10 YEARS, THE GROWTH OF REGISTERED MOTORCYCLE WAS **THREE TIMES HIGHER** THAN THAT OF AUTOMOBILES

3X

ROAD NETWORK 4.000 KM

CRASHES AND VICTIMS IN 2016

27.492
ROAD CRASHES

274
FATAL CRASHES

14.873
INJURY CRASHES

12.345
PROPERTY DAMAGE ONLY CRASHES

281
FATALITIES

18.295
INJURED VICTIMS

ONE PERSON DIES FOR EVERY 98 RECORDED CRASHES

4. TOTAL CRASHES IN 2016

4.1 NUMBER AND TYPES OF CRASHES

In 2016, SIAT recorded a grand total of 27,492 crashes. However, the statistical series must be interpreted with caution (Figure 03) as the data collection methodology was improved in the last year. The main change was in obtaining data from the SAMU emergency service, which increased the recorded number of injury crashes, a fact that can be clearly seen in the jump of reported injury crashes from 2015 to 2016 (Figure 04). 274 crashes had at least one fatality, but this parameter shows a decreasing trend (Figure 05). In 2016, 82.2% of all crashes were recorded as collisions. Among the collisions with injured or fatal victims, the most frequent was "Transversal Collision". Figure 06 shows the distribution of occurrences by type and severity.

FIGURE 03 - TOTAL CRASHES (2002-2016)

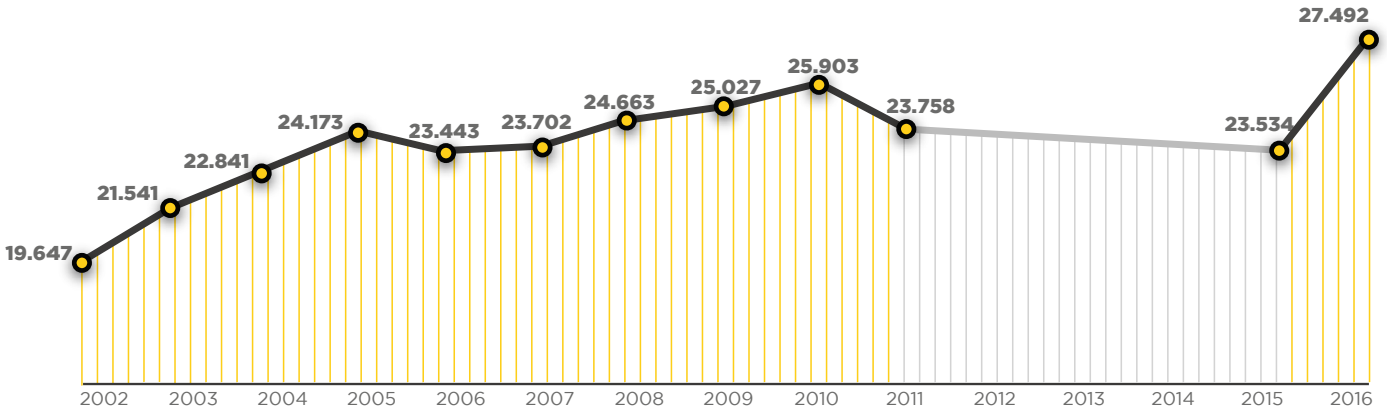


FIGURE 04 – INJURY CRASHES (2002-2016)

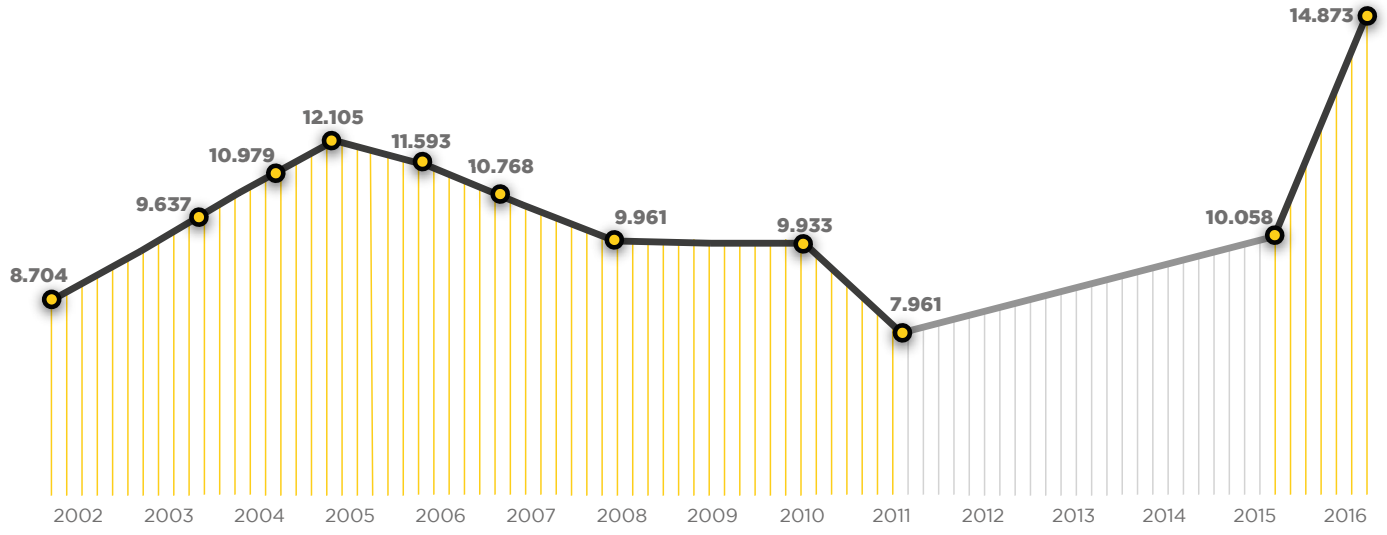


FIGURE 05 – FATAL CRASHES (2002-2016)

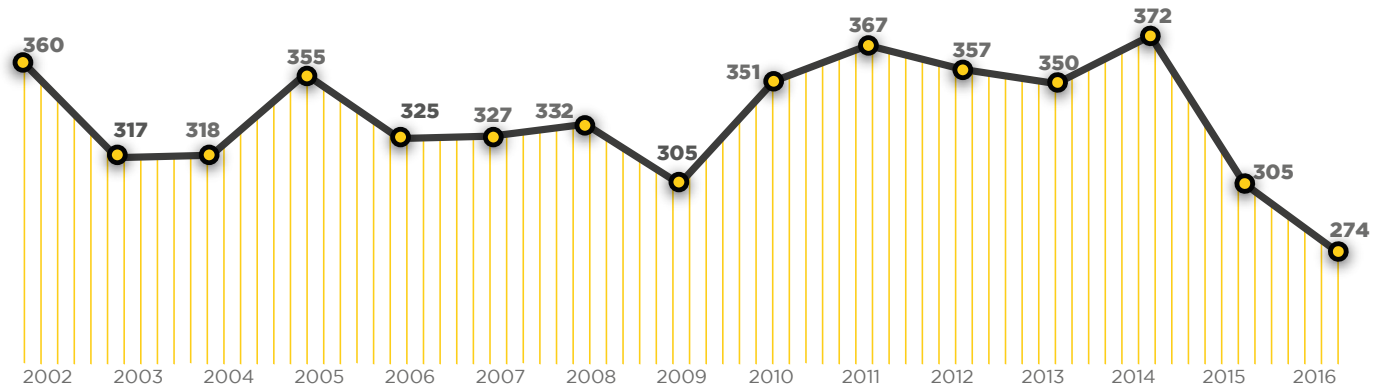
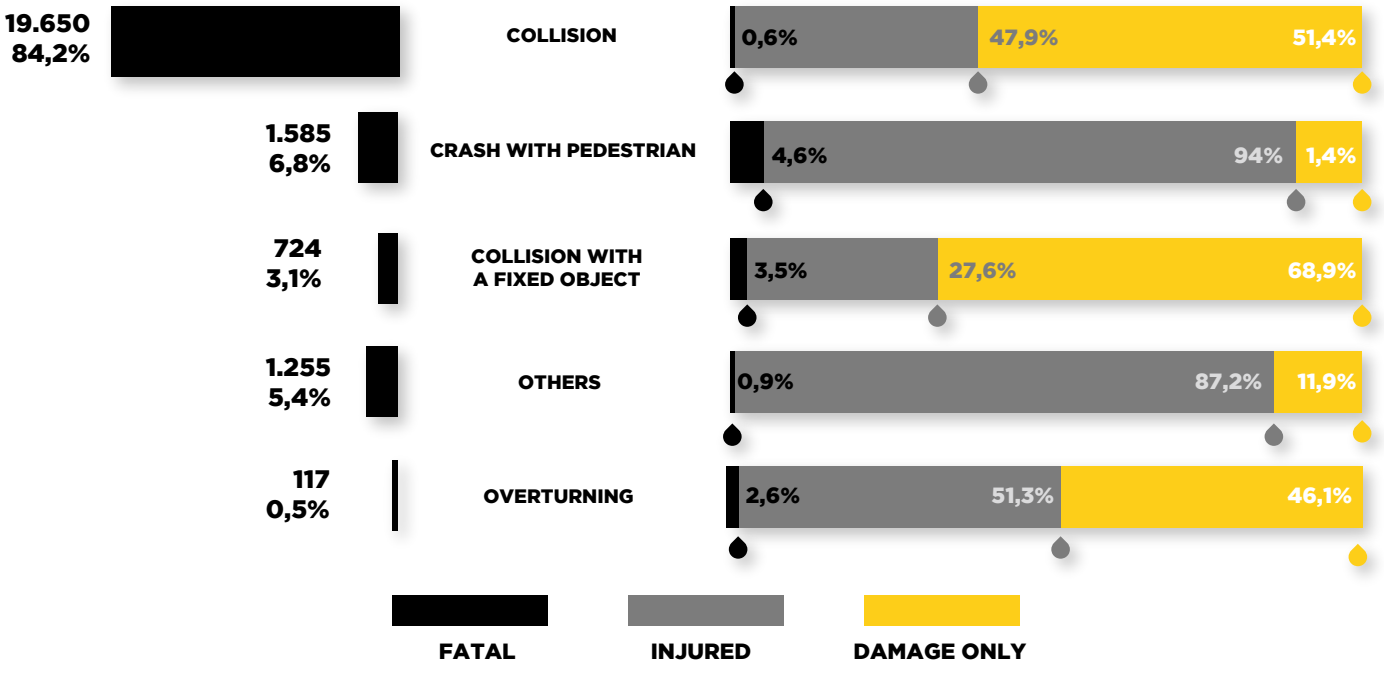


FIGURE 06 - TYPE OF CRASH AND SEVERITY



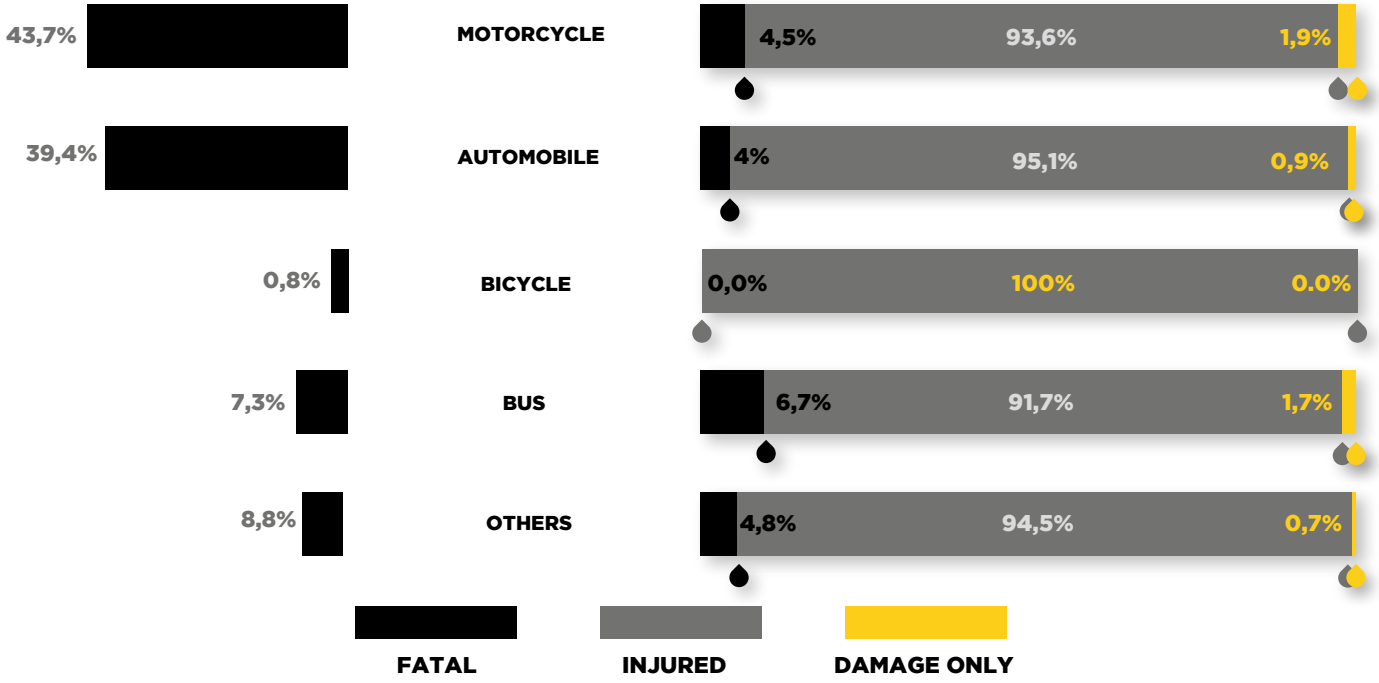
CRASHES INVOLVING CYCLISTS

In 2016, 721 crashes involving cyclists were recorded. On this page you can see the distribution of crashes involving cyclists by severity (fatal, injury, victims and damage only). As it is a vulnerable category of users, the death rate is three times higher than the average of all crashes. The low number of crashes with damage only is due, among other reasons, to the fact that such crashes are seldom reported or collected by the SIAT. The same occurs with crashes involving pedestrians.

FIGURE 07 - SEVERITY BY TYPE OF CRASH INVOLVING CYCLISTS (2016)

Crashes with pedestrians are quite a problematic reality in Fortaleza. Figure 08 shows that one every 22 occurrences results in fatalities. Pedestrians are run over mostly by motorcycles

FIGURE 08 – CRASHES WITH PEDESTRIANS BY TYPE OF VEHICLE AND SEVERITY (2016)



VULNERABLE USERS

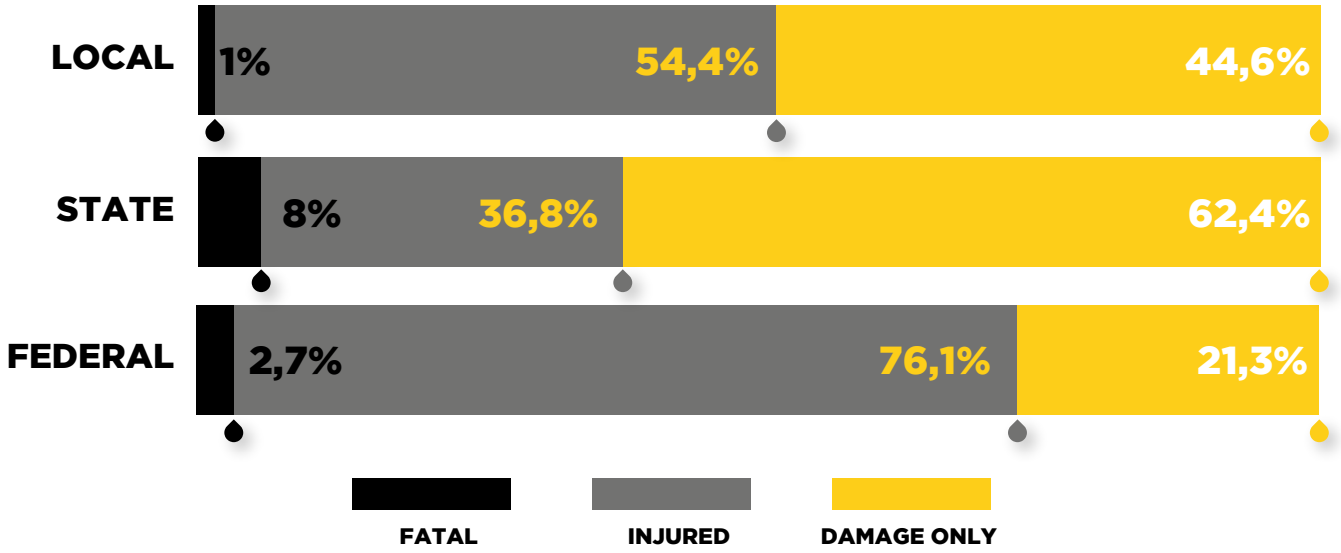
The table below (Table 01) shows the type of vehicles more frequently involved in cyclist, pedestrian and motorcycle crashes. These are the most physically unprotected users. Overall, in 2016 there were 214 fatalities among such vulnerable users.

TABLE 01 - TYPE OF VEHICLES INVOLVED IN FATAL COLLISIONS WITH VULNERABLE USERS

Hitting vehicle / Vulnerable user	MOTORCYCLE	AUTOMOBILE	PICK-UP TRUCK	TRUCK	BUS	MINIBUS	OBSTACLE	GRAND TOTAL
PEDESTRIAN	31	26	3	3	8	2	1	74
CYCLIST	3	5	3	4	5	0	0	20
MOTORCYCLIST	7	46	13	8	23	0	23	120
TOTAL	41	77	19	15	36	2	24	214

An analysis of the distribution of crashes by road jurisdiction and severity shows that 7.4% of all crashes occurred on state or federal roads (92.6% on local, 4.8% on state and 2.6% on federal roadways), similar to the distribution reported in the 2015 Annual Report of Road Crashes. Figure 09 shows that crashes on federal roads tend to be more severe, a fact that may be related to their higher speed limits as these roads often function as urban highways.

FIGURE 09 - CRASHES ACCORDING TO ROAD JURISDICTION



4.2 TEMPORAL DISTRIBUTION OF CRASHES

Figures 10, 11 and 12 show the distribution of total crashes by month, day and time of day, respectively. The distribution of crashes by day shows that most crashes occur during the weekend, when the consumption of alcohol is more common and when the roads are less congested, thus allowing higher speeds.

FIGURE 10 - DISTRIBUTION OF CRASHES BY MONTH

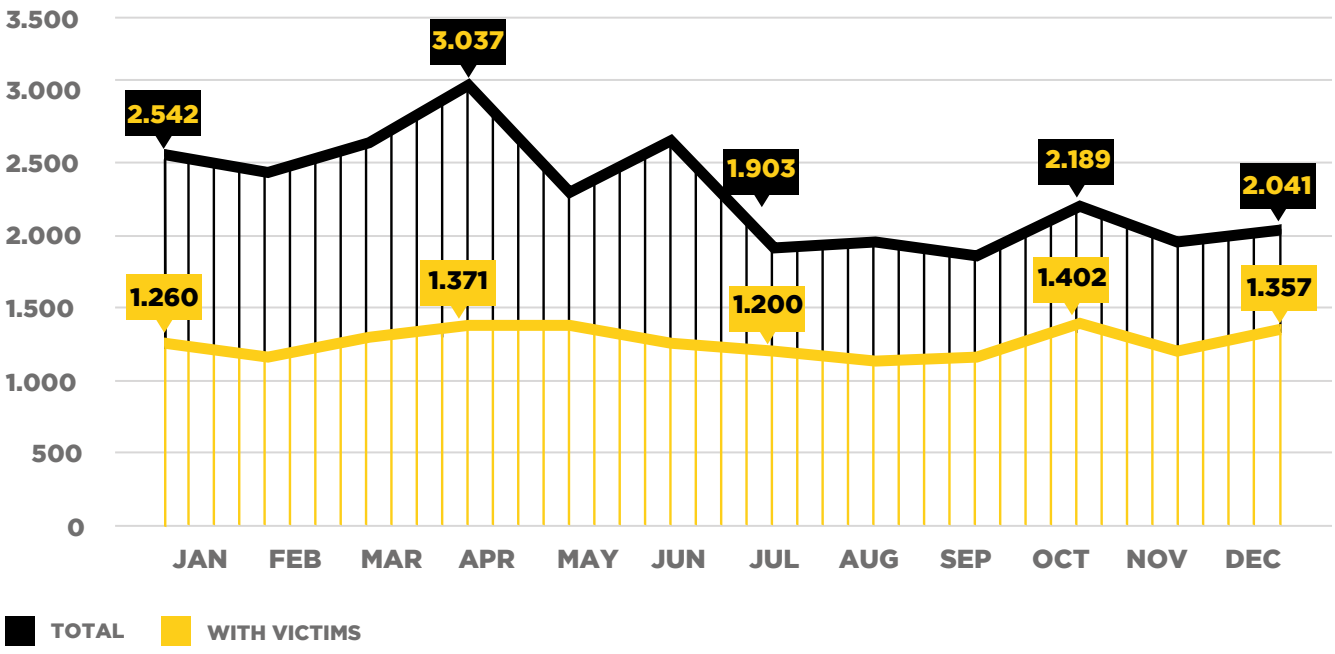


FIGURE 11 - DISTRIBUTION OF CRASHES BY DAY OF THE WEEK

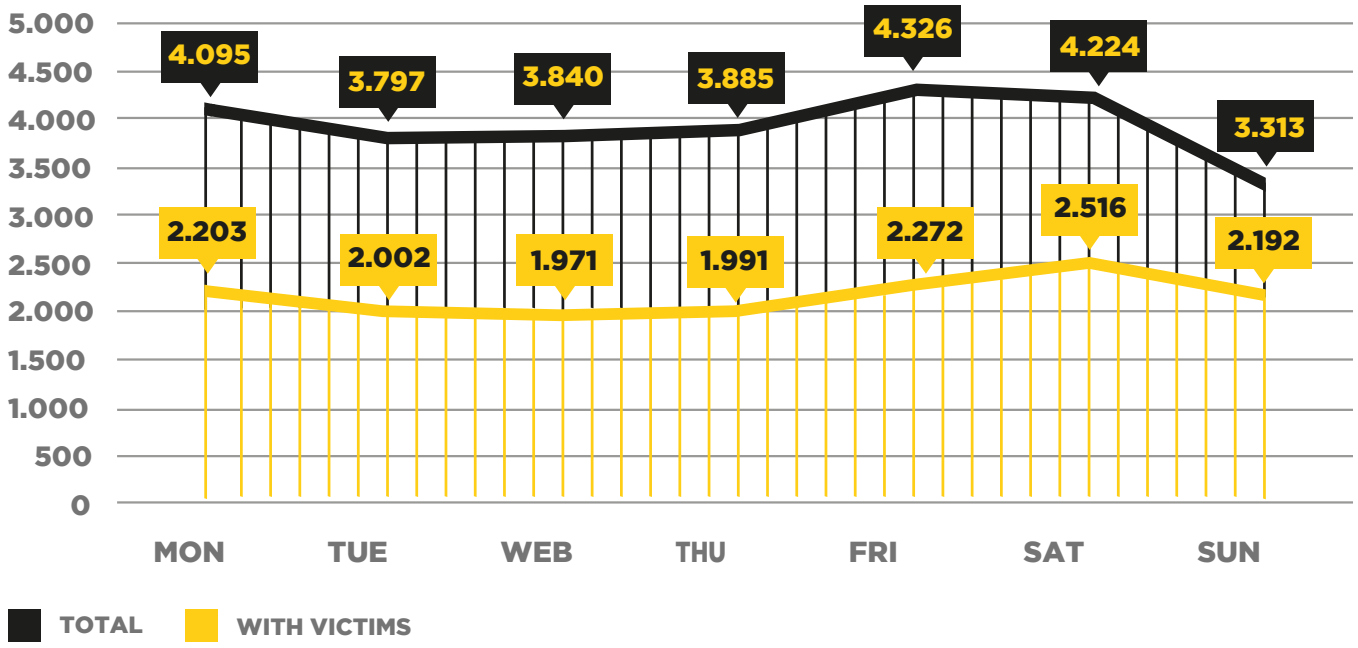
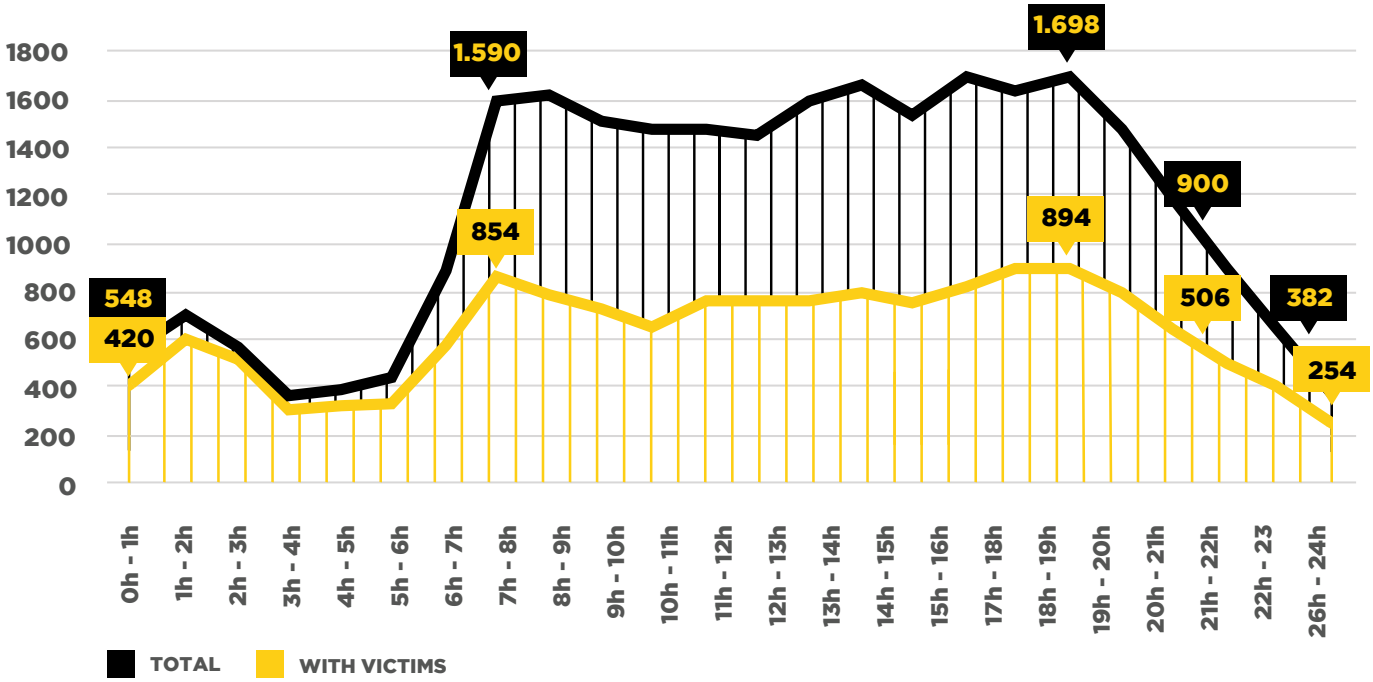


FIGURE 12 - DISTRIBUTION OF CRASHES BY TIME OF DAY



Tables 02 to 05 show a heatmap by day and by time of day, making it possible to identify critical periods and weekly patterns. In general, we can see that 34.8% of all occurrences with fatalities or injured victims occur between 7:00 am and 10:00 am and from 5:00 pm to 8:00 pm. Likewise, on weekends 30.9% of all occurrences occur between 3:00 pm and 9:00 pm.

TABLE 02 - CRASHES WITH FATALITIES OR INJURED VICTIMS

TIME	MON	TUE	WED	THU	FRI	SAT	SUN	TOTAL
00:00 to 01:00am	80	30	40	38	71	67	94	**420**
01:00 to 02:00am	97	81	70	73	85	90	105	**601**
02:00 to 03:00am	78	50	57	73	72	71	110	**511**
03:00 to 04:00am	58	23	21	37	25	74	71	**309**
04:00 to 05:00am	36	32	29	32	49	76	63	**317**
05:00 to 06:00am	34	48	44	42	35	55	72	**330**
06:00 to 07:00am	82	85	86	77	77	95	74	**576**
07:00 to 08:00am	145	140	99	129	149	112	80	**854**
08:00 to 09:00am	140	117	120	102	123	111	71	**784**
09:00 to 10:00am	126	96	111	90	92	123	92	**730**
10:00 to 11:00am	95	91	93	94	88	119	72	**652**
11:00 to 12:00pm	122	114	98	110	90	123	100	**757**
12:00 to 01:00pm	98	120	98	94	125	125	105	**765**
01:00 to 02:00pm	102	107	107	105	120	118	108	**767**
02:00 to 03:00pm	119	106	102	102	138	118	111	**796**
03:00 to 04:00pm	93	101	100	95	124	126	105	**744**
04:00 to 05:00pm	109	116	111	115	118	133	123	**825**
05:00 to 06:00pm	149	106	109	138	153	120	117	**892**
06:00 to 07:00pm	124	140	116	130	137	130	117	**894**
07:00 to 08:00pm	107	107	123	108	109	130	110	**794**
08:00 to 09:00pm	86	72	79	71	88	136	107	**639**
09:00 to 10:00pm	55	50	76	59	83	102	81	**506**
10:00 to 11:00pm	46	44	58	50	69	80	63	**410**
11:00 to 12:00am	20	21	23	25	50	79	36	**254**
Missing	2	5	1	2	2	3	5	**20**
TOTAL	2.203	2.002	1.971	1.991	2.272	2.516	2.192	**15.147**

TABLE 03 – FATAL AND INJURY CRASHES INVOLVING MOTORCYCLES

TIME	MON	TUE	WED	THU	FRI	SAT	SUN	TOTAL
00:00 to 01:00am	43	18	23	21	43	44	56	**248**
01:00 to 02:00am	65	61	55	49	56	47	61	**394**
02:00 to 03:00am	59	40	46	56	61	51	63	**376**
03:00 to 04:00am	39	20	14	27	15	48	43	**206**
04:00 to 05:00am	21	27	25	22	29	42	31	**197**
05:00 to 06:00am	24	36	35	22	22	43	46	**228**
06:00 to 07:00am	64	64	60	54	54	63	50	**409**
07:00 to 08:00am	111	114	84	104	120	92	59	**684**
08:00 to 09:00am	116	84	93	81	90	87	44	**595**
09:00 to 10:00am	97	71	72	71	76	77	59	**523**
10:00 to 11:00am	72	72	64	70	69	84	52	**483**
11:00 to 12:00pm	91	85	67	87	64	89	64	**547**
12:00 to 01:00pm	75	90	76	72	87	90	66	**556**
01:00 to 02:00pm	71	80	73	77	83	80	69	**533**
02:00 to 03:00pm	85	75	71	80	105	78	69	**563**
03:00 to 04:00pm	71	69	78	68	84	87	70	**527**
04:00 to 05:00pm	79	84	68	80	82	81	83	**557**
05:00 to 06:00pm	107	78	76	92	98	77	71	**599**
06:00 to 07:00pm	93	109	77	102	90	74	65	**610**
07:00 to 08:00pm	77	69	88	58	73	78	68	**511**
08:00 to 09:00pm	57	45	43	45	53	78	66	**387**
09:00 to 10:00pm	33	33	50	30	52	59	54	**311**
10:00 to 11:00pm	28	20	35	34	42	48	45	**252**
11:00 to 12:00am	9	16	12	17	29	46	19	**148**
Missing	1	5	0	2	1	2	4	**15**
TOTAL	1.588	1.465	1.385	1.421	1.578	1.645	1.377	**10.459**

TABLE 04 - FATAL AND INJURY CRASHES CRASHES INVOLVING CYCLISTS

TIME	MON	TUE	WED	THU	FRI	SAT	SUN	TOTAL
00:00 to 01:00am	3	0	4	1	3	0	3	**14**
01:00 to 02:00am	5	3	2	3	5	4	4	**26**
02:00 to 03:00am	0	2	3	3	0	4	4	**16**
03:00 to 04:00am	3	1	2	2	0	1	3	**12**
04:00 to 05:00am	3	1	1	0	0	5	5	**15**
05:00 to 06:00am	2	4	3	3	2	0	4	**18**
06:00 to 07:00am	2	1	4	3	1	4	2	**17**
07:00 to 08:00am	2	7	2	3	5	1	2	**22**
08:00 to 09:00am	4	9	6	2	4	4	6	**35**
09:00 to 10:00am	7	4	7	5	2	8	7	**40**
10:00 to 11:00am	6	3	4	0	0	5	6	**24**
11:00 to 12:00pm	2	8	7	10	4	4	12	**47**
12:00 to 01:00pm	4	8	6	3	4	6	6	**37**
01:00 to 02:00pm	4	6	6	5	9	8	4	**42**
02:00 to 03:00pm	7	3	5	1	5	7	10	**38**
03:00 to 04:00pm	1	4	5	1	3	7	6	**27**
04:00 to 05:00pm	3	4	4	3	6	8	7	**35**
05:00 to 06:00pm	10	3	5	11	7	9	9	**54**
06:00 to 07:00pm	10	4	8	5	8	7	11	**53**
07:00 to 08:00pm	8	5	4	3	6	9	3	**38**
08:00 to 09:00pm	7	3	5	3	3	8	3	**32**
09:00 to 10:00pm	3	4	4	5	5	2	1	**24**
10:00 to 11:00pm	4	2	2	1	5	2	2	**18**
11:00 to 12:00am	2	0	1	0	2	3	2	**10**
Missing	0	0	0	0	0	0	0	**0**
TOTAL	102	89	100	76	89	116	122	**694**

TABLE 05 - FATAL AND INJURY CRASHES INVOLVING PEDESTRIANS

HORA	MON	TUE	WED	THU	FRI	SAT	SUN	TOTAL
00:00 to 01:00am	13	2	6	4	11	7	16	**59**
01:00 to 02:00am	5	8	6	13	6	10	11	**59**
02:00 to 03:00am	3	1	3	5	7	6	7	**32**
03:00 to 04:00am	7	1	1	2	4	8	3	**26**
04:00 to 05:00am	5	2	1	2	2	6	8	**26**
05:00 to 06:00am	5	3	4	6	3	10	4	**35**
06:00 to 07:00am	6	7	8	8	5	9	6	**49**
07:00 to 08:00am	18	12	9	9	14	8	3	**73**
08:00 to 09:00am	11	12	14	6	12	11	6	**72**
09:00 to 10:00am	15	10	12	10	8	12	12	**79**
10:00 to 11:00am	10	9	10	10	12	18	9	**78**
11:00 to 12:00pm	9	13	8	12	14	12	9	**77**
12:00 to 01:00pm	12	15	10	12	17	15	14	**95**
01:00 to 02:00pm	16	10	9	8	16	9	12	**80**
02:00 to 03:00pm	8	18	11	11	11	18	17	**94**
03:00 to 04:00pm	10	15	8	17	19	9	18	**96**
04:00 to 05:00pm	13	17	16	14	12	13	17	**102**
05:00 to 06:00pm	28	15	11	29	21	14	15	**133**
06:00 to 07:00pm	22	21	14	16	25	28	22	**148**
07:00 to 08:00pm	14	22	18	21	11	20	21	**127**
08:00 to 09:00pm	9	11	13	9	14	25	14	**95**
09:00 to 10:00pm	4	3	11	10	15	18	14	**75**
10:00 to 11:00pm	6	4	8	4	8	10	11	**51**
11:00 to 12:00am	4	1	3	1	6	8	0	**23**
Missing	0	1	1	0	0	1	0	**3**
TOTAL	253	233	215	239	273	305	269	**1.787**

4.3. SPATIAL DISTRIBUTION OF CRASHES

The following heatmaps are a tool for identifying spatial crashes concentration patterns. The spatial distribution of events along with the identification of the critical time periods allow more efficient enforcement and education actions in areas of critical crash intensity.

Below we show a list of the maps (A to H) shown in the following pages. It is important to point out that heatmaps allow a comparative analysis between different densities for the same map. However, each map has its own scale so it is not recommended to compare these intensities between the different maps.

FATAL AND INJURY CRASHES — A

FATAL CRASHES — B

FATAL AND INJURY PEDESTRIAN CRASHES — C

FATAL AND INJURY CRASHES INVOLVING CYCLISTS — D

FATAL AND INJURY CRASHES INVOLVING MOTORCYCLES — E

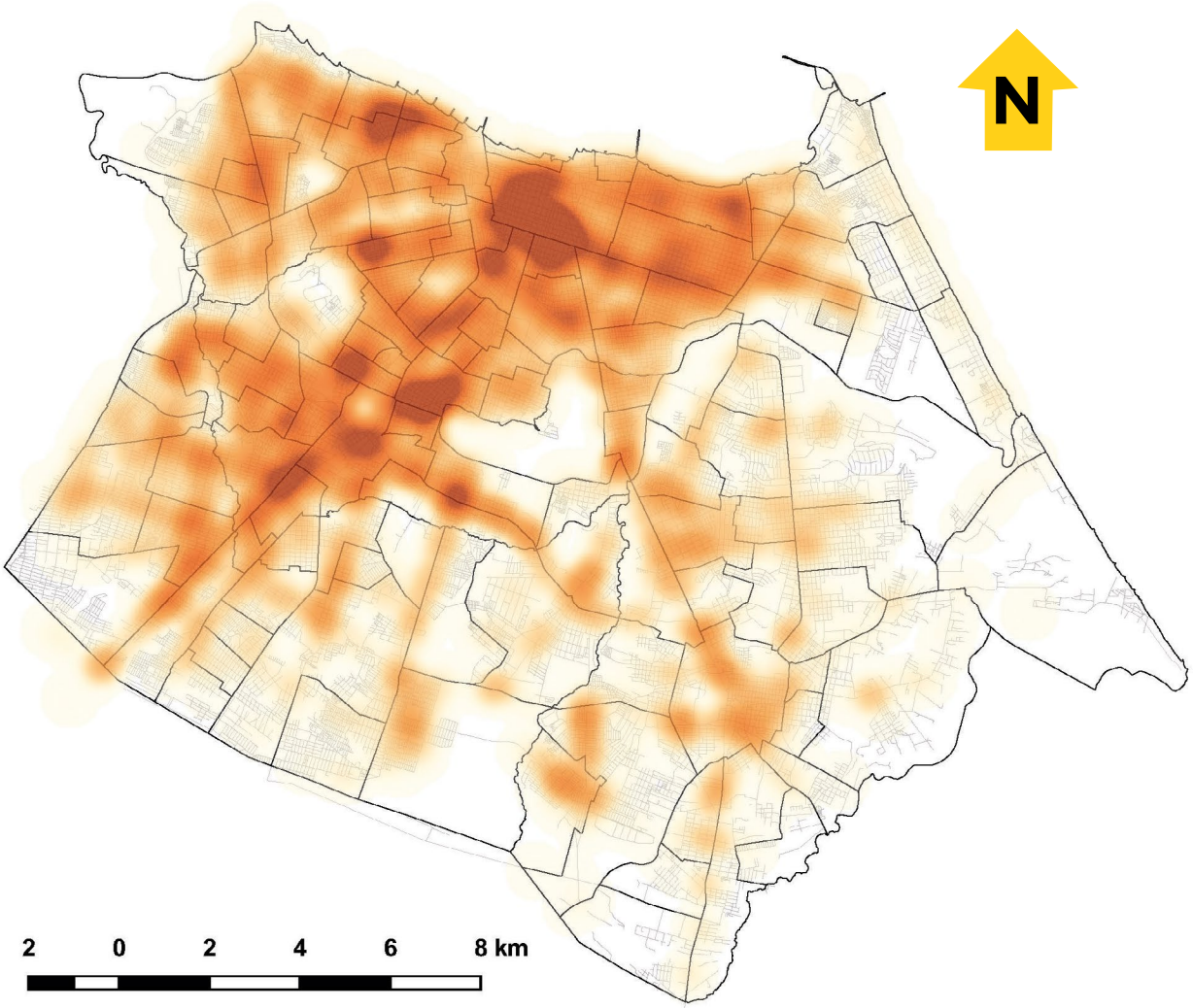
FATAL CRASHES INVOLVING MOTORCYCLES — F

WEEKEND FATAL AND INJURY CRASHES — G

WEEKEND FATAL CRASHES — H

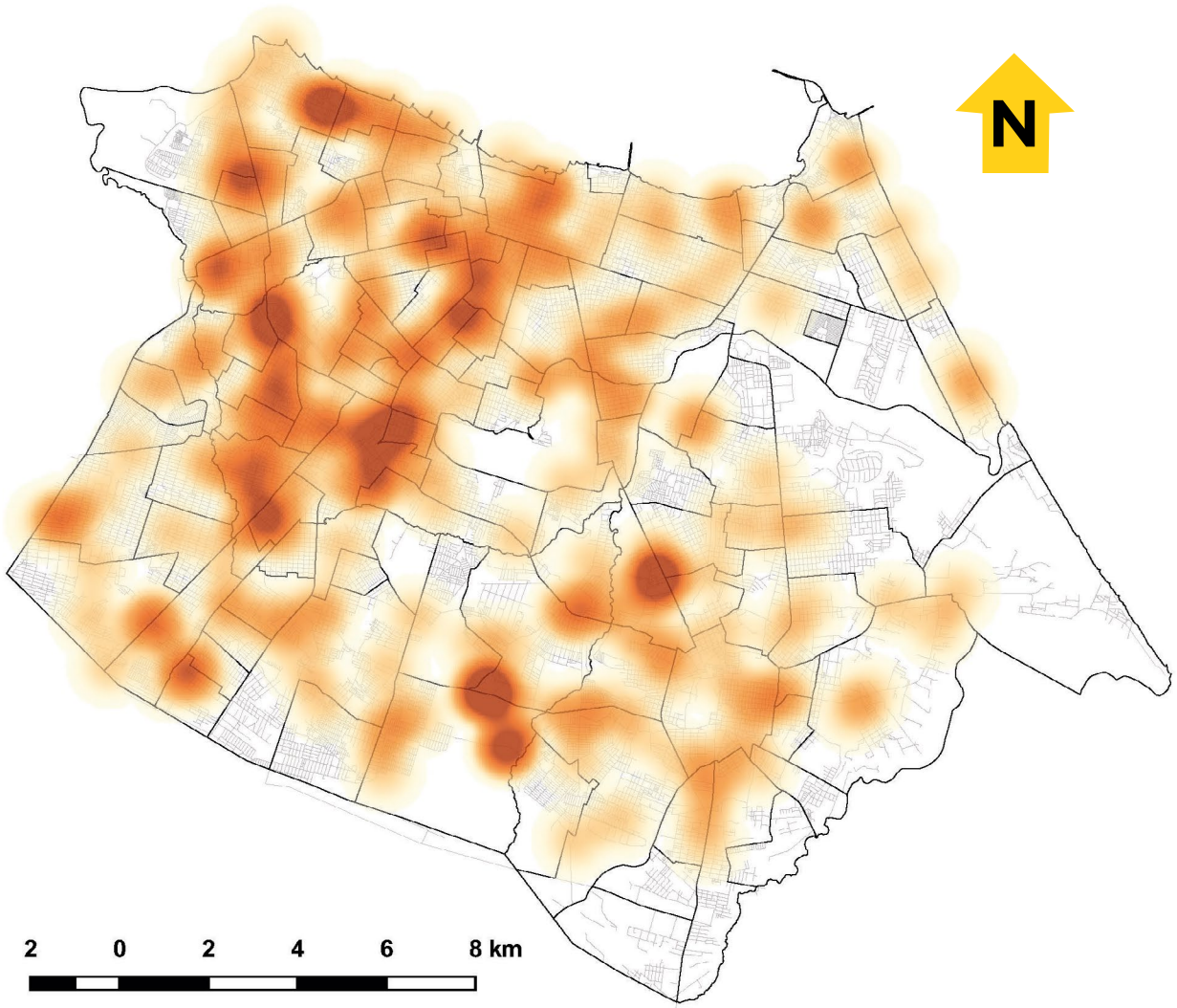
FATAL AND INJURY CRASHES

A

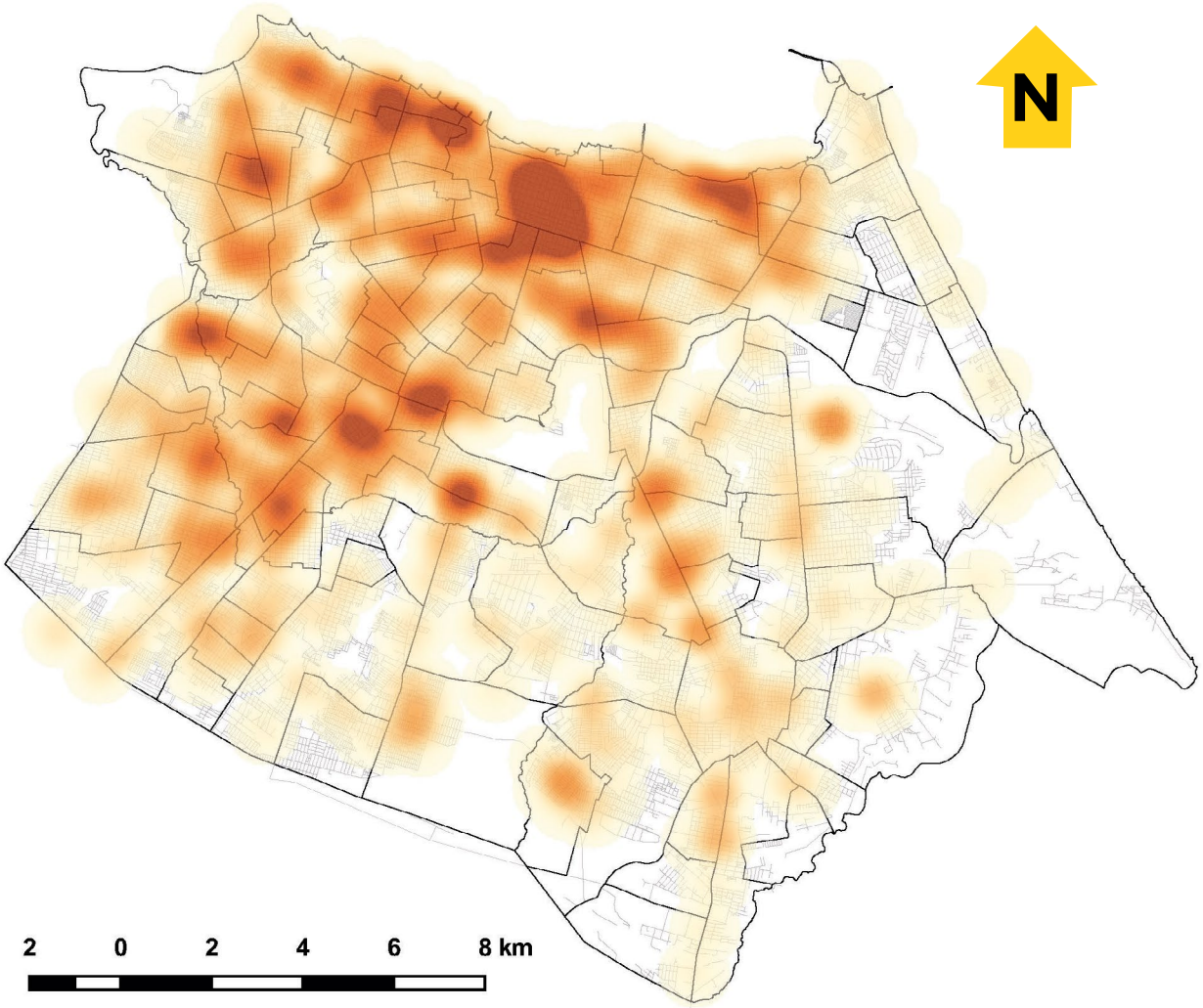


FATAL CRASHES

B

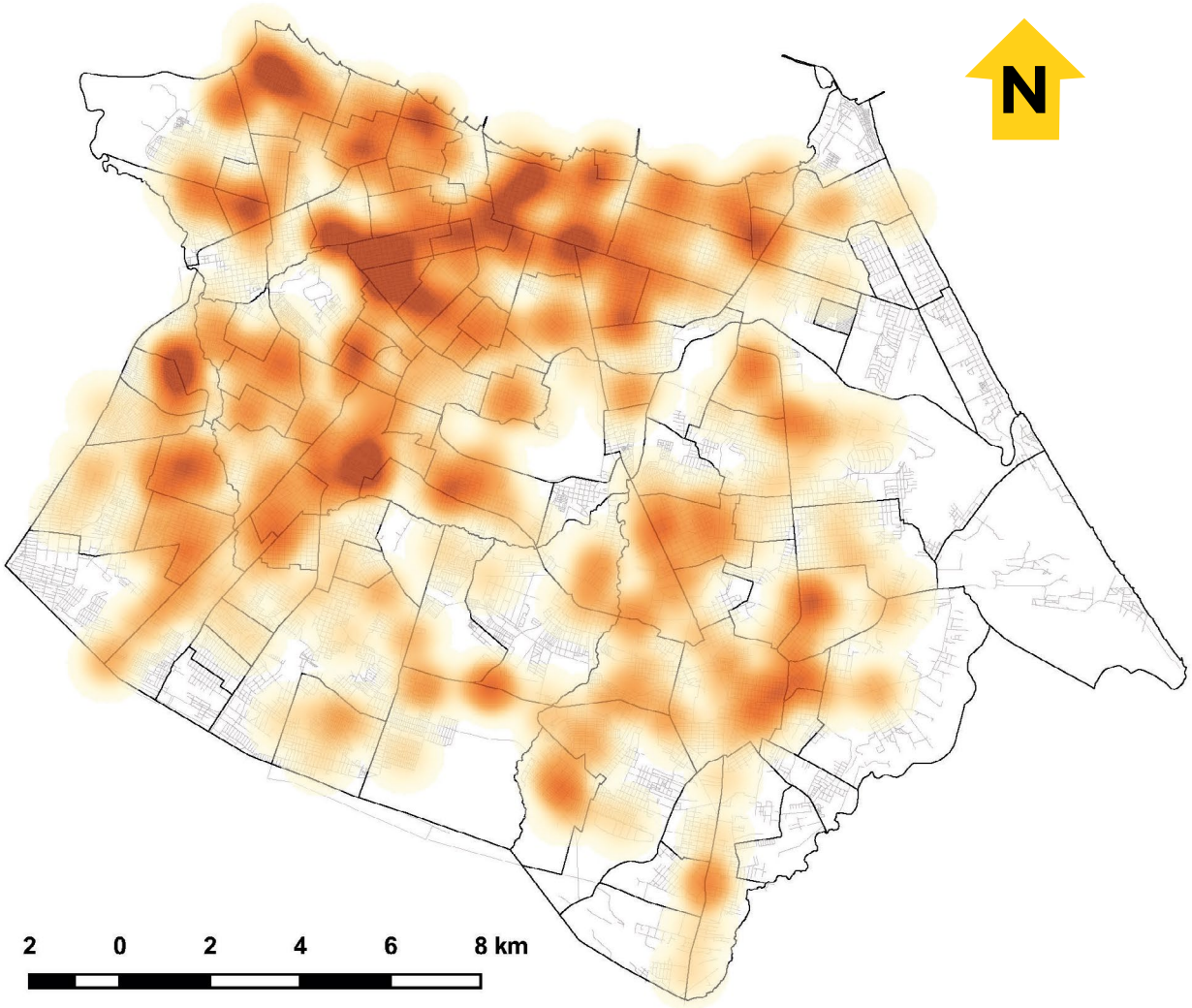


FATAL AND INJURY PEDESTRIANS CRASHES



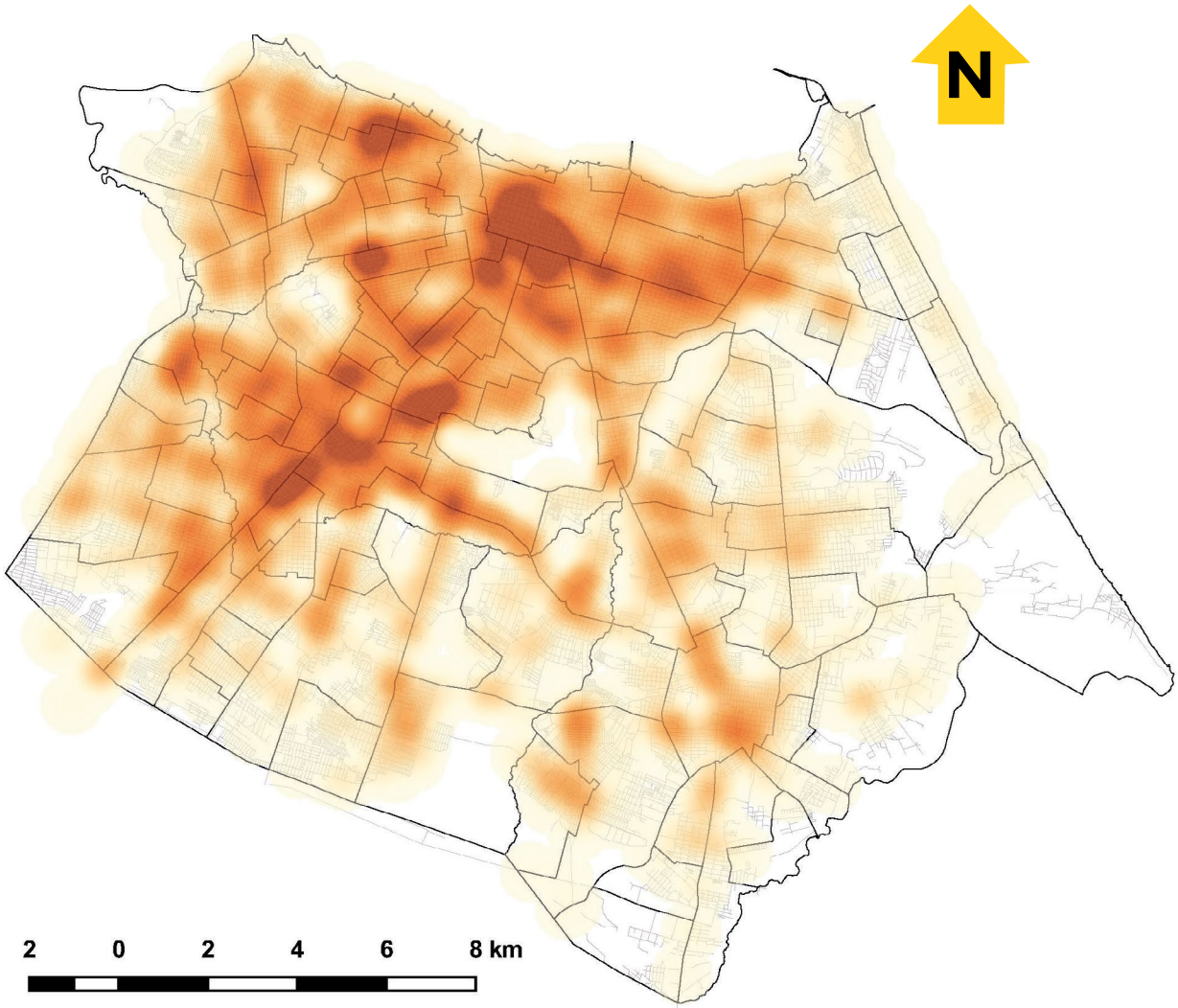
FATAL AND INJURY CRASHES INVOLVING CYCLISTS

D

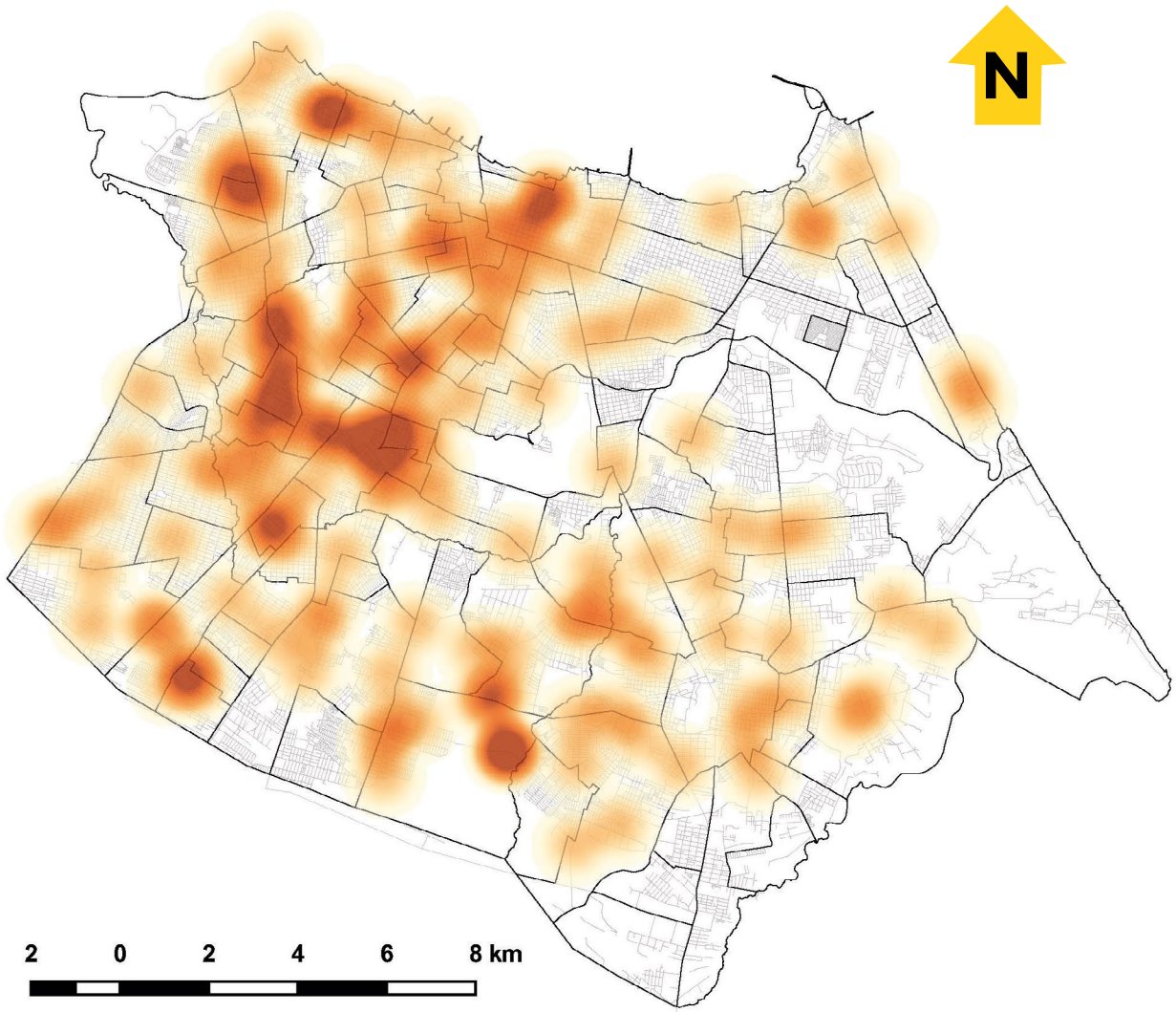


FATAL AND INJURY CRASHES INVOLVING MOTORCYCLES

E

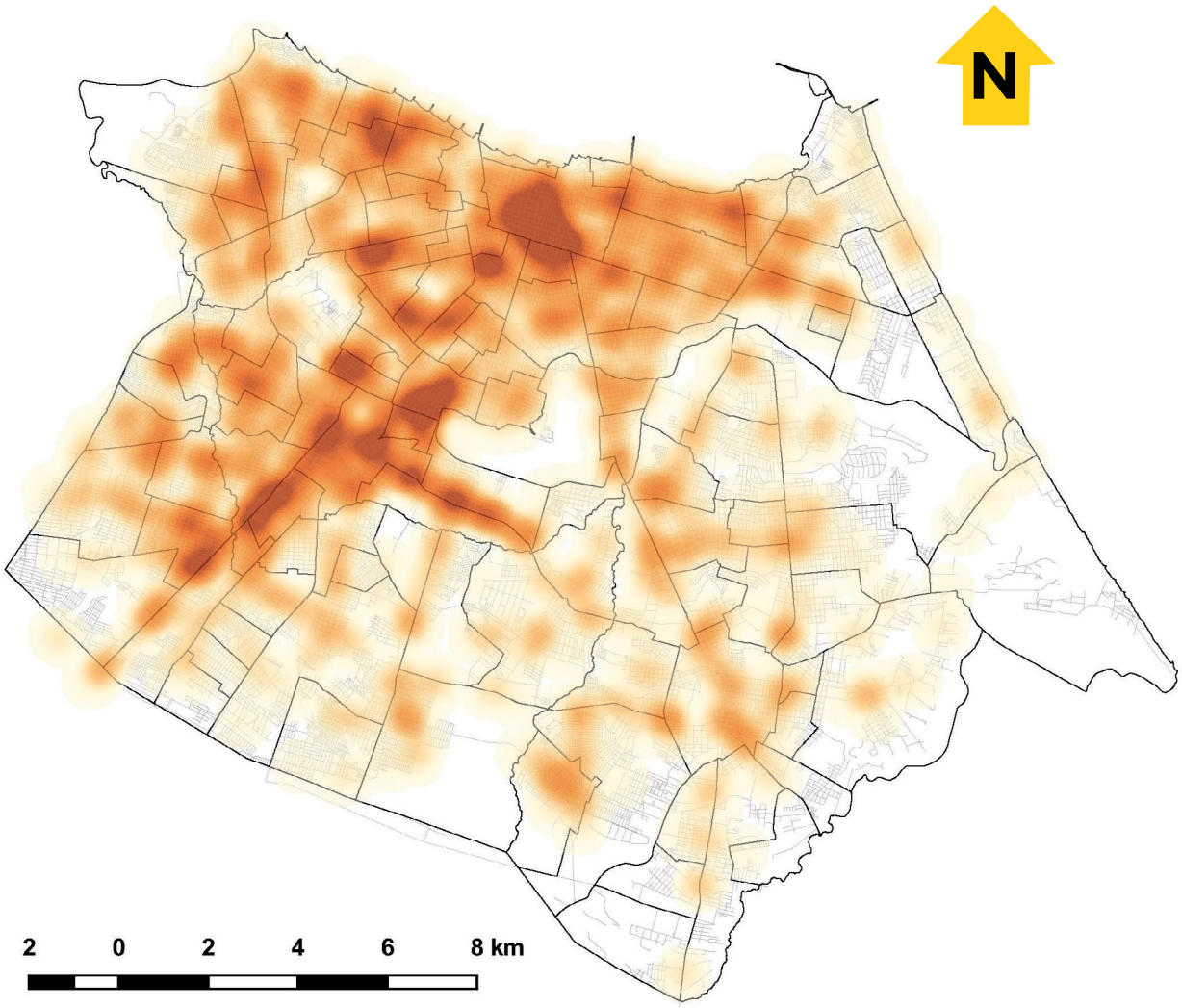


FATAL CRASHES INVOLVING MOTORCYCLES

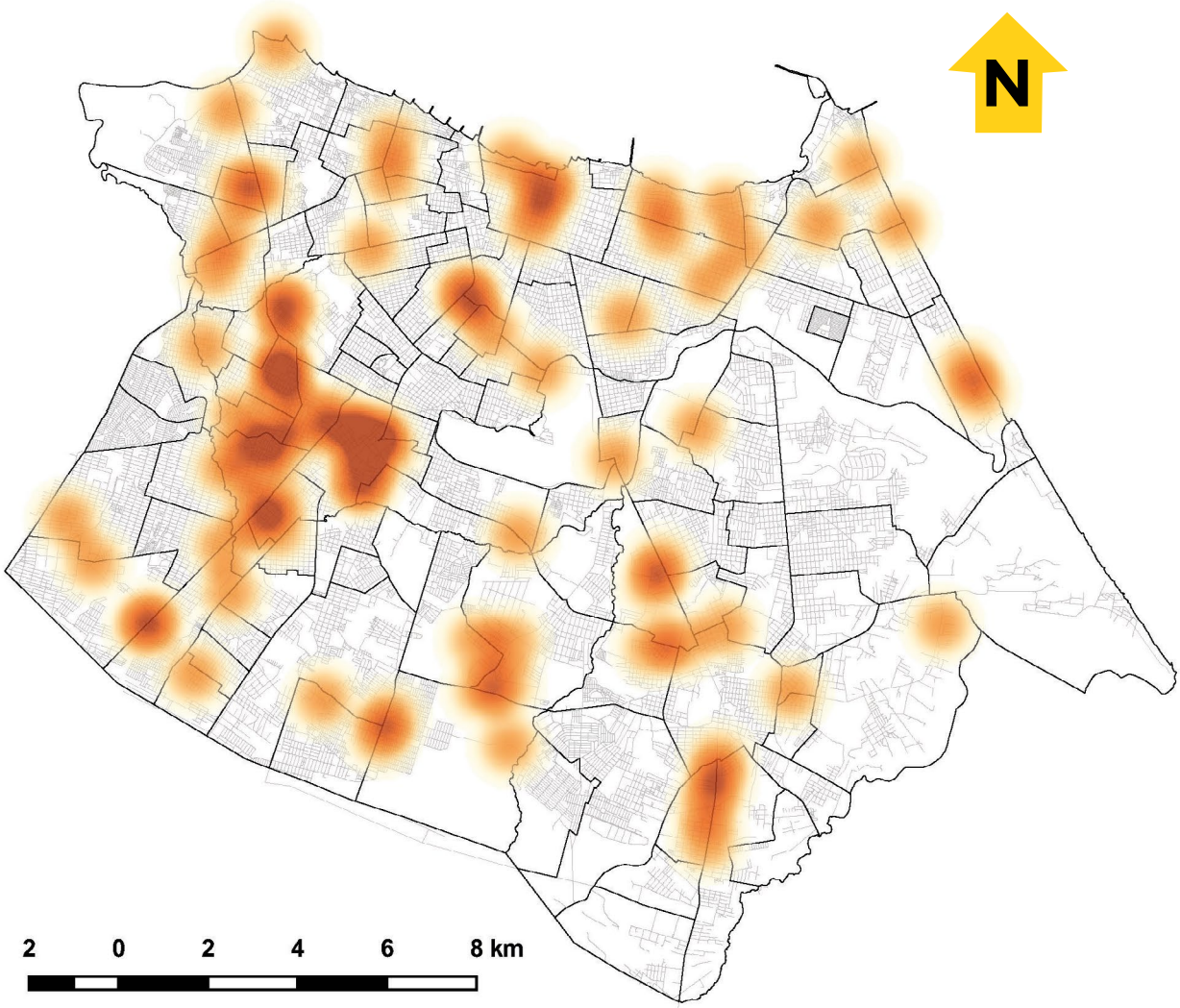


WEEKEND FATAL AND INJURY CRASHES

G



WEEKEND FATAL CRASHES



5. VICTIM PROFILES

INJURED VICTIMS

During 2016, there was an improvement in the recording of injured victims, mainly because of the information provided by SAMU after a better routine road crash database search was put in place. As a result, we have a higher number of recorded cases in 2016 than in 2015, but that does not necessarily mean an increase in the number of victims, as the data collection method changed. Therefore, caution is recommended when comparing the absolute number of injured victims in historical series. However, the analysis involving user type, gender and age for the year of 2016 are still valid. The period between 2012 and 2014 only contains information on fatal victims. In 2016, we had a total of 18,295 injured victims in road crashes (Figure 13). Motorcyclists remain the most frequent injured victims, followed by car drivers (together with drivers of other vehicles with 4 or more wheels) (Figure 14).

FIGURE 13 - HISTORICAL SERIES OF ROAD TRAFFIC INJURIES

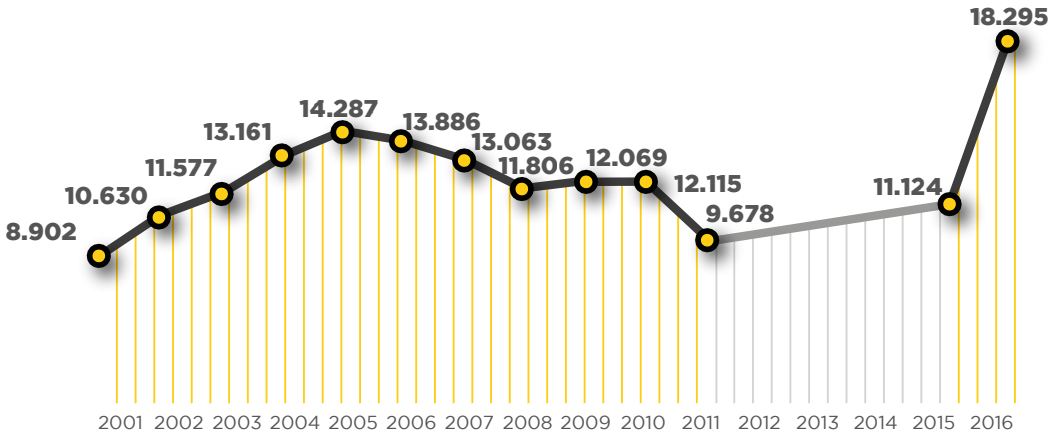
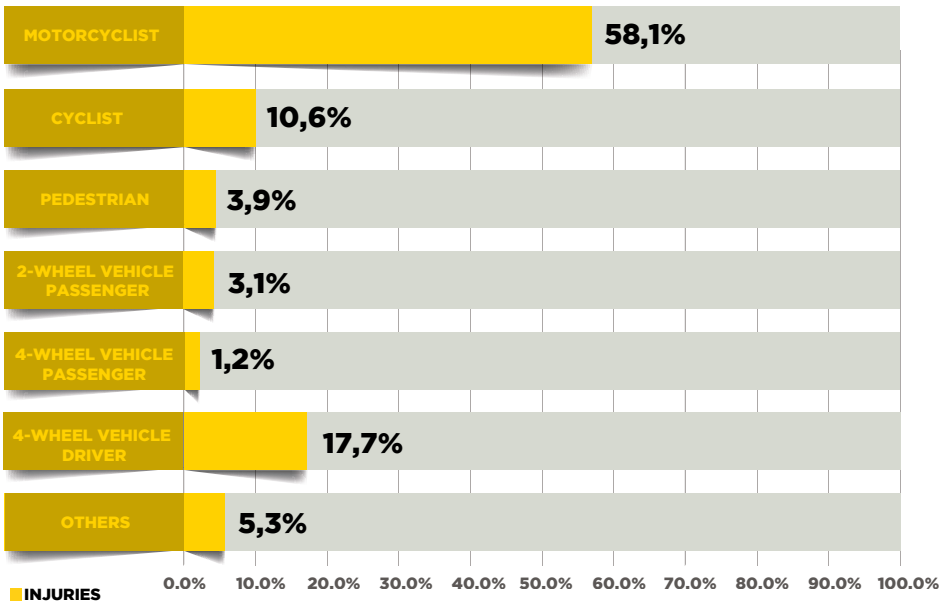


FIGURE 14 - DISTRIBUTION OF ROAD TRAFFIC INJURIES BY ROAD USER TYPE (2016)



PROFILE OF VICTIMS HOSPITALIZED AT THE IJF HOSPITAL

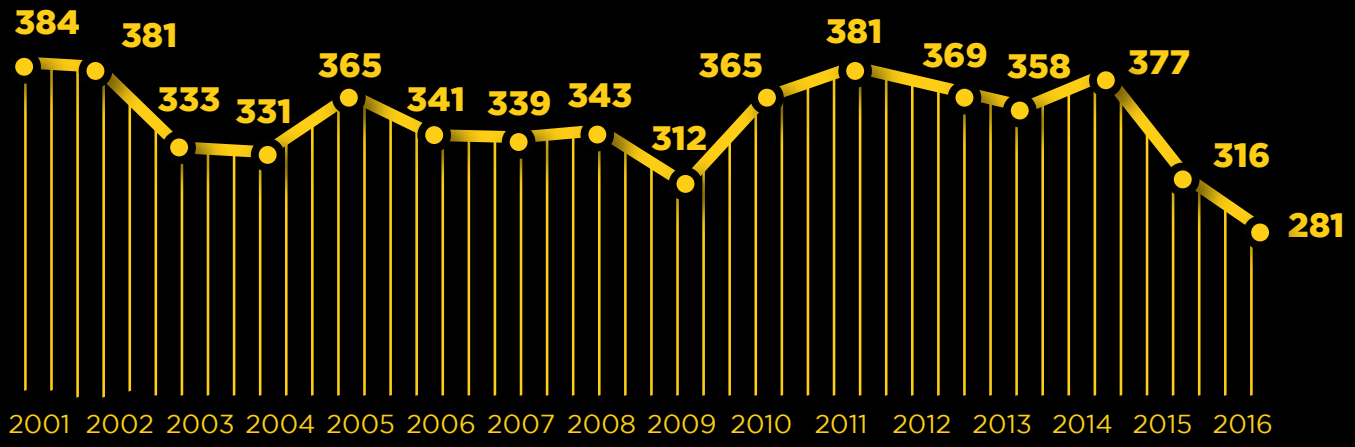
According to a sample survey conducted in 2016 by the IJF Hospital´s Epidemiology Department, the profile of injured motorcyclistscrashes, both in the capital and in the rest of the state, is alarming, as it shows clear behavioral risks: 55% did not have a driver license, 48% did not use a helmet, and 59% had consumed alcohol. Here we see a tragic combination of alcohol, lack of protection and lack of qualification for driving a motorcycle.

FATAL

The recording methodology of fatal victims has been consistent throughout the years, allowing comparisons of historical series. In Figure 15 we can see that between 2015 and 2016 there was a reduction of 10.8% in the absolute number of traffic deaths, resulting in less than 300 fatalities for the first time since 2002.

FOR THE FIRST TIME, THE NUMBER OF ANNUAL TRAFFIC DEATHS **WERE LESS THAN 300.** 157 LIVES WERE SAVED BETWEEN 2014 AND 2016.

FIGURE 15 - HISTORICAL SERIES OF FATAL VICTIMS



The problem of accidents involving motorcyclists is also highlighted when we analyze fatalities. Motorcycle users are the top fatal victims, followed by pedestrians (Figure 16). This is due to a significant reduction of 29.2%, between 2015 and 2016, in the number of pedestrians killed in road accidents.

FIGURE 16 - DISTRIBUTION OF FATAL VICTIMS BY TYPE (2016)

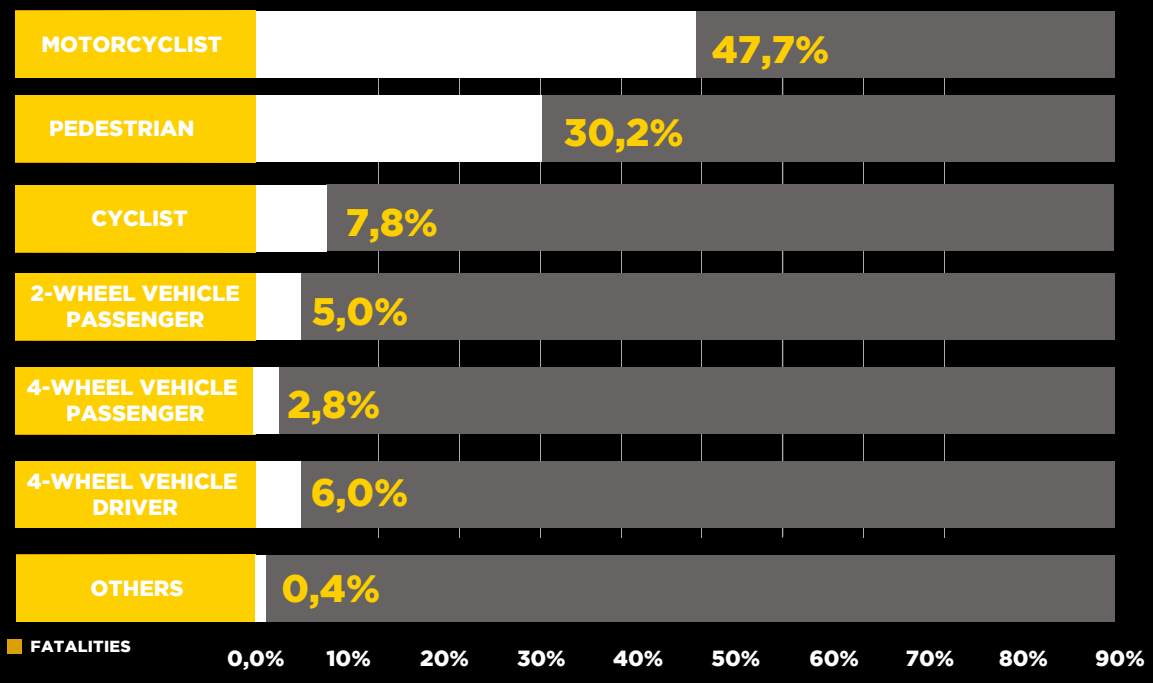
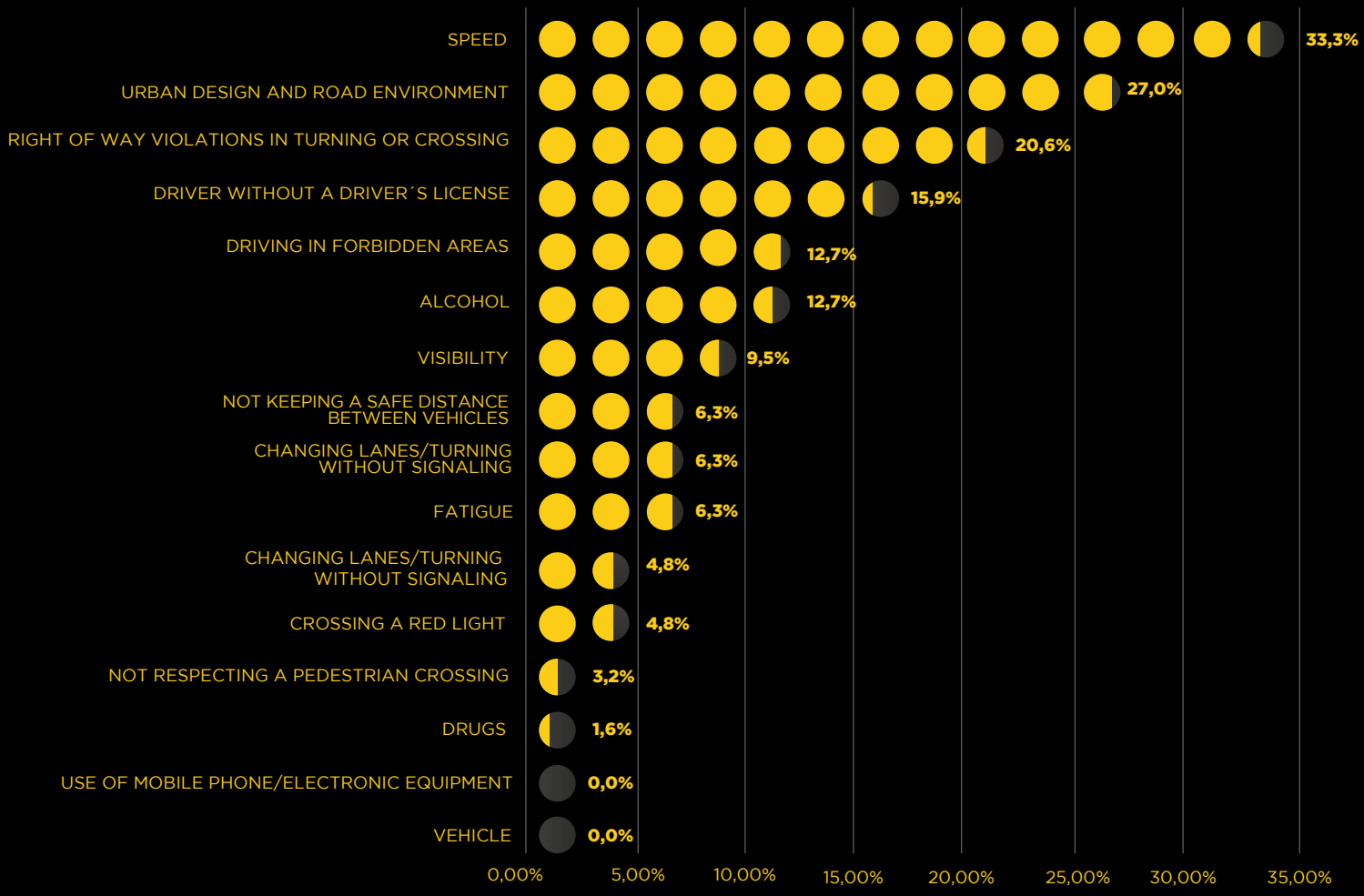


FIGURE 17 - ROAD MORTALITY INVESTIGATION IN FORTALEZA

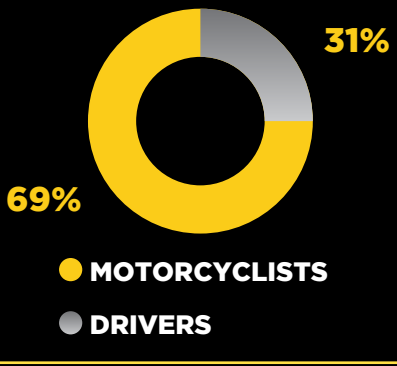
The first meeting of the Death Review Committee in Traffic Crashes (known as CGDMAT), composed by representatives of AMC, SMS, SAMU, IJF and PEFOCE, was held in September 2016. This Committee seeks to establish the main factors contributing to traffic deaths through a thorough investigation of all related information. The Committee follows the methodology established by the Life in Traffic Program of the Ministry of Health (Programa Vida no Trânsito), ranking the different contributing factors, which can be behavioral, infrastructural, logistical or post-crash hospital care. In this context, a study of the fatalities of the first quarter of 2016 was conducted, with the following results:

FACTORS WITH AN INFLUENCE ON THE OCCURRENCE OF AN CRASH

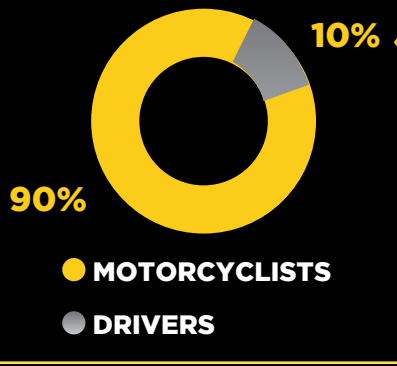


The graph above indicates the existence of a risk behavior in the recorded crashes. There can be multiple risk behaviors in one crash, resulting in a sum greater than 100%. The percentage of each behavior represents the number of times such behavior was recorded as a percentage of all cases analyzed. For example, we see that “Speeding” occurred in 33% of all cases.

RIGHT OF WAY VIOLATIONS IN TURNING OR CROSSING

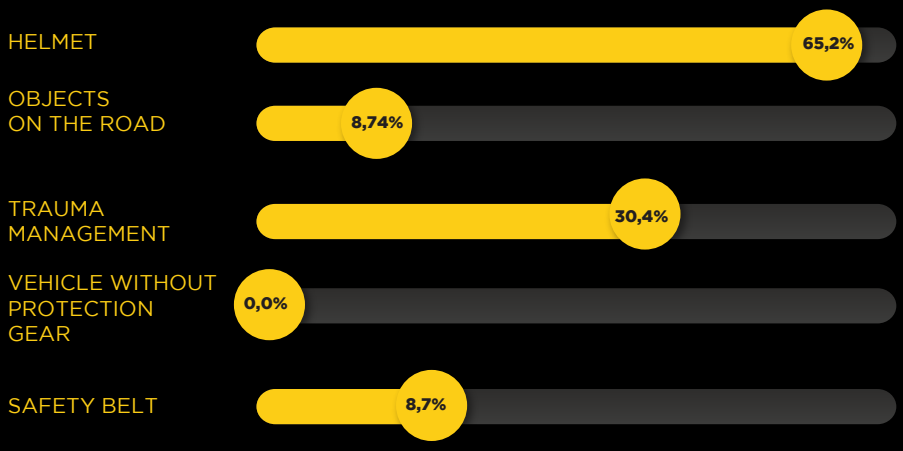


DRIVER WITHOUT A DRIVER´S LICENSE



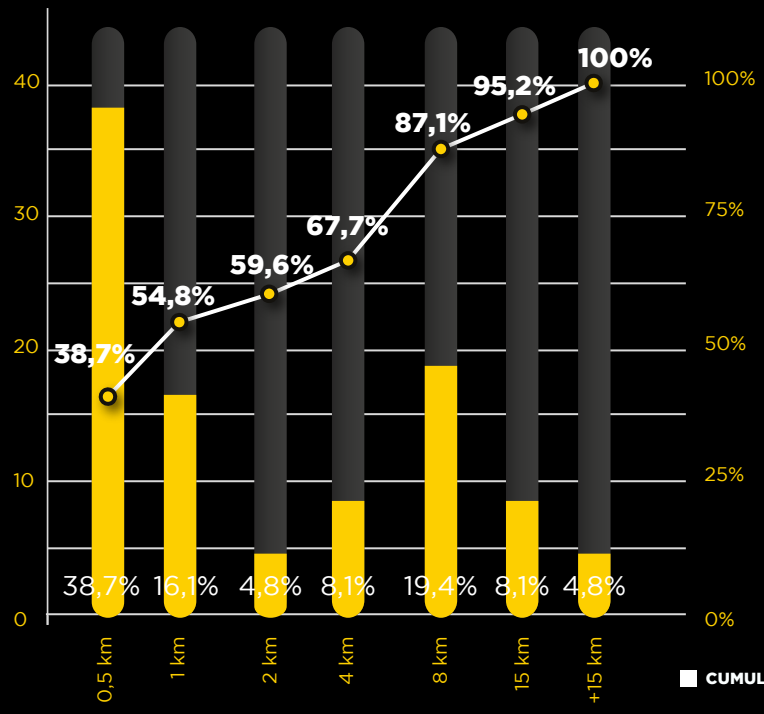
Motorcyclists accounted for 69% of fatal victims in crash in which right of way violations Turning/ crossing in violation of the right of way were a contributing factor. Likewise, 90% of the fatal victims whose crash had "Driver without a driver´s license" as a contributing factor were motorcyclists.

FACTORS WITH INFLUENCING CRASH SEVERITY CRASH



NOT USING A HELMET WAS THE FACTOR THAT CONTRIBUTED THE MOST TO INCREASE CRASH SEVERITY CRASH.

DISTANCE BETWEEN CRASH SITE AND VICTIM´S RESIDENCE



54.8% of deaths occurred within 1 km from the victim´s home. Among pedestrians, this rate was 78%. These high rates may be due to greater distraction and imprudence when the person is closer to his or her home, for example by not fastening the safety belt or not using a helmet.

INJURED VICTIMS

Table 6 presents the number of injured victims by type, as recorded over the years. We do not recommend taking the changes between 2011 and 2016 as a representation of the actual picture in Fortaleza because of the changed SIAT data collection methodology mentioned above, i.e. the addition of data from SAMU. As already pointed out, the comparison of the user type distribution by gender and age between the years is still valid.

When considering motorcycle drivers, motorcycle passengers, cyclists and pedestrians as vulnerable users, we see that in 2016 they represented 90% of all injured victims. Between 2004 and 2016 motorcyclists have increased their share in the total annual number of injured victims, showing a consistent increase as opposed to the consistent decrease in the number of injured pedestrians and cyclists.

TABLE 06 - HISTORICAL SERIES OF INJURED VICTIMS, BY USER TYPE

YEAR	4-WHEEL VEHICLE DRIVER	4-WHEEL VEHICLE PASSENGER	MOTOR-CYCLIST	2-WHEEL VEHICLE PASSENGER	CYCLIST	PEDESTRIAN	OTHERS	MISSING/ UNKNOWN	TOTAL
2004	1.258	752	4.949	678	2.083	2.996	43	402	13.161
2005	1.452	675	5.791	689	2.229	3.085	66	300	14.287
2006	1.559	694	5.955	731	1.990	2.713	65	179	13.886
2007	1.465	666	5.603	792	1.496	2.702	42	297	13.063
2008	1.174	494	5.601	640	1.430	2.261	39	167	11.806
2009	1.091	543	5.749	859	1.296	2.379	5	147	12.069
2010	1.291	515	6.331	815	1.089	2.038	0	36	12.115
2011	1.242	307	5.108	629	623	1.727	5	37	9.678
2012	-	-	-	-	-	-	-	-	-
2013	-	-	-	-	-	-	-	-	-
2014	-	-	-	-	-	-	-	-	-
2015	1.170	179	6.229	243	298	1.141	167	1.697	11.124
2016	3.022	206	9.930	534	673	1.818	913	1.199	18.295

RECLASSIFICATION OF USER TYPES

USERS WERE RECLASSIFIED IN THE 2016 ROAD SAFETY ANNUAL REPORT. FIRSTLY, THE AGGREGATED "PASSENGERS" CATEGORY WAS DIVIDED INTO "PASSENGERS OF VEHICLES WITH 2 OR 3 WHEELS" AND "PASSENGERS OF VEHICLES WITH 4 OR MORE WHEELS". "PASSENGERS" OF NON-MOTORIZED VEHICLES, SUCH AS THE BICYCLE, WERE RECLASSIFIED AS "CYCLISTS" BECAUSE OF THE LOW INCIDENCE OF THESE USERS AMONG THE VICTIMS. THIS NEW CLASSIFICATION INVOLVED SMALL CHANGES AMONG THE HISTORICAL SERIES PRESENTED IN THE 2015 ROAD SAFETY REPORT. IT IS IMPORTANT TO NOTE THAT THIS RECLASSIFICATION NOW ALLOWS A MORE DETAILED ANALYSIS OF THE HISTORICAL SERIES.

FATALITIES

Table 07 shows the historical evolution of the total number of traffic deaths from 2004 to 2016, by user type. It is important to note that in the last decade motorcyclists and pedestrians have shown opposite trends. While the number of pedestrians killed fell from 144 in 2007 to 85 in 2016, the number of motorcyclists killed increased from 83 to 134 in the same period. In the last year, the fatality records for the years of 2012, 2013 and 2014 were surveyed, mainly using the Mortality Information System and the Forensic Polices of the State of Ceará as data sources, with good total results despite a high number of user types classified as "Unknown".

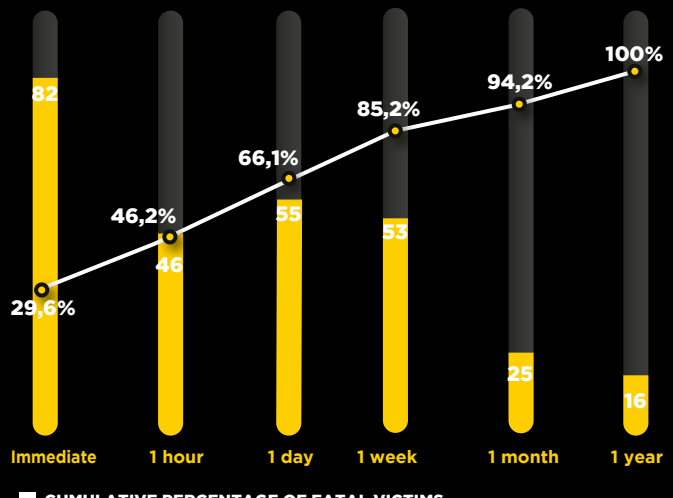
TABLE 07 - HISTORICAL SERIES OF FATAL VICTIMS, BY USER TYPE

YEAR	4-WHEEL VEHICLE DRIVER	4-WHEEL VEHICLE PASSENGER	MOTOR-CYCLIST	2-WHEEL VEHICLE PASSENGER	CYCLIST	PEDESTRIAN	OTHERS	UNKNOWN/ MISSING	TOTAL
2004	22	10	77	15	67	135	2	3	331
2005	30	12	81	18	62	160	2	0	365
2006	18	14	86	12	64	141	1	5	341
2007	12	10	83	16	70	144	2	2	339
2008	30	11	85	14	62	138	3	0	343
2009	17	6	85	11	43	140	5	5	312
2010	26	12	110	17	41	158	0	1	365
2011	24	14	114	16	39	171	2	1	381
2012	15	3	129	19	24	157	0	22	369
2013	8	6	120	8	20	150	2	44	358
2014	55	7	115	10	17	125	0	48	377
2015	20	14	111	35	16	120	0	0	316
2016	17	8	134	14	22	85	1	0	281

TIME ELAPSED BETWEEN CRASH AND DEATH

More than 50% of all fatalities passed away within the first 24 hours after the crash (Figure 18). This percentage rises to 61% among motorcyclists, highlighting the more severe nature of crashes involving this type of user.

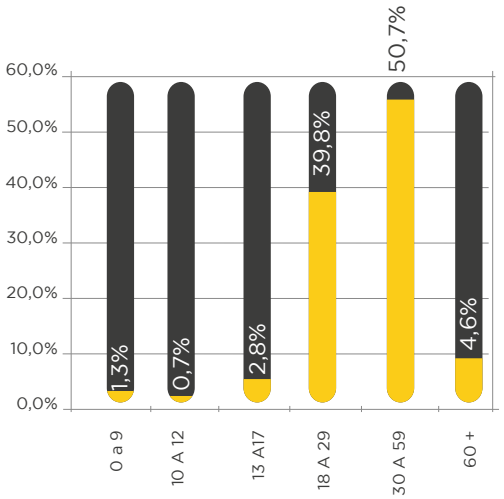
FIGURE 18 - TIME ELAPSED BETWEEN CRASH AND DEATH



INJURED VICTIMS

The known pattern of traffic crash victims in developing countries is evident in Fortaleza, where men, motorcyclists and young people are the most involved in crashes. Figure 19 shows the age distributions of the victims, followed by Figure 20 showing the distribution by gender for the year of 2016. Tables 08 and 09 show the relationship between the gender, age and user type variables, making it possible to identify the general profile of injured victims in Fortaleza.

AGE DISTRIBUTION
FIGURE 19 - INJURED VICTIMS



GENDER DISTRIBUTION
FIGURE 20 - INJURED VICTIMS

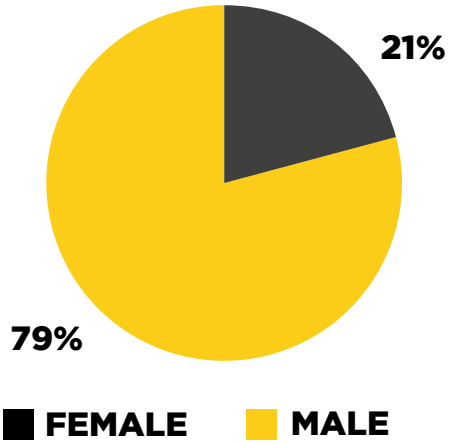


TABLE 8 - DISTRIBUTION OF INJURED VICTIMS - TYPE VS. AGE

AGE	AUTOMOBILE DRIVER	MOTOR-CYCLIST	CYCLIST	2-WHEEL VEHICLE PASSENGER	4-WHEEL VEHICLE PASSENGER	PEDESTRIAN	OTHERS	UNKNOWN/ MISSING	TOTAL
0-9	8	20	12	17	18	87	7	9	178
10-12	7	13	9	10	8	38	7	1	93
13-17	20	149	28	42	13	66	36	31	385
18-29	534	3.604	134	171	46	253	338	313	5.393
30-59	903	3.952	319	169	61	672	431	363	6.870
60+	101	141	42	7	11	259	40	27	628
MISSING/ UNKNOWN	1449	2051	129	118	70	443	33	455	4748
TOTAL	3.022	9.930	673	534	227	1.818	892	1.199	**18.295**

TABLE 9 - DISTRIBUTION OF INJURED VICTIMS - TYPE VS. GENDER

GENDER	AUTOMOBILE DRIVER	MOTOR-CYCLIST	CYCLIST	2-WHEEL VEHICLE PASSENGER	4-WHEEL VEHICLE PASSENGER	PEDESTRIAN	OTHERS	UNKNOWN/ MISSING	TOTAL
MALE	1.130	5.359	341	161	73	608	290	440	8.402
FEMALE	402	794	57	276	119	358	70	151	2.227
UNKNOWN/ MISSING	1/.490	3.777	275	97	35	852	532	608	7.666
TOTAL	3.022	9.930	673	534	227	1.818	892	1.199	**18.295**

FATALITIES

The fatalities pattern is similar to that of injured victims. We should highlight that pedestrians dying in road crashes are mostly older and even elderly people. Figure 21 shows the age distribution of the victims, followed by Figure 22 with the distribution by gender for the year of 2016. Tables 10 and 11 provide a relationship between the gender, age and user type variables, making it possible to identify the profile of fatal victims in Fortaleza.

FIGURE 21 - DISTRIBUTION OF FATAL VICTIMS BY AGE RANGE

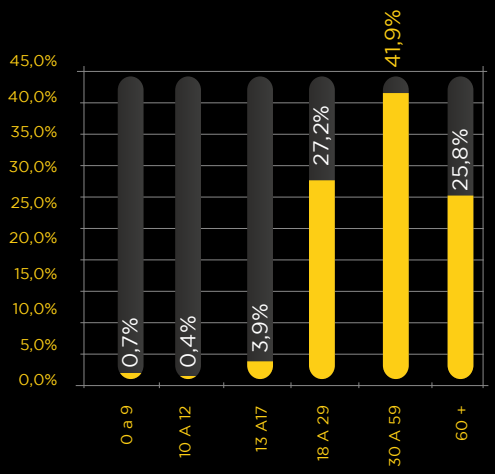


FIGURE 22 - DISTRIBUTION OF FATAL VICTIMS BY GENDER

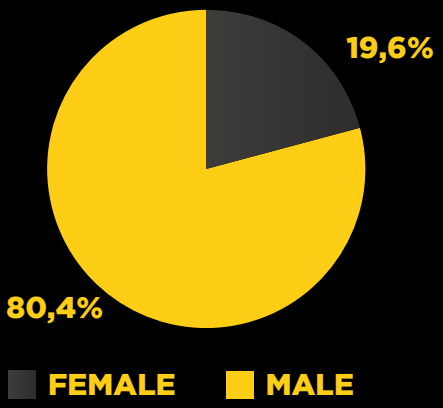


TABLE 10 - DISTRIBUTION OF FATAL VICTIMS - TYPE VS. AGE

AGE	AUTOMOBILE DRIVER	MOTOR-CYCLIST	CYCLIST	2-WHEEL VEHICLE PASSENGER	4-WHEEL VEHICLE PASSENGER	PEDESTRIAN	OTHERS	UNKNOWN/ MISSING	TOTAL
0-9	0	0	0	0	0	2	0	0	2
10-12	0	0	1	0	0	0	0	0	1
13-17	0	4	3	2	0	2	0	0	11
18-29	7	52	2	5	5	5	0	0	76
30-59	9	70	7	5	1	25	0	0	117
60+	1	8	9	2	3	49	0	0	72
MISSING/ UNKNOWN	0	0	0	0	0	2	0	0	2
TOTAL	17	134	22	14	9	85	0	0	**281**

TABLE 11 - DISTRIBUTION OF FATAL VICTIMS - TYPE VS. GENDER

GENDER	AUTOMOBILE DRIVER	MOTOR-CYCLIST	CYCLIST	2-WHEEL VEHICLE PASSENGER	4-WHEEL VEHICLE PASSENGER	PEDESTRIAN	OTHERS	UNKNOWN/ MISSING	TOTAL
MALE	16	126	22	5	5	52	0	0	226
FEMALE	1	8	0	9	4	33	0	0	55
MISSING/ UNKNOWN	0	0	0	0	0	0	0	0	0
TOTAL	17	134	22	14	9	85	0	0	**281**

6. WHO INDICATORS

At the local level, the city of Fortaleza has been measuring the indicators recommended by the World Health Organization in the document "Global reference list of 100 core health indicators" (WHO, 2015), such as the rates of mortality and morbidity due to traffic crashes.

Table 12 shows the mortality rates per 10,000 vehicles, considering: (a) all vehicle types (b) motorcycles, and (c) automobiles (and other vehicles with 4 or more wheels), in addition to the total vehicle fleet.

Figure 23 shows the evolution of the indicator over the years, showing an overall reduction of 13.3% between 2015 and 2016. If we compare 2016 with 2010, when the UN Decade of Action for Road Safety began, we can see a reduction of 47.2%. When we study the rates of motorcyclists killed, we see an increase of 13.9% between 2015 and 2016 in the number of motorcyclists killed/10,000 motorcycles.

Table 13 presents the mortality rates per 100,000 inhabitants. Figure 24 shows the historical series of this indicator, also illustrating the population growth over these years.

THERE ARE TWO WAYS TO CALCULATE MORBIDITY AND MORTALITY RATES, DEPENDING ON THE DENOMINATOR USED. IN THE FIRST CASE, WE CALCULATE THE NUMBER OF PERSONS KILLED PER NUMBER OF REGISTERED VEHICLES. THIS LETS US RELATE THE PROBLEM TO THE ANNUAL GROWTH OF REGISTERED VEHICLES. IN THE SECOND CASE, WE CALCULATE THE NUMBER OF PERSONS KILLED OR INJURED PER 100,000 INHABITANTS, THUS RELATING THE MORBIDITY AND MORTALITY TO THE POPULATION GROWTH. BOTH INDICATORS ARE PRESENTED IN THIS SECTION, WITH A BREAKDOWN OF CERTAIN VEHICLE AND USER CLASSES.

TABLE 12 - DEATHS/10,000 VEHICLES (BY TOTAL VEHICLES AND BY MOTORCYCLISTS AND AUTOMOBILE DRIVERS)

YEAR	TOTAL KILLED/ 10K VEHICLES	TOTAL REGISTERED VEHICLES	AUTOMOBILE OCCUPANT DEATHS/ 10K AUTOMOBILES	REGISTERED AUTOMOBILES	MOTORCYCLIST DEATHS/ 10K MOTORCYCLES	REGISTERED MOTORCYCLES
2002	9,38	406.057	1,10	272.901	13,1	57.283
2003	7,80	426.712	0,95	285.047	8,7	62.304
2004	7,41	446.570	0,74	295.594	11,4	67.750
2005	7,75	470.985	0,97	309.404	11,0	73.834
2006	6,78	503.044	0,55	326.372	10,4	82.722
2007	6,24	543.634	0,35	347.623	8,8	94.467
2008	5,80	591.375	0,81	370.783	7,7	110.659
2009	4,83	645.765	0,43	396.774	6,6	129.447
2010	5,12	712.996	0,61	425.211	7,1	156.026
2011	4,85	785.370	0,55	454.150	6,1	186.738
2012	4,35	848.297	0,31	483.448	6,2	208.184
2013	3,94	908.074	0,16	511.109	5,2	229.154
2014	3,91	964.724	1,02	536.895	4,6	247.794
2015	3,12	1.009.695	0,36	556.100	4,2	265.237
2016	2,70	1.039.062	0,30	566.423	4,8	278.172

TABLE 13 - DEATHS/100,000 INHABITANTS

YEAR	DEATHS/100,000 INHAB.	TOTAL POPULATION
2002	17,16	2.219.837
2003	14,76	2.256.233
2004	14,19	2.332.657
2005	15,37	2.374.944
2006	14,11	2.416.920
2007	13,79	2.458.549
2008	13,87	2.473.618
2009	12,45	2.505.558
2010	14,88	2.452.185
2011	15,38	2.476.592
2012	14,76	2.500.197
2013	14,03	2.551.808
2014	14,66	2.571.899
2015	12,20	2.591.188
2016	10,77	2.609.716

FIGURE 23 - REGISTERED VEHICLES AND DEATHS/ 10,000K VEHICLES BY YEAR

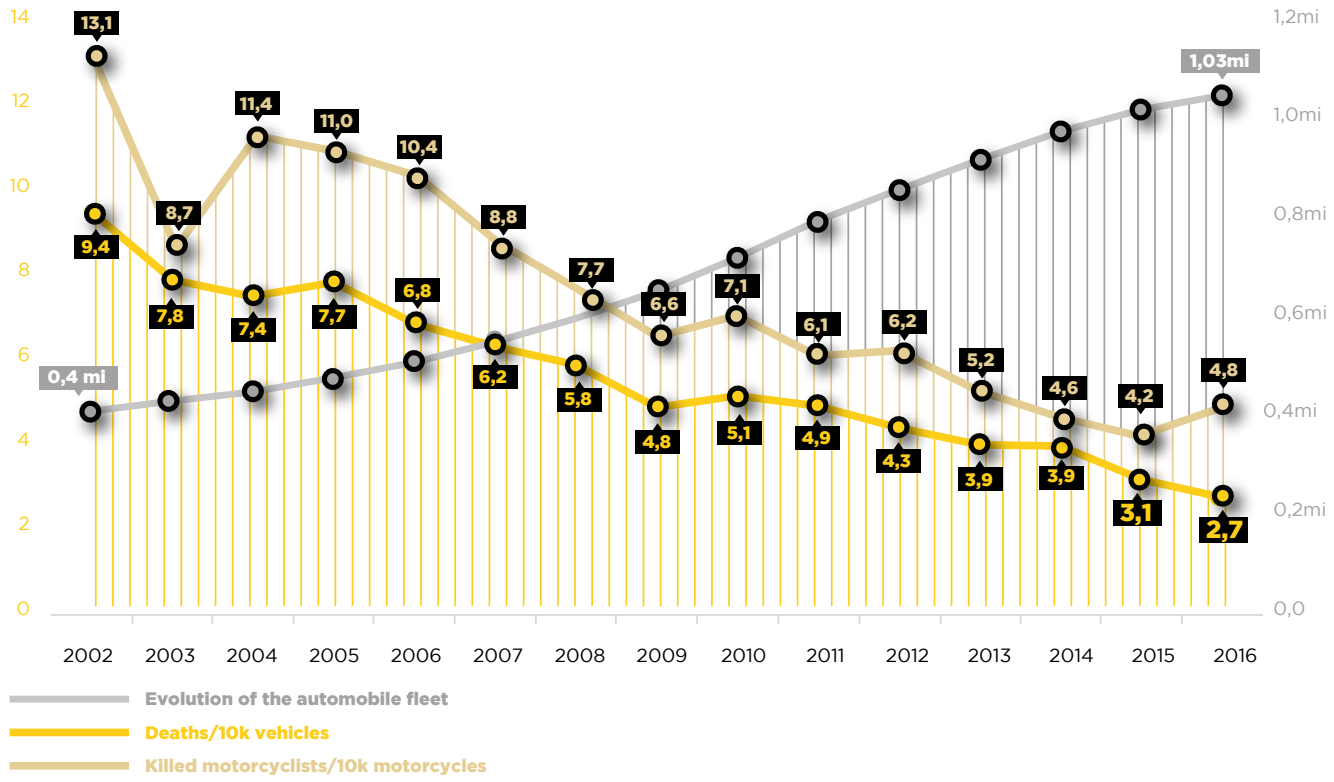
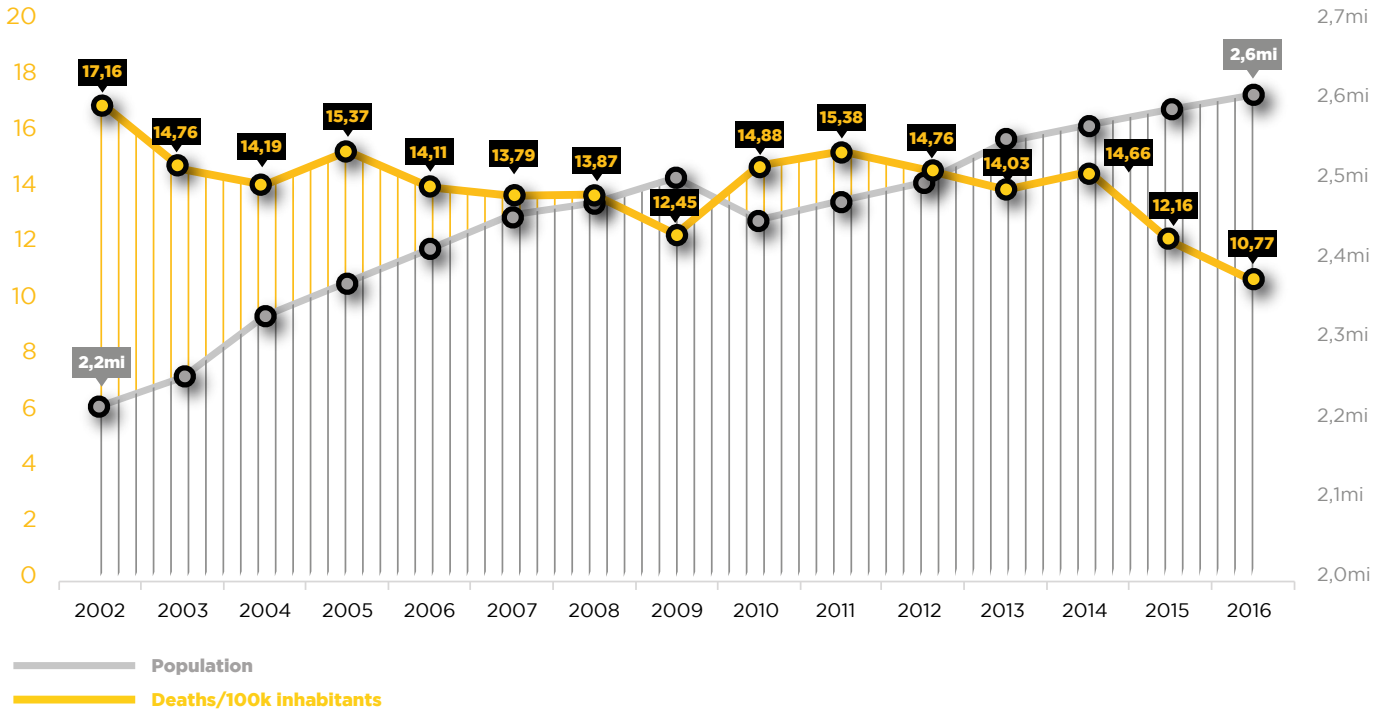


FIGURE 24 - POPULATION AND DEATHS/ 100K INHABITANTS BY YEAR

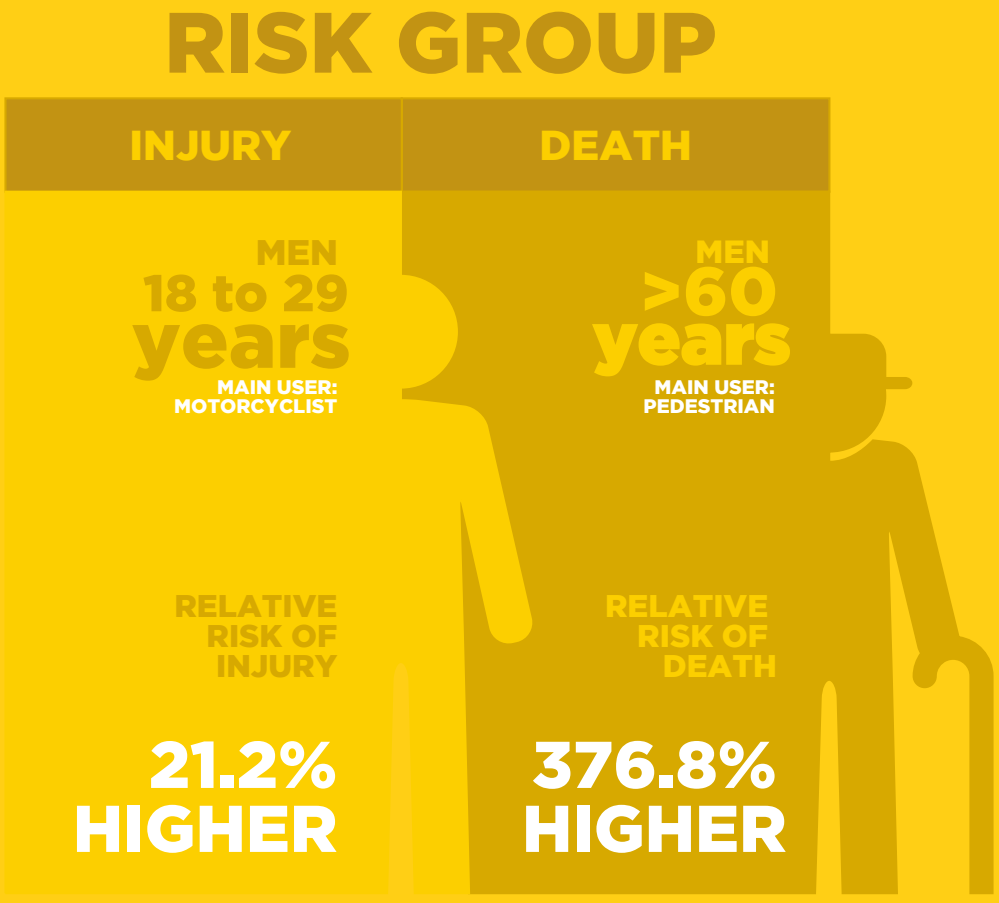


A DETAILED LOOK AT THE RISK OF DEATH OR INJURY

By taking a closer look at the 2016 morbidity and mortality rates, Table 14 presents a comparison between the deaths per 100,000 inhabitants and the rate of injuries per 100,000 inhabitants, disaggregated by age and gender. This analysis lets us know that men aged over 60 years and men aged 18 to 29 years are the demographic groups at greater risk of death or injury from traffic crashes, respectively. The relative death risk of elderly men due to traffic crashes is 376.8% greater than that of other demographic groups. Likewise, the relative risk of injury of men aged 18 to 29 years due to a traffic crash is 21.2% higher than that of the general population.

TABLE 14 - COMPARED MORTALITY AND MORBIDITY RATES AMONG DIFFERENT DEMOGRAPHIC GROUPS (2016)

DEATHS/100,000 INHABITANTS							
TOTAL POPULATION	GENDER	POPULATION AGED 0-9	POPULATION AGED 10-12	POPULATION AGED 13-17	POPULATION AGED 18-29	POPULATION AGED 30-59	POPULATION AGED > 60
10,77	BOTH	0,5	0,8	4,7	12,3	11,7	28,5
	MALE	0,5	1,5	6,9	21,3	21,9	51,3
	FEMALE	0,6	0,0	2,5	4,0	3,1	13,7
INJURED/100,000 INHABITANTS							
TOTAL POPULATION	GENDER	POPULATION AGED 0-9	POPULATION AGED 10-12	POPULATION AGED 13-17	POPULATION AGED 18-29	POPULATION AGED 30-59	POPULATION AGED > 60
	BOTH	48,3	70,9	164,1	869,5	685,6	248,3



7. ESTIMATED COST

In 2003, the Institute of Research and Applied Economics (IPEA) presented a "Social and Economic Impact of Road Crashes in Brazilian Urban Agglomerations" report, which provides an estimate of direct and indirect costs related to traffic crashes with fatal and injured victims, and of those with property damage only. As mentioned in the document, "there are also intangible and subjective costs, related to the loss of persons killed in traffic crashes, to the physical suffering and psychological violence suffered by the victims, their relatives and friends." The same method was applied in this report and the amounts were adjusted for inflation as of December 2016 (12/31/2016) using the Extended Consumer Price Index (IPCA). It is important to note that conducting a study of this type adapted to the context of the city of Fortaleza would provide a more accurate estimate of the local reality.

Considering that 274 crashes involving fatalities, 14,873 crashes involving injured victims and 12,345 crashes with property damage only were recorded in 2016, the estimated cost in Fortaleza with traffic crashes totaled an approximate amount of R$ 730 million (ca. USD 210 million). Table 15 shows the estimated costs disaggregated by type of crash.

TABLE 15 - ESTIMATED COST OF TRAFFIC CRASHES IN 2016

YEAR	TYPE OF CRASH	UNIT COST PER TYPE OF CRASH	NO. OF CRASHES	PARTIAL COST PER TYPE OF CRASH	TOTAL ANNUAL COST
2016	NO VICTIMS	R$ 7.023,89	12.345	R$ 86.709.922,0	R$ 730.913.836,7
	INJURED	R$ 34.597,7	14.873	R$ 559.160.994,8	
	FATALITIES	R$ 310.375,6	274	R$ 85.042.919,8	

R$ 730 MILLION

(USD 210 million)

*ESTIMATE BASED ON THE SURVEY BY IPEA (2003)

8. BLACK SPOTS

In this section we present the 20 most critical intersections of the city, with and without traffic lights, according to the incidence of crashes with fatal and injured victims (Tables 16 and 17).

METHOD USED FOR BLACK SPOT IDENTIFICATION

The used method, known as Rate Quality Control, consisted in the calculation of the Observed Severity-Weighted Crash Rate (TO) and of the Expected Severity-Weighted Crash Rate (TE) of each intersection, assuming that traffic crashes follow a Poisson distribution of probability. The difference between these rates was the criterion for the ranking of these critical intersections.

The Observed Severity-Weighted Crash Rate (TO) was calculated according to Equation 1. Crashes are weighted according to the Standard Severity Unit (UPS) of each intersection, according to Equation 2. For example, a fatal crash has a weight of 13 while a property damage-only crash has a weight of 1. Then we calculated the number of vehicles that crossed the intersection during the studied period (MVE) according to Equation 3, considering the effect of this variable on the analysis. A location with a lower vehicle volume tends to be more critical than one with a more intense traffic if both have the same frequency and severity of crashes. It should be noted that the Annualized Daily Average Volumes - VDMA were estimated from Fortaleza´s Area Traffic Control (CTAFOR) and by the traffic survey equipment, applying the expansion factors indicated on the Decision-Making Support Report on the Planning, Operation and Management of Public Transport Systems and Road Circulation of Fortaleza (ASTEF/UFC, 2015).

The Expected Severity-Weighted Crash Rate (TE) defines the expected frequency and severity value of each intersection through statistical techniques, considering their operational characteristics (Equation 4). For that purpose, intersections with and without traffic lights were divided into two different populations. Finally, the intersections were ranked according to the difference (Δ) between TO and TE, as per Equation 5. The reference population used in this analysis comprised the 50 intersections with the higher UPS for each of the 2 groups.

Intersections with an crash rate (TO) higher than the expected rate (TE) tend to be more prone to the occurrence of crashes, not by random but due to their own specific deficiencies.

MVE - Millions of vehicles entering the intersection in t years, where t = 1 for this study.
VDMA - Annualized daily average volumes
a – Property damage-only crashes
b – CraInjury crashes
c – Pedestrian injury crashes
d – Fatal crashes
λ - Average severity-weighted crash rate of the studied intersections
k - Constant indicating the adopted confidence level. For this study, it was 90% (K = 1.64);

LIST OF EQUATIONS:

$$To = \frac{UPS}{MVE} \quad (1)$$

$$UPS = 1a + 4b + 6c + 13d \quad (2)$$

$$MVE = \frac{VDMA \times t \times 365}{10^6} \quad (3)$$

$$Te = \lambda + k\sqrt{\frac{\lambda}{MVE} + \frac{1}{2 \times MVE}} \quad (4)$$

$$\Delta = To - Te \quad (5)$$

TABLE 16 - RANKING OF CRITICAL INTERSECTIONS WITH TRAFFIC LIGHTS

RANKING	INTERSECTIONS	CRASHES			UPS	TUPS	TCR	Δ
		FATAL	INJURED	DAMAGE ONLY				
1º	Av. João Pessoa X Rua Prof. Costa Mendes	1	8	9	54	5,4	3,9	1,5
2º	Av. Prs. Costa e Silva X Av. Prs. Juscelino Kubitschek	2	6	12	62	4,9	3,8	1,1
3º	Av. Imperador X Rua São Paulo	0	7	3	33	4,8	4,1	0,7
4º	Av. Imperador X Av. Duque de Caxias	0	11	5	53	4,5	3,8	0,6
5º	Rua Júlio Braga X Av. Lineu Machado	0	8	2	40	4,6	4	0,6
6º	Rua Alberto Magno X Rua Bar. Sobral	0	9	5	43	4,5	3,9	0,5
7º	Av. José Bastos X Av. Eng. Humberto Monte	1	5	8	41	4,2	3,9	-0,2
8º	Av. Prs. Castelo Branco X Av. Dr. Theberge	0	11	2	50	2,9	3,7	-0,8
9º	Rua Rio Grande do Sul X Av. Carneiro de Mendonça	0	9	1	37	3	3,8	-0,8
10º	Rua Sen. Pompeu X Av. Duque de Caxias	0	7	3	35	2,9	3,8	-1
11º	Av. Cel. Carvalho X Av. Sgt. Hermínio Sampaio	0	8	7	43	2,7	3,7	-1
12º	Av. Carapinima X Av. 13 de Maio	0	9	20	56	2,2	3,6	-1,3
13º	Av. dos Expedicionários X Av. Prs. Costa e Silva	0	7	21	51	2,2	3,6	-1,4
14º	Av. Des. Moreira X Av. Abolição	0	4	20	36	2,3	3,7	-1,4
15º	Av. Cel. Carvalho X Av. Maj. Assis	1	5	2	39	2,3	3,7	-1,4
16º	Av. Sen. Virgílio Távora X Av. Antônio Justa	0	8	2	36	2,2	3,7	-1,5
17º	Av. Dr. Silas Munguba X Rua Bernardo Manuel	0	9	8	50	2	3,6	-1,6
18º	Av. Pontes Vieira X Rua Cap. Gustavo	0	7	7	39	2	3,6	-1,6
19º	Av. José Bastos X Av. Augusto dos Anjos	0	7	12	44	1,9	3,6	-1,7
20º	Av. Godofredo Maciel X Rua Nereu Ramos	1	8	11	43	1,9	3,6	-1,7

TABLE 17 - RANKING OF CRITICAL INTERSECTIONS WITHOUT TRAFFIC LIGHTS

RANKING	INTERSECTIONS	CRASHES			UPS	TUPS	TCR	Δ
		FATAL	INJURED	UNHARMED				
1º	Rua Pergentino Maia X Rua Antônio Barros	0	13	12	64	17,5	11	6,9
2º	Rua Amadeu Furtado X Rua Gustavo Sampaio	0	14	10	66	16,6	11	6
3º	Av. L X Av. F (Cj. José Walter)	1	6	5	44	15,3	11	4,4
4º	Rua César Fontenele X Rua Prof. Lino Encarnação	0	11	6	51	12,4	11	1,9
5º	Rua Meton de Alencar X Rua Maj. Facundo	0	12	13	61	11,6	10	1,4
6º	Rua Amazonas X Rua Rio Grande do Sul	0	8	3	35	12,2	11	1,2
7º	Rua Azevedo Bolão X Rua Amadeu Furtado	0	9	3	39	10,8	11	0,1
8º	Rua Gal. Clarindo de Queiroz X Rua Floriano Peixoto	0	7	12	40	9,1	10	-1,3
9º	Rua Pernambuco X Rua Rio Grande do Sul	1	6	3	40	9,1	10	-1,3
10º	Rua Jaime Benévolo X Rua Gal. Clarindo de Queiroz	0	9	7	43	8,7	10	-1,6
11º	Rua Osvaldo Cruz X Rua Des. Leite Albuquerque	0	6	15	39	8,7	10	-1,6
12º	Av. Domingos Olímpio X Rua Floriano Peixoto	1	18	14	103	7,2	9,3	-2,2
13º	Av. C X Av. F (Cj. Ceará)	0	8	5	37	8,2	10	-2,2
14º	Av. Pinto Bandeira X Rua Luiza Miranda Coelho	0	10	6	46	6,8	9,9	-3,1
15º	Rua Assunção X Rua Saldanha Marinho	0	8	8	40	6,2	10	-3,8
16º	Rua Meton de Alencar X Rua Vinte e Quatro de Maio	0	8	5	37	6,2	10	-3,8
17º	Rua 15 de Novembro X Rua Alm. Rubim	0	11	2	46	5,5	9,7	-4,2
18º	Av. H X Av. C (Cj. Ceará)	0	9	0	38	5,4	9,9	-4,5
19º	Rua Mon. Hipólito Brasil X Rua Prof. Heribaldo Costa	1	5	3	36	4,7	9,8	-5,1
20º	Rua Bar. de Canindé X Rua Elcias Lopes	0	9	4	40	4,5	9,7	-5,2

9. RISK FACTORS

This section presents findings collected over the last three years (2015, 2016 and 2017), which makes it possible for us to characterize behavioral risk factors related to traffic crashes. This section is divided into four subsections according to the main risk factors defined by the WHO, which are: a) Motorcycle helmets, b) Safety belts and child restraint, d) Speeding, and e) Drink driving.

The results presented here come from the sources indicated below: a) An observational survey of the main behavioral risk factors; b) The Road Death Review CommitteeeCrashes; c) An evaluation of the campaign on the correct use of helmets; and d) Traffic tickets given in enforcement actions.

A) Observational survey of the main behavioral risk factors (conducted by JHU and UFC)

Since 2015, under the Bloomberg Initiative for Global Road Safety, Johns Hopkins University (JHU) together with the Federal University of Ceará (UFC), and independently the City of Fortaleza, have collected observational data every six months on the main risk factors defined by WHO. Four survey rounds were completed as of the date of publication of this document.

B) Road death review committee case reports

As indicated in the section “Road mortality investigation in Fortaleza”, CGDMAT investigates the probable causes of traffic-related fatalities, identifying the risk behaviors that might have influenced each fatal crash.

C) Evaluation of the campaign on the correct use of helmets

After the “Helmet Saves Lives” campaign launched in February and March of 2017 was completed, a qualitative and quantitative evaluation survey was carried out with the target public, in this case motorcycle users. Different questions were asked, among them the behavioral perceptions of motorcyclists regarding the correct use of the helmet.

D) Traffic tickets given in enforcement actions (AMC)

Records of traffic tickets directly related to risk behaviors were collected from AMC. Such tickets were given both at police checkpoints and through video-monitoring systems.

DEFINITION OF RISK FACTOR

According to the World Health Organization, a risk factor is any attribute, characteristic or exposure of an individual that increases his or her likelihood of developing an illness or suffering an injury. The risk of being injured in traffic is composed of multiple risk factors ranging from socioeconomic and cultural characteristics of the population, land use distribution, the performance of the public transportation system, and aggressive and/or imprudent behaviors of road users. In this annual report we will address the risk factors that are most significant in the prevention actions against traffic-related mortality.

9.1 MOTORCYCLE HELMETS

According to the findings of JHU´s and UFC´s observational survey, motorcycle users in Fortaleza overwhelmingly use the helmet (99%). However, the problem is the correct use of this protective gear, as only 88% of them buckle it up. When an crash occurs, if the helmet is not properly buckled the kinetic force may be enough to eject the helmet from the motorcyclist´s head, leaving the head unprotected and exposed to severe trauma. Figure 25 and Table 18 bring the historical series of both the correct and incorrect use of the helmet by motorcyclists and motorcycle passengers, showing a gradual increase in the correct use of the helmet among these users.

An analysis of the data evaluation survey conducted after the "Helmet Saves Lives" campaign shows that the rate of motorcycle users claiming to know the legislation about the correct use of the helmet is also high (96% of the total). However, approximately 34% of these motorcyclists report they do not regularly use helmets and 23% said that they do not always buckle it up. With regard to motorcycle passengers, one in three respondents said they had at least once taken a passenger who did not use a helmet or who did not buckle it up.

This imprudent behavior usually occurs near the residence of these users. According to the CGDMAT analysis, 50% of motorcyclists killed in road crashes die within 1 km of their residence, and 57% within 2 km. That Committee found that in 65.2% of motorcycle deathscrash, the non-use or misuse of the helmet appears as a factor increasing the severity of injuriescrash. More than 70% of such deaths were mainly due to traumatic brain injury.

FIGURE 25 - PREVALENCE OF THE USE AND/ OR CORRECT USE OF THE HELMET (2015-2017)

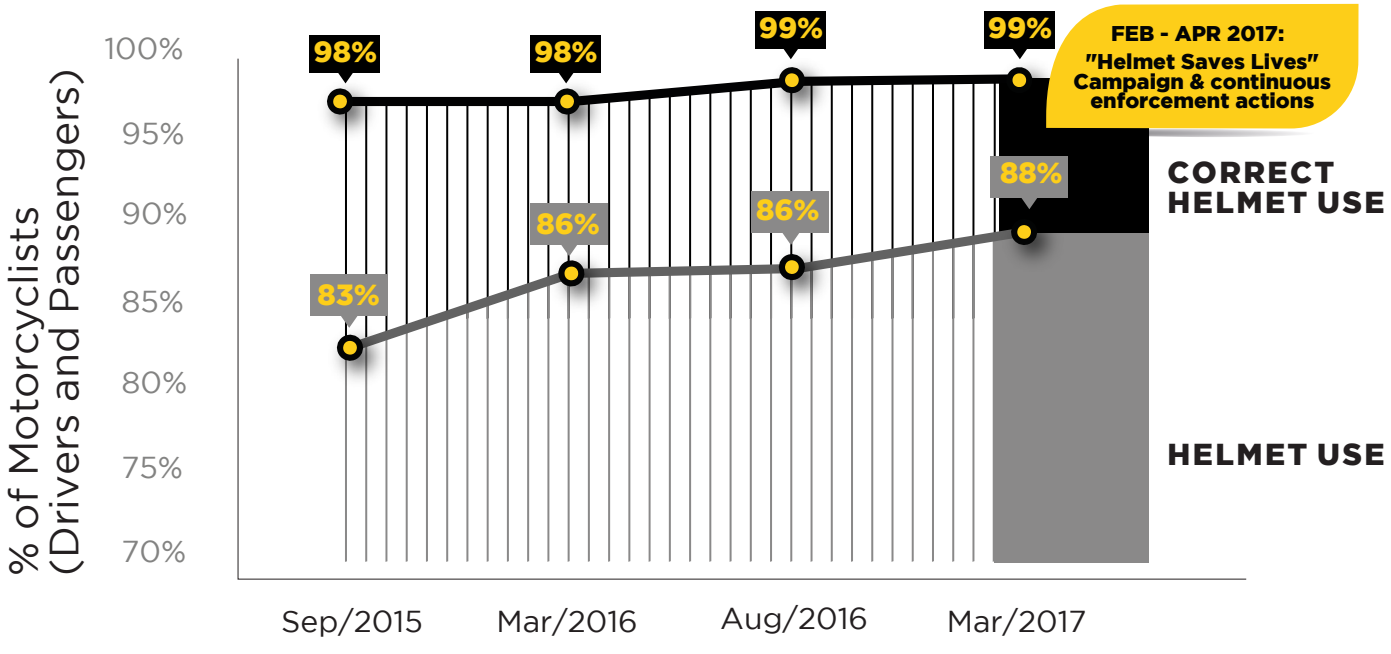


TABLE 18 - PREVALENCE OF THE USE AND/ OR CORRECT USE OF THE HELMET (2015-2017)

OBSERVED BEHAVIOR	BASELINE	2ND ROUND	3RD ROUND	4TH ROUND
	SEP/15	MAR/16	AUG/16	MAR/17
All motorcyclists occupants (drivers and passengers) using a helmet	98%	98%	99%*	99%
Drivers using a helmet	98%	98%*	99%	99%
Passengers using a helmet	97%	97%*	97%	97%
All motorcyclists occupants (drivers and passengers) correctly using a helmet	83%	86%*	86%	88%*
Drivers correctly using a helmet	85%	88%*	88%	90%*
Passengers correctly using a helmet	74%*	81%*	77%*	82%*

*Indicates a statistical significance compared to the results of the immediately preceding round.

According to the WHO, the correct use of the helmet reduces the risk of death by 40% and the risk of serious injury by 70%. In other words, for every 10 motorcyclists who died and were not using the helmet, 4 would have survived; and for every 10 who were seriously injured, 7 would have avoided serious injury if they were using helmets.

The evaluation survey of the correct helmet use campaign also showed that 95% of motorcycle users understand that AMC's enforcement should be intensified (76%) or at least remain at current levels (19%). Only 4% believe that such enforcement should be relaxed. 75% believe that the penalty applicable to those not using a helmet should be more severe.

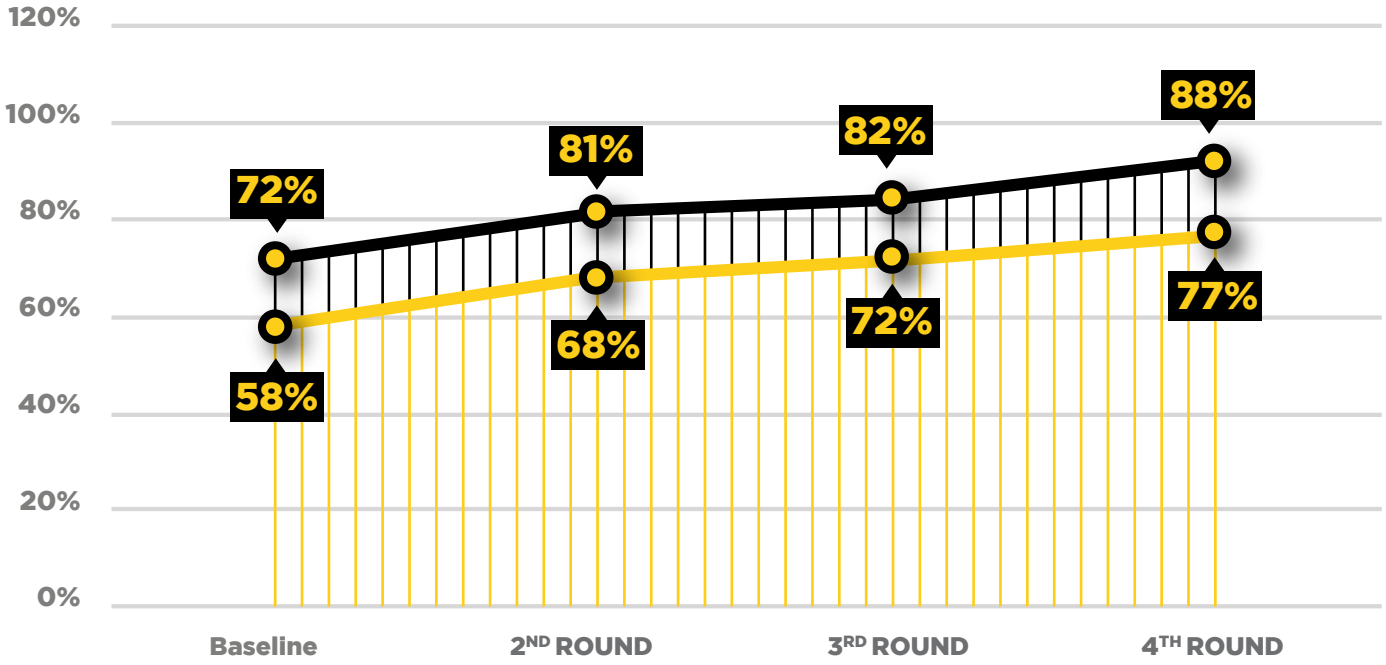
The tickets given at AMC´s checkpoints in the first half of 2017 highlight the unbuckled helmet problem. Nearly half (44.8%) of approximately 67,900 tickets issued in such checkpoints were related to the incorrect use of the helmet. Driving a motorcycle with inappropriate footwear is another problem. This is a common problem in the streets of Fortaleza, as such improper footwear may impair the handling of the motorcycle and/or the driver´s response in situations of risk.

9.2 SEAT BELTS AND CHILD RESTRAINTS

The survey conducted by JHU and UFC points out that the percentage of adult drivers and passengers using seat belts has been increasing since 2015. However, there were no statistically significant changes in the use of child restraints. This situation not only did not change over the years, but the figures are also unsatisfactory. Only 42% of vehicles with children (under 5 years of age) had some sort of child restraint. In the last round of the survey it was noted that 88% of the drivers had their seat belts fastened, along with 77% of front seat and 53% of rear seat passengers. Figures 26 and 27 and Table 19 show the progression of these risk factors since 2015.

This survey also pointed out the influence that the behavior of the driver has on the passenger. Passengers are 12.8 times more likely to fasten their seat belt if the driver of the vehicle does. In 2016, AMC issued 31,963 tickets to drivers or passengers for not using the seat belt.

FIGURE 26 - PREVALENCE OF THE USE OF THE SAFETY BELT (2015-2017)

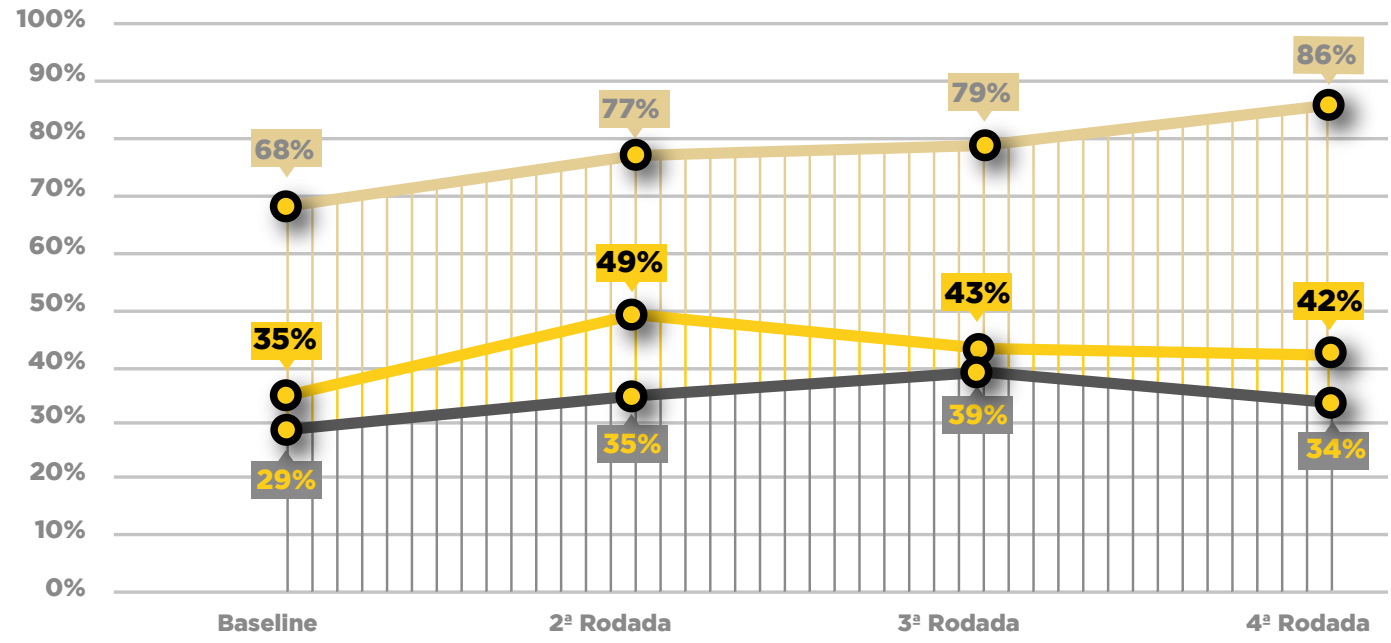


Drivers using seat belts

Adult passengers using seat belts

BASELINE: JULY-AUGUST 2015
2ND ROUND: MARCH-APRIL 2016
3RD ROUND: JULY-AUGUST 2016
4TH ROUND: APRIL-MAY 2017

FIGURE 27 - PREVALENCE OF CHILD RESTRAINTS USE COMPARED TO ADULT SEAT BELT USE (2015-2017)



Passengers (children**) using some kind of child restraint

Passengers (infants***) using some kind of child restraint

Drivers and passengers (adults) using seat belts

BASELINE: JULY-AUGUST 2015
2ND ROUND: MARCH-APRIL 2016
3RD ROUND: JULY-AUGUST 2016
4TH ROUND: APRIL-MAY 2017

TABLE 19 - PREVALENCE OF THE USE OF SEAT BELTS (2015-2017)

OBSERVED BEHAVIOR	BASELINE	2ND ROUND	3RD ROUND	4TH ROUND
	SEP/15	MAR/16	AUG/16	MAR/17
Drivers and passengers (adults) using seat belts	68%	77%*	79%*	86%*
Drivers using seat belts	72%	81%*	82%*	88%*
Passengers (adults) using seat belts	58%	68%*	72%*	77%*
Passengers (children**) using some kind of child restraint	29%	35%	39%	34%
Passengers (infants***) using some kind of child restraint	35%	49%*	43%	42%

*Indicates a statistical significance compared to the results of the immediately preceding round
*Children younger than 11 years
**Children younger than 5 years

ACCORDING TO THE WHO, SEAT BELT USE REDUCES THE RISK OF FATAL INJURIES BY UP TO 50% FOR FRONT SEAT PASSENGERS AND BY 75% FOR REAR SEAT PASSENGERS.

9.3 SPEEDING

Of all the risk factors surveyed since 2015, this is the only one that has not shown any significant difference between the different rounds (Figure 28). On average, 1 driver in 5 was speeding (20% of the total). When looking at the disaggregated behavior of drivers by type of vehicle, motorcyclists more frequently drive above the speed limits (30% of all types of vehicles - Figure 29). This fact, together with the vulnerability of these users, represents a very serious exposure to severe injury and death. Tables 20 and 21 present more details on the progression of this risk factor.

FIGURE 28 - SPEEDING DRIVERS (2015/2017)

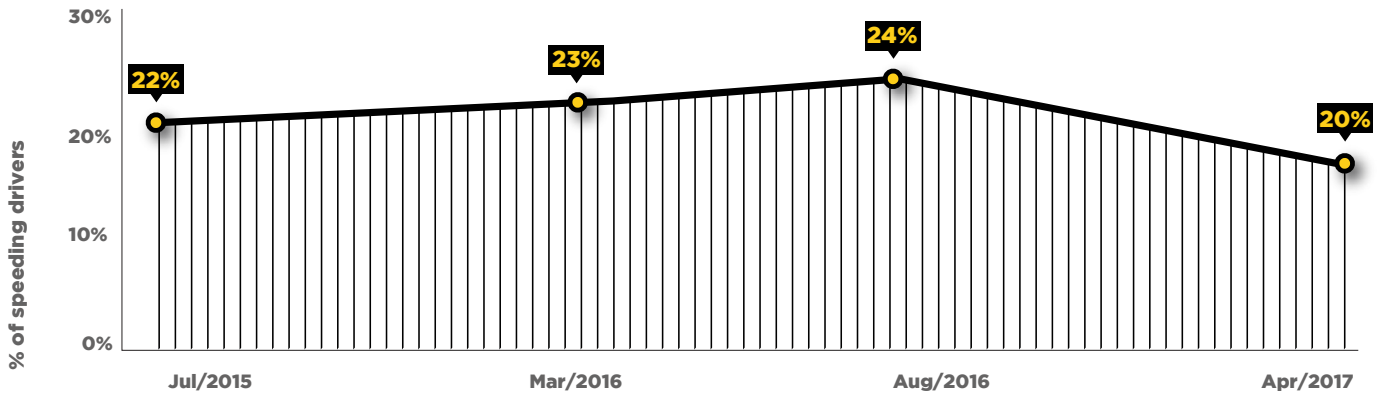
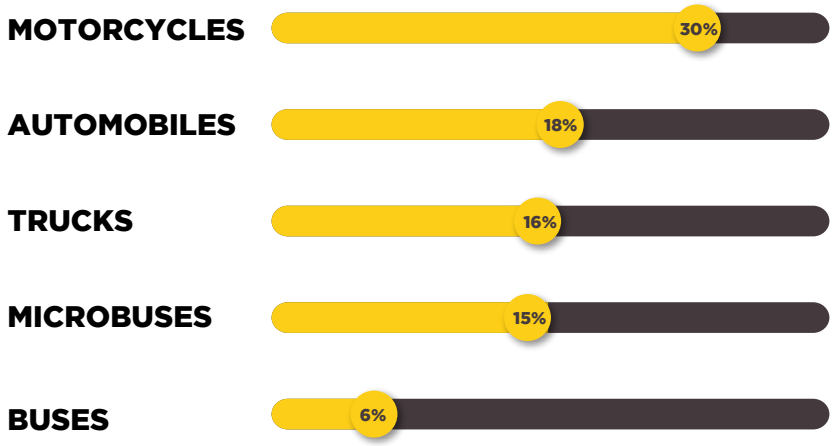


FIGURE 29 - SPEEDING DRIVERS, BY TYPE OF VEHICLE (ROUND 4, MARCH 2017



% of speeding drivers, by type of vehicle

TABLE 20 - SPEEDING DRIVERS (2015 - 2017)

OBSERVED BEHAVIOR	BASELINE	2ND ROUND	3RD ROUND	4TH ROUND
	SEP/15	MAR/16	AUG/16	MAR/17
All speeding vehicles	22%	23%*	24%*	20%*
Motorcycles	34%	35%	32%*	30%*
Automobiles	19%	20%*	23%*	18%*
Trucks	16%	17%	16%	16%
Buses	7%	5%	7%*	6%
Microbuses	14%	17%*	17%	15%
Taxi cabs	18%	15%*	21%*	N/A
Others	15%	16%	20%	0%

*Indicates a statistical significant difference compared to the immediately preceding round

TABLE 21 - SPEEDING VEHICLES, BY EXCESS SPEED RANGE (2015 - 2017)

OBSERVED BEHAVIOR	BASELINE	2ND ROUND	3RD ROUND	4TH ROUND
	SEP/15	MAR/16	AUG/16	MAR/17
Speeding vehicles	22%	23%*	24%*	20%*
Vehicles exceeding the speed limit by 5 km/h	15%	16%*	17%*	14%*
Vehicles exceeding the speed limit by 10 km/h	8%*	9%	10%*	8%*
Vehicles exceeding the speed limit by 15 km/h	4%	5%*	5%	4%*
Vehicles exceeding the speed limit by 20 km/h	1%*	2%	2%	2%*

*Indicates a statistical significant difference compared to the immediately preceding round

The CGDMAT studies show that in 33% of studied cases speeding was a contributing factor to a fatal outcome. In these cases, severe drag burns and multiple and complex trauma are strong indications of the high speed at the time of impact. We see that half (52%) of the crashes in which speed was a contributing factor resulted in a motorcyclist death, reinforcing the problematic reality of motorcycles in Fortaleza.

During the evaluation survey on the correct helmet use campaign, 90% of motorcyclists stated that speeding is one of the reasons that can always (64%) or frequently (26%) cause traffic crashes. Thus, there is a good knowledge of the causal relationship between speeding and the probability of getting involved in an crash. However, the behavior of the motorcyclists is still not consistent with what they say.

An analysis of the traffic tickets issued by radars in 2016 shows that speeding represents 48.4% of all monthly traffic tickets. In second place we have the problem of private cars driving on bus-only lanes, which accounts for 17.2% of all tickets issued. We would like to highlight the significant difference between the first and second places in this ranking, emphasizing the absolute dominance of speeding as the leading risk factor.

9.4 DRINK DRIVING

In the observational survey conducted by JHU and UFC, university researchers were embedded in the checkpoints, counting the number of alcohol tests performed. It is important to highlight that the results for this risk factor, albeit interesting for a historical follow-up, must be also considered with caution as we must recognize the limitations of the accuracy of the drink driving data in Fortaleza given the existence of mobile applications aimed to elude such checkpoints. These applications hinder law enforcement efforts and lower the potential to identify this behavior in the city. In addition, some drivers refuse to perform the breathalyzer test. In Fortaleza, on average 2% of the drivers refuse to perform the test.

Figure 30 and Table 22 show a clear decreasing trend of drivers who drink and drive. However, this evolution is not statistically significant, probably due to the low number of positive tests. In light of this trend, the researchers from Johns Hopkins University expect that such decrease may be statistically significant in the next data collection rounds.

FIGURE 30 - DRIVERS DRIVING UNDER THE INFLUENCE OF ALCOHOL (2015 - 2017)

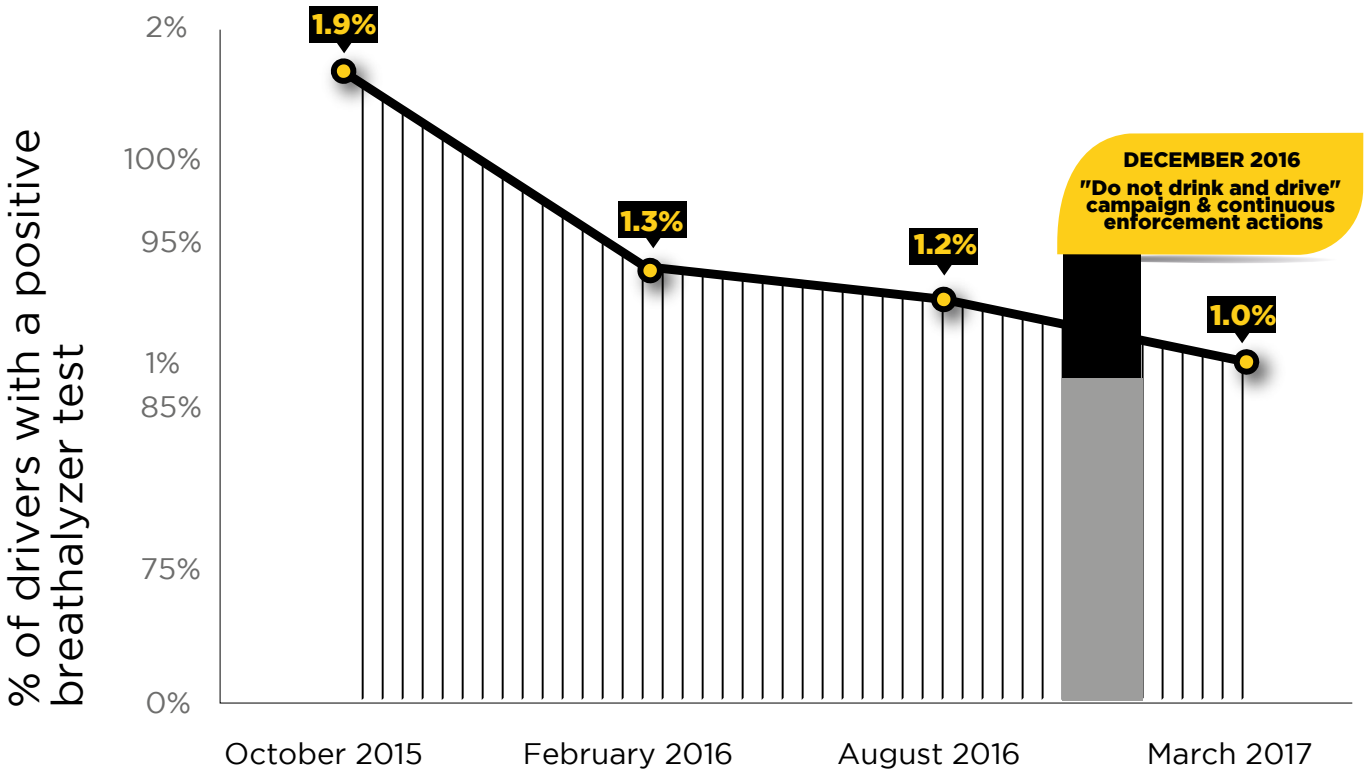


TABLE 22 - DRIVERS WITH A POSITIVE BREATHALYZER TEST

OBSERVED BEHAVIOR	BASELINE	2ND ROUND	3RD ROUND	4TH ROUND
	OCT/15	FEB/16	AUG/16	MAR/17
Drivers with a positive breathalyzer test	1,9%	1,3%	1,2%	1%
Sample	n=3.505	n=1.926	n=2.753	n=2.535

We should note that 80.8% of all drivers with alcohol blood levels above the legal limit were men, 85.7% of them aged between 25 and 59 years (Table 23).

TABLE 23 - GENDER AND AGE OF DRIVERS WITH A POSITIVE BREATHALYZER TEST (ROUND 4 - MARCH/ APRIL 2017)

AGE RANGE	MEN WITH A POSITIVE BREATHALYZER TEST	WOMEN WITH A POSITIVE BREATHALYZER TEST
18 - 24 YEARS	40%	9,52%
25 - 59 YEARS	60%	85,72%
>60 YEARS	0%	4,76%

In the last round of the survey (4th round, March/April 2017), we estimated that up to 3.2% of the drivers were under the influence of alcohol (Table 24). This number is the sum of the percentage of drivers with a positive test result (1%) and the percentage of drivers who refused to take the breathalyzer test (2.2%), which were considered to be likely positives.

TABLE 24 - ESTIMATED LIKELY POSITIVES (ROUND 4 - MARCH/APRIL 2017)

A. NO. OF REQUESTED BREATHALYZER TESTS	2021
B. NO. OF PERFORMED BREATHALYZER TESTS	1977
C. NO. OF REFUSING DRIVERS	44
D. NO. OF POSITIVE RESULTS	20
PREVALENCE OF POSITIVES (D/B)	1,0%
LIKELY POSITIVES [(C+D)/A]	3,2%

In the evaluation survey of the correct helmet use campaign, 79% of respondents believed that drinking and driving is one of the three main causes of road crashes. On the other hand, 23% of respondents agreed that "having one or two drinks does not increase the chance of crashing the car", indicating an alcohol permissiveness that can result in impaired driver reflexes and consequently in an increased risk of traffic-related injury or even death.

Between July and September 2017, when the enforcement actions were conducted together with the "Do not drink and drive" media campaign, 15,160 drivers were stopped at different "Dry Law" checkpoints. 6,773 breathalyzer tests were requested but 246 drivers (3.6%) refused to take it and 44 (0.7%) were positive for alcohol. When we add up the drivers who refused to take the test and the actual positives, we have an average of 3.2 alcohol-related violations per day during the studied period.

10. IMPLEMENTED POLICIES AND ACTIONS

Since 2015, The Municipality of Fortaleza has been implementing the Fortaleza Road Safety Program, which provides Urban Design, Enforcement and Communication guidelines and implements integrative actions in these fields based on the analysis of traffic crash data and records, with the ultimate goal of preventing traffic fatalities and injuries. This section presents the actions performed in these areas in recent years, showing the proactive and responsive stance of municipal authorities regarding this public health epidemic.

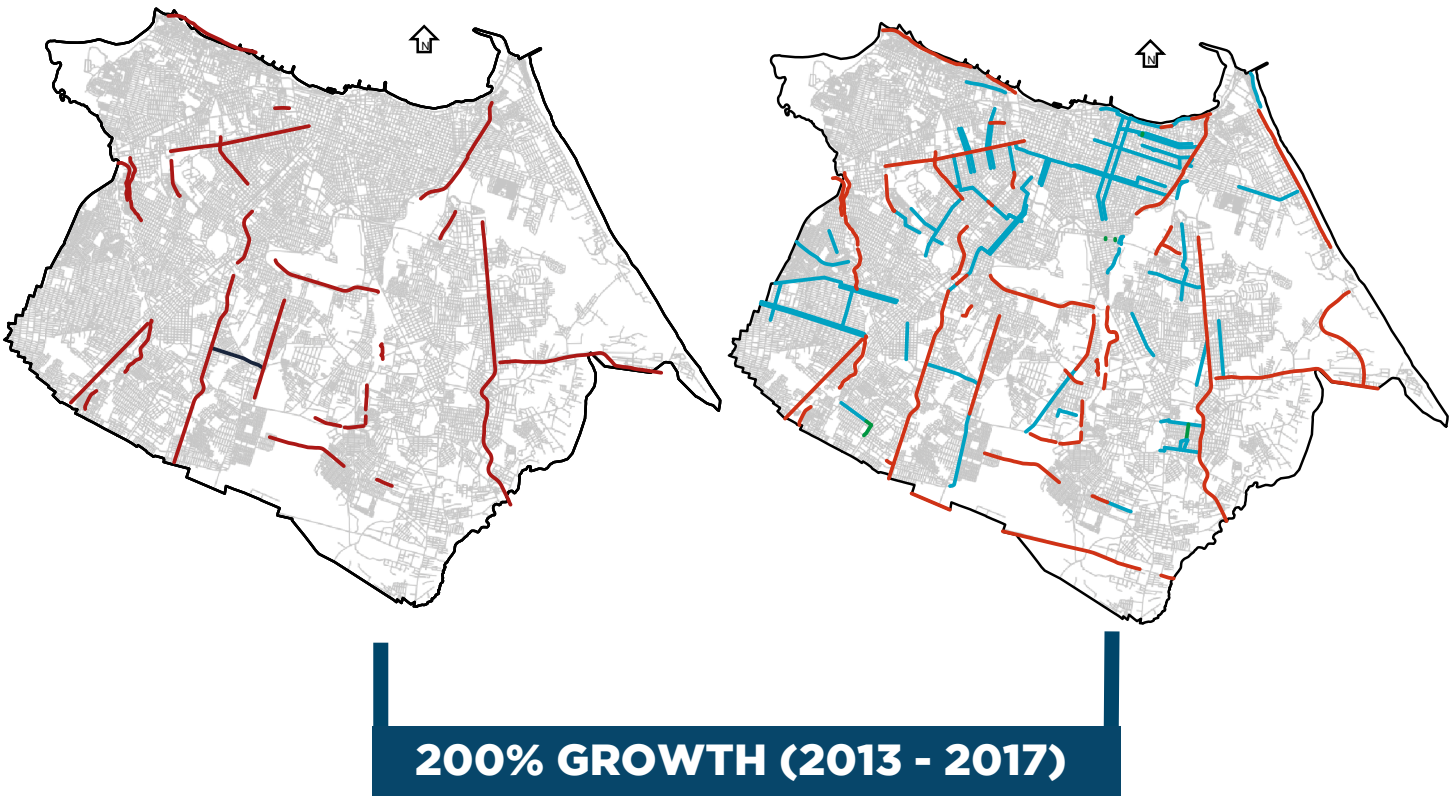
The first theme, Urban Design, presents the infrastructural interventions, including the expansion of bike lLanes, bus-only lanes, lLow sSpeed zZones and the pedestrian infrastructure program. Enforcement actions are presented as well, highlighting the focus on prevention and monitoring of risk behaviors. The achievements in the field of traffic education are then presented, based on road safety and focused on the protection of life and on the prioritization of more physically vulnerable transportation means. Finally, we present the actions taken with regard to the recording and analysis of crash data supporting the actions mentioned above.

URBAN DESIGN

CYCLING INFRASTRUCTURE EXPANSION PROGRAM

Between 2013 and 2017, 150.8 km of bike paths were built, representing an increase of 220%, continuing the expansion of the cycling network according to the recommendations of the Cycling Master Plan. Currently, the bike grid covers 218.8 km (Figure 31).

FIGURE 31 - GROWTH OF THE BIKE PATH GRID



Cyclist counts show the relevance of investing in better infrastructure for them. Bike paths such as the ones on Santos Dumont Avenue and on Domingos Olímpio Avenue have significantly increased the number of circulating cyclists. Between 2012 and 2017, Santos Dumont Avenue rose from 33 to 181 cyclists in a 2-hour interval at the afternoon rush hour. Domingos Olímpio Avenue, which already had an intense flow, also showed a 153% increase in the volume of cyclists, going from 311 to 789 in the same 2-hour interval. The bike paths on these two avenues were implemented in 2014 and 2016, respectively.

In addition to the two bicycle sharing systems, Bicicletar (Classic bike sharing system) which have 80 docking stations, and the Bicicleta Integrada (a bike rental system with a 14-hour rental period), 5 additional docking stations belonging to the Mini-Bicicletar, a bicycle sharing system for children were opened in 2017. We should note that all these systems are integrated as part of the public transport system and holders of a Bilhete Único, the municipal transport card, can use it at no charge.

The percentage of female cyclists is one of the most relevant indicators of how bike-friendly a city is. The counts made in 2016 on several roads in the city showed that 8% of all bikers were women. On the other hand, the Bicicletar bike sharing system´s data show that 29% of the trips are performed by women, a much higher percentage than the general cyclist data. The Bicicletar system, therefore, is an important encouraging intervention for the increased use of bicycles in Fortaleza.

DEDICATED BUS LANE PROGRAM

Prioritizing collective transportation is not only an efficient urban sustainability measure but also a road safety improvement tool. Making buses more attractive to the general public will lead to fewer circulating motorcycles and cars, which are more dangerous. For example, the risk of a motorcyclist or a car driver to die in a traffic crash is 200 and 20 times higher, respectively, than that of a bus passenger, as shown in Table 25 (Vasconcelos, 2013). Since 2013, the extension of bus-only lanes in Fortaleza jumped from 3.3 km to 100 km, clearly showing the city's commitment to collective transportation.

TABLE 25 - RELATIVE RISK OF INJURY IN TRAFFIC, BY TRANSPORT MODE (VASCONCELOS, 2013)

VEHICLE	INJURY	DEATH
BUS	0,26	0,1
CAR	1	1
MOTORCYCLE	29,8	19,7

OPTIMIZATION OF VEHICLE CIRCULATION

Road optimization projects are a solution for the remodeling of the existing roads within a short implementation time. In general, two-way roads are transformed into one-way ones, which triggers a series of direct and indirect benefits. These circulation changes allow for the safe inclusion of active transport modes, mainly pedestrians and cyclists, the prioritization of public transport and an increased flow of general traffic. Those changes also result in the restoration of the urban space, providing the adjacent areas with new lighting, paving and drainage. 18 projects have been put in place since 2014.

One of the last to be implemented was located at the Vila Manoel Sátiro neighborhood, where small refuge islands, traffic lights and pedestrian crosswalks were put in place, as well as a bidirectional bike paths providing safety to local cyclists. An innovative urban design was also implemented, consisting in the extension and marking of the sidewalks with paint - the first of its kind in Fortaleza. Figure 32 presents the urban impact of this type of intervention, showing the situation before and after it was completed.

FIGURE 32 - INTERSECTION OF CÔNEGO DE CASTRO AVE. AND DELTA ST., VILA MANOEL SÁTIRO NEIGHBORHOOD

LOW SPEED ZONE

In 2016, a Low Speed Zone was established in the Rodolfo Teófilo neighborhood, in an area of hospitals and universities with an intense flow of pedestrians, especially people with mobility limitations. A survey was conducted in 2017, one year after its implementation, by the Civil Engineering program of the University of Fortaleza with the support of the Municipal Secretariat of Conservation and Public Services. The goal of this study was to describe local user perceptions about the situation before and after project implementation. Before implementation, only 30% of pedestrians reported their perception of the safety situation when walking through this area as good or very good. This percentage rose to 80% after the project was completed. The interventions considered most important by users were raised crosswalks, with 42% of respondents, while 83% praised the good condition of the sidewalks which allowed them to walk easily through this area.

The construction of a second Low Speed Zone in the surroundings of the Albert Sabin Children's Hospital began in 2017. The project includes actions aimed to provide pedestrians more safety and comfort, such as the construction of sidewalk extensions, raised crosswalks, speed bumps, new bus stop shelters, improved lighting and new signage. Each day, more than 3,000 pedestrians walk through the area, including the flow generated by the hospital and the surrounding schools and residences. The new urban design interventions received consultancy support of the Bloomberg Initiative for Global Road Safety and its partners.

PROJECT “CIDADE DA GENTE”

A pilot project was implemented in the Cidade 2000 neighborhood in the framework of the “Cidade da Gente” Program. It is a road intervention program, based on international experiences, aimed to show the population new possible uses of the public space, beyond the parking and traffic of vehicles. With easy-to-remove paint, simple and inexpensive plant jars and urban furniture, the main avenue of the Cidade 2000 neighborhood gained an exclusive area for pedestrians, with cultural and educational activities, public services and a new place for the local community. This type of low-cost and simple intervention, instigating change and breaking paradigms, is known as Tactical Urbanism (Figures 33-38). Thus, with a short-term commitment and realistic expectations, it is possible to anticipate results of a future, permanent intervention.

Data from an interactive totem survey show that 97% of all respondents believe that pedestrians should be prioritized in that area. The road safety perception after the intervention was also notable in this survey, as the number of people who felt safe when walking through the area rose from 11% to 80%, which can be explained by the increase of 350% of the number of people served by the sidewalk infrastructure. It was also important to hear the opinion of the local shop owners, considering the intense retail trade in the area. 86% of them approved of the intervention and 64% believed that this kind of project can have a positive effect on their business. The project was a success and had an 86% approval rate. The population asked and obtained from the municipal authorities for the project to remain until the permanent measures are implemented.

The actions in the Cidade 2000 neighborhood were carried out with the support of the Global Designing Cities Initiative (NACTO-GDCI), the World Resources Institute – Brasil (WRI-Brasil) and Vital Strategies, all of them partners in the Bloomberg Initiative for Global Road Safety, which since 2015 supports the policies of the Municipality of Fortaleza to reduce traffic deaths and injuries.

PHOTOS: RODRIGO CAPOTE/WRI BRASIL

PEDESTRIAN INFRASTRUCTURE PROGRAM

This program consists in the implementation of different infrastructures, such as sidewalk extensions, raised crosswalks, refuge islands, diagonal crosswalks and speed bumps. Such elements are placed in strategic locations of the road system, aiming to increase pedestrian safety.

RAISED CROSSWALKS

The deployment of raised crosswalks in Fortaleza is a standing municipal policy. As of September 2017, 31 raised crosswalks were built throughout the city, especially near schools, hospitals and squares with high pedestrian flow. The last one was deployed near the Cathedral of Fortaleza, in the city center, which has an intense pedestrian flow due to the many tourist and commercial venues in the area (Figure 39).

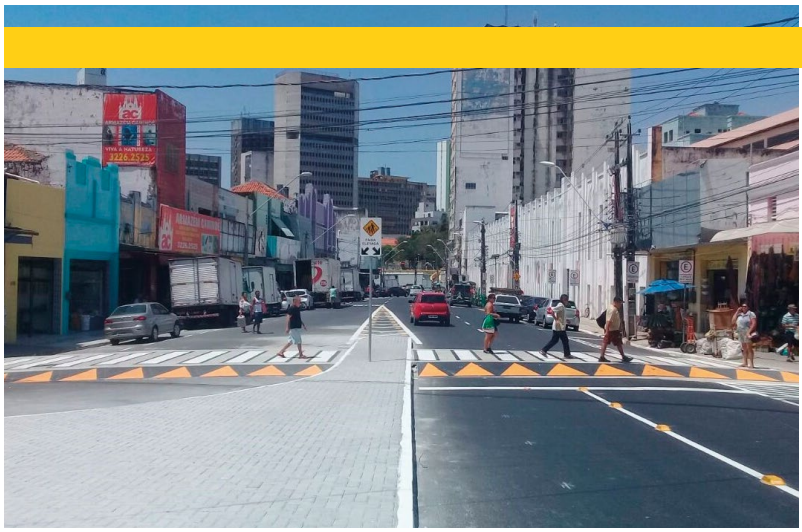


FIGURE 39 - RAISED CROSSWALK NEAR THE CATHEDRAL OF FORTALEZA

DIAGONAL CROSSWALKS

Diagonal crosswalks are designed to allow a faster pedestrian crossing to the opposite corner. Instead of crossing in two consecutive steps (one street at a time), the pedestrian may choose to do so in a single step. The waiting time to cross the streets has dropped by more than 50% in most places, such as in the intersection of Santos Dumont Ave. and Desembargador Moreira Ave., where it dropped by 62%.

Today, Fortaleza has 5 such crossings already in place and the most recent is the crossing of the intersection of Oliveira Paiva Ave. and Gonzaga Ave., in the Cidade dos Funcionários neighborhood.

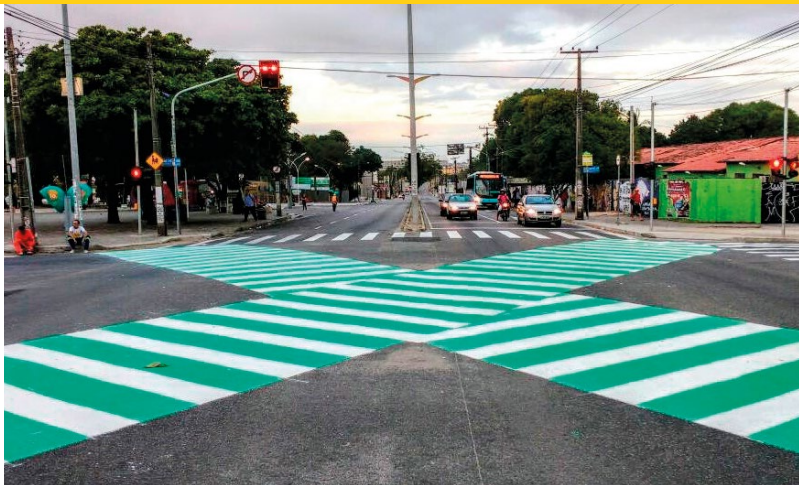


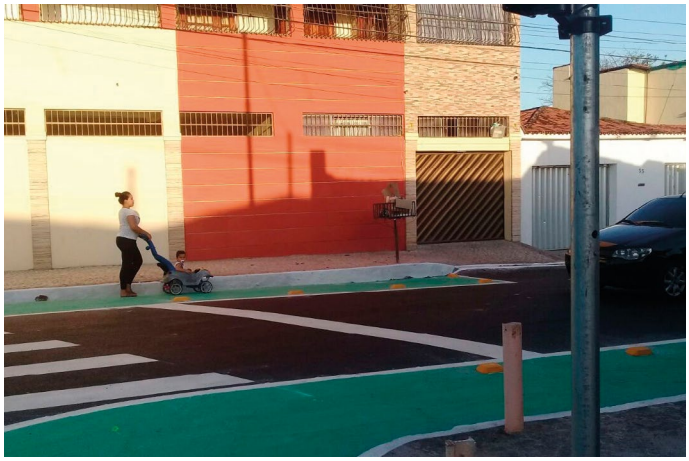
FIGURE 40 - DIAGONAL CROSSWALK AT THE INTERSECTION OF OLIVEIRA PAIVA AVE. AND GONZAGA AVE., CIDADE DOS FUNCIONÁRIOS NEIGHBORHOOD.

REFUGE ISLANDS AND SIDEWALK EXTENSIONS

Other actions implemented in Fortaleza for the safety of pedestrians are refuge islands and sidewalk extensions. Since 2016, 6 refuge islands have been built in wide two-way roads and 16 sidewalks have been widened (Figures 41 and 42).

FIGURE 41 – REFUGE ISLAND AT CORONEL JOÃO OLIVEIRA ST., MESSEJANA NEIGHBORHOOD

FIGURE 42 - SIDEWALK EXTENSION AT THE INTERSECTION OF CONEGO DE CASTRO ST. AND DELTA ST.



According to a World Resources Institute (WRI) study, for every meter of sidewalk extended on a pedestrian crosswalk, there is a 6% reduction in the probability of fatal pedestrian crashes at that location.

FIGURA 55 – I FÓRUM DE COMBATE À ALCOOLEMIA

ENFORCEMENT

The creation and maintenance of a social environment in which the existing laws are enforced promotes prudence and reduces risky road behaviors. Since 2016, there has been a systematic integration between the analysis of crash patterns and the operational planning of enforcement actions. Since the resumption of the checkpoints, AMC has been maintaining a constant enforcement in the streets of Fortaleza. In 2017, education and enforcement actions were integrated into the strategic campaigns schedule, focused on correct helmet use and the fight against drink driving. Since 2015, 10 trainings courses have been conducted in partnership with the Global Road Safety Partnership. In July 2017, the first Drink Driving Prevention Panel was held (Figure 43), exposing AMC officers to best practices for planning, execution and monitoring taught by trainers from Australia and Rio de Janeiro, who brought their successful experiences with the Dry Law. In 2017 we began implementing enforcement actions aided by video cameras, which increased AMC´s operational capacity to enforce the law and promote safer traffic behaviors.

EDUCATION

Making it clear that the individual person, with his or her inappropriate behaviors, is part of the problem, is already part of the solution, as such person has the capacity to change such behaviors. That is the main goal behind the educational actions. AMC's Traffic Education Division has been developing and running several educational campaigns with specific approaches, depending on the age range, user type or risk behavior of the target audience, such as the risks involved in pedestrian crosswalks (Figure 44). In 2017, such educational actions were in strategic synergy with the topics covered in the media campaigns. During the "Helmets Save Lives" campaign, for instance, motorcycle drivers were approached and explained the importance of the helmet, while during the "Do not Drink and Drive" campaign, the "AMC at the bars" initiative was intensified. This initiative informed the population about the importance of choosing a designated driver, that is, one person in each group who should not drink as he or she will be the one driving the others back home safely. We estimate that in 2017 approximately 26,500 people were directly impacted by these educational actions.

FIGURE 44 - AMC EDUCATIONAL OUTREACH

SURVEILLANCE AND EVALUATION

The work initiated in 2016 to rescue and improve data recording and analysis processes was essential to generate a better understanding of crash patterns in Fortaleza and ensure a better design of public policies. In 2017, this work was continued by inputting additional data into the system, such as the historical series of fatal crashes between 2012 and 2014 and improving data collection from different SIAT data sources. During this period, internal guidance processes were conceived for systematic and preventive urban design and enforcement actions, along with the development of routine rapid-response blackspot monitoring, with the help of AMC´s customer-service call center. We should also note the creation of the Rapid Death Review Committee, which brought together some of AMC´s internal sectors (Engineering, Enforcement, CTAFOR and SIAT) in order to investigate traffic-related deaths and find any engineering failures, leading to faster corrective and preventive actions and to the creation of a responsive culture.

Finally, there is an ongoing research project in partnership with the University of Fortaleza, the Dr. José Frota Hospital and the Bloomberg Initiative for Global Road Safety, aimed to characterize the causal relationships between risky behaviors, types of crashes and severity of injuries (Figure 45). The result of this coordinated work throughout 2017 can be seen in the different sections of this report, in which we intended not only to provide a numerical, temporal and spatial picture of road traffic crashes but also add other data sources in order to have a more comprehensive understanding of the traffic-related morbidity and mortality epidemic in Fortaleza.

FIGURE 45 - TRAINING OF MEDICAL STUDENTS AT THE UNIVERSITY OF FORTALEZA (UNIFOR) WITH REPRESENTATIVES OF THE MUNICIPALITY OF FORTALEZA, UNIFOR, THE IJF HOSPITAL AND BIGRS.

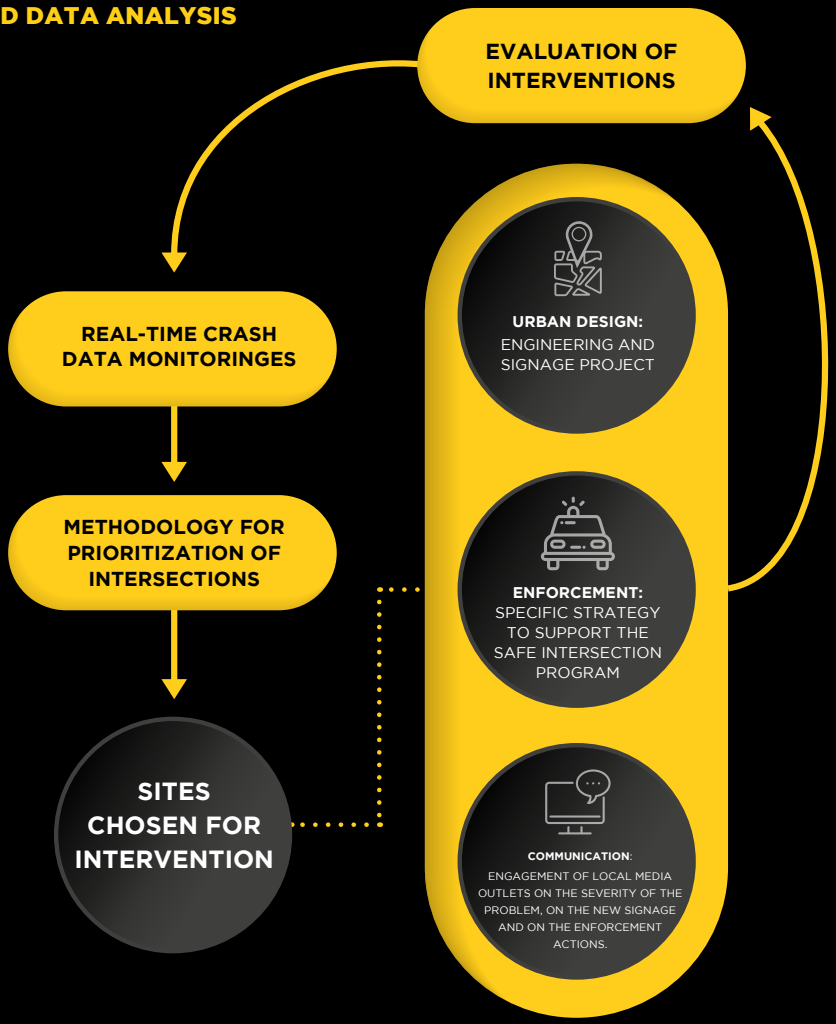
SAFE INTERSECTION: INCEPTION, EXECUTION AND EVALUATION

About 10,000 crashes were registered in the intersections of Fortaleza in 2016 alone and, of this total, 43.5% had at least one injured victim. In order to encourage compliance with traffic and parking regulations in street corners and reduce the high number of crashes at intersections, in March 2017 the Municipality of Fortaleza launched Operation Safe Intersection. The project focuses on fast interventions consisting in the renovation of the horizontal and vertical signage, the placement of "No Parking" signs, street markings and cat eye reflective markers, as well as a strategic realignment of the enforcement activities. This program brings together innovative urban design, communication and enforcement actions that are the result of real-time data monitoring, resulting in AMC´s enhanced responsiveness (Figure 46).

Figures 47 and 48 show an example of a horizontal and vertical signage project deployed in the framework of the Safe Intersection Program. Furthermore, enforcement has been intensified at these sites. By the end of October, more than 2,000 vehicles had been towed for failing to comply with article 181 of the Brazilian Transit Code (Figure 49).

FIGURE 47 - NEW SIGNAGE UNDER THE SAFE INTERSECTION PROGRAM

FIGURE 46 - ACTION GUIDANCE PROCESS FROM MONITORING AND DATA ANALYSIS



*DATA SOURCE: SAC, AMC

FIGURE 49 - ENFORCEMENT ACTIONS - OPERATION SAFE INTERSECTION

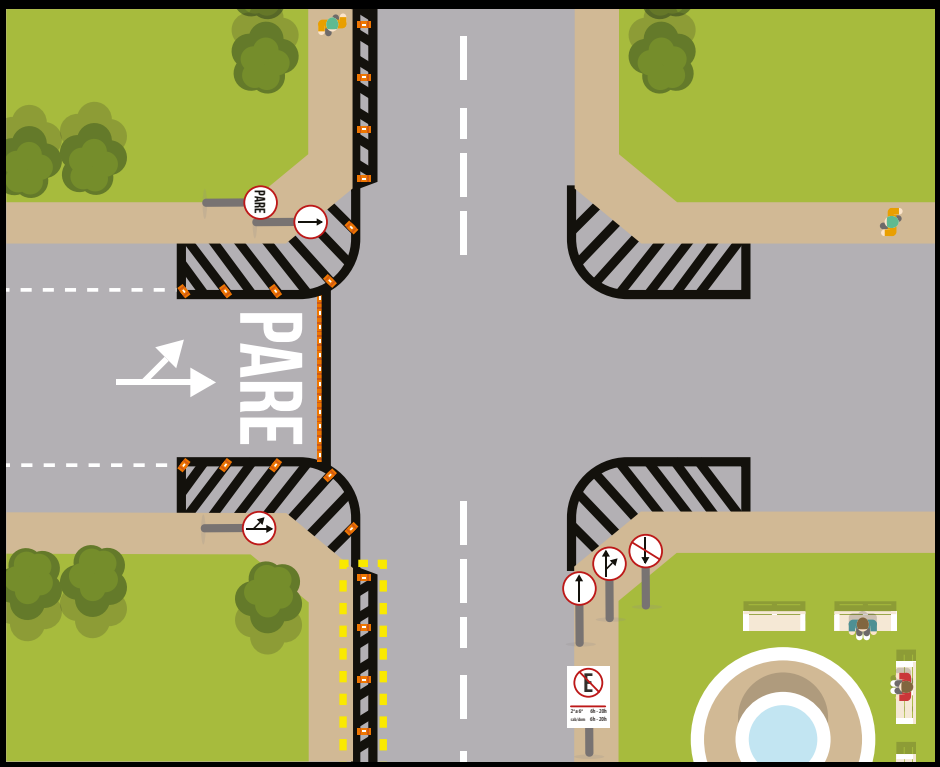
From March to September 2017, 137 Safe Intersections were deployed in Fortaleza. An evaluation was performed using a control group in order to identify whether the reduced number of crashes at these locations was a natural trend or if the new signage resulted in safer intersections.

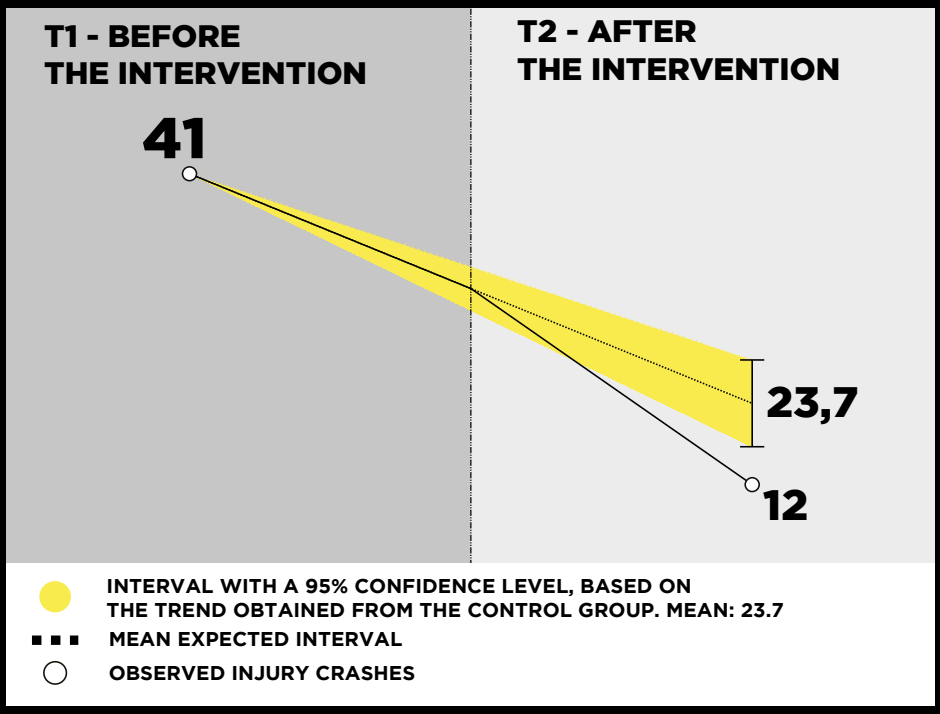
The evaluation was made by comparing crash data fromes a group of 55 intersections with similar geometries, yet without the new signage, called "the control group", and from 55 intersections with the new signage and a more intense enforcement, called "the treatment group".

FIGURE 50 - ANALYSIS OF THE SAFE INTERSECTION OPERATION THROUGH A CONTROL GROUP

The trends identified in the control group let us estimate the range of probable values in the treated intersections if new signage had not been implemented.

Prior to the intervention, 41 crashes were recorded at treatment intersections. According to control intersection findings, the expected number of treatment intersection crashes without the intervention would have been 23.7 (95% CI 22.2 to 25.2) crashes. When we compare the expected number of crashes (23.7) to the 12 crashes actually recorded in the post-intervention period, we can estimate that, on average, the Safe Corner program tends to reduce the number of traffic crashes by 49% (Figure 50). These figures are strong statistical evidence that Operation Safe Intersection is an essential and efficient program for the reduction of traffic violence in the city of Fortaleza.





COMMUNICATION

Throughout 2017, the Municipality of Fortaleza, with the support of the Bloomberg Initiative for Global Road Safety, carried out several communication actions in order to raise community awareness on the need for safer traffic behaviors to reduce the number of crashes, especially those with most deaths and injuries. Two mass media campaigns were launched this year, focused on risk factors that according to the World Health Organization claim most victims worldwide.

The "Helmet Saves Lives" campaign was launched In February (Figure 51). The main video alerted motorcycle drivers about the importance of wearing a helmet and buckling it correctly, even for short rides. The video, aired in cinemas, TV channels, radio, printed newspapers and also in the social media of the Municipality of Fortaleza, was developed from an analysis with focus groups that recommended the "testimonial" format as the most effective to reach the public most vulnerable to this risk factor. The video shows a maen talking about his mother's death and how he knew that she did not use the helmet correctly, as it was "loose". On a short ride, they are hit by a car and the mother dies after the crash.

FIGURE 51 - ADVERTISING ITEMS OF THE "HELMET SAVES LIVES" CAMPAIGN

A survey commissioned by Vital Strategies, a partner in the Bloomberg Initiative for Global Road Safety, carried out by the Multifocus Institute among 651 motorcyclists and 354 motorcycle passengers from February 2 to March 8, concluded that 37% of respondents recalled the campaign, which suggests that the campaign had probably reached 925,000 adults in Fortaleza. The recall was consistent among men and women and among drivers and passengers. The key messages in the campaign were “Always wear a helmet” (45%) and “Always buckle your helmet” (57%). Most of those who remembered the campaign agreed that it was easy to understand (96%), that it was an effective campaign (97%), that it had made them stop and think (90%), that they have become more aware about the need to wear the helmet correctly (93%), and that it made them understand the consequences of failing to properly fasten the helmet (95%).

In July, the Municipality of Fortaleza launched a new campaign, also with the support of the Bloomberg Initiative for Global Road Safety, this time focused on drink driving (Figure 52). The main video was broadcast on television, radio, printed newspapers and on the social media of the Municipality of Fortaleza. The campaign´s material was developed from a concept already used with success in other countries and adapted to the local reality. The video shows the fate of a young man turning into tragedy after he drinks socially with friends and, after a distraction of just a few seconds, he loses control of the car and hits the wall of a house where a child was playing. The impact message asks the viewer “Could you live with that guilt?” and ends with the phrase “If you drink, do not drive”. The impact evaluation results of this campaign are expected to be available in early 2018.

FIGURE 52 - AN ADVERTISING ITEM FROM THE “DO NOT DRINK AND DRIVE” CAMPAIGN

In addition to the advertising campaigns, other events were held seeking to capitalize on the attention of the press and introduce the issue of traffic safety into society’s discussion agenda. Some examples are the Yellow May program (Figure 53), which sought to alert the population on the risks of speeding and the severity of speed collisions through a series of activities. During this program, a Road Safety Journalism Workshop showed journalists the importance of keeping the subject under discussion in the press. In September, Mobility Week (Figure 54) was organized, with several cultural and educational activities and seeking to draw the attention of different sectors of society to the importance of the prevention of traffic crash.

FIGURE 53 - CAMPAIGN SUPPORTING THE "YELLOW MAY" MOVEMENT

FIGURE 54 - ACTIVITIES PERFORMED DURING THE MOBILITY WEEK

The actions described above require strong institutional integration and coordination, activating multiple internal and external resources of the Municipality of Fortaleza in order to face the dramatic situation created by traffic crashes. From the data and actions described above, we can see that the city has performed an intense effort and achieved important results, such as a reduction in the number of deaths and in the mortality rate. However, there is still a long road ahead of us, a road that should not be traveled exclusively by the public authorities. We all live in a city that still has traffic crashes as the 5th cause of death, a city where 1 in 5 drivers exceeds the allowed speed limits, a city where the elderly are the ones who die in traffic crashes the most. This set of information can be used to get a better understanding of the morbidity and mortality in Fortaleza´s traffic, disseminate official information and, most importantly, make the population aware of their essential role in changing behavior so we can mitigate this problem.

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