Development of the Investment Case to Reduce Road Traffic Injuries among Adolescents

Vietnam Road Safety Case Study

A project funded by FIA Foundation

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Introduction

This case study on the road safety situation in Vietnam has been undertaken to illustrate how more detailed information on a country can be used to better inform an investment case on the introduction of a set of interventions to reduce road traffic deaths and serious injuries among adolescents. The study contains a review of the road safety situation in Vietnam, a description of Government regulations and performance reviews, as well as a description of road infrastructure and the motor vehicle fleet, the causes of road accidents and fatalities, and other information relevant to modelling an investment case.

The information gathered together is used to refine the assumptions and data for the Road Safety Intervention Model (RSIM) to estimate the impact of a range of interventions on road traffic fatalities and injuries in Vietnam. The RSIM is described in detail in the main body of the report to FIA Foundation. The set of interventions used in the modelling is shown in Table 1.

Table 1: Interventions summary

	Intervention	Baseline 2019	Effective reduction
Motor cycles	Helmet usage	70%	36%
	Alcohol limit enforcement	5%	25% for Vietnam
	Infrastructure	See Table 9 & Table 10	21% for Vietnam
	Speed compliance	0%	14%
	Public awareness and education	0%	6%
	Graduated Licensing Scheme 15–19	0%	20%
	Graduated Licensing Scheme 20–24	0%	4%
Motor vehicles	Seat belts	10%	20%
	Alcohol limit enforcement	5%	25% for Vietnam
	Infrastructure	See Table 9 & Table 10	22% for Vietnam
	Speed compliance	0%	14%
	Graduated Licensing Scheme 15–19	0%	20%
	Graduated Licensing Scheme 20–24	0%	4%
	NCAP	0%	1%
	Public awareness and education	0%	6%
Cyclists	Alcohol limit enforcement	5%	4% for Vietnam
	Infrastructure	See Table 9 & Table 10	28% for Vietnam
	Speed compliance	0%	14%
	Public awareness and education	0%	6%
Pedestrians	Alcohol limit enforcement	5%	4% for Vietnam
	Infrastructure	See Table 9 & Table 10	47% for Vietnam
	Speed compliance	0%	14%
	Public awareness and education	0%	6%
All	Capacity building	N/A	N/A

The bulk of this report is a series of graphs comparing deaths and serious injuries under the baseline with those under the intervention scenario. Separately for males and females in three age groups, 10 to 14, 15 to 19 and 20 to 24, graphs are given for deaths and injuries for pedestrians, cyclists, motorcyclists, motor vehicle occupants, and in total in both urban and rural settings.

The results for each age cohort show a general downwards trend in the number of fatalities for all age groups (more so for 10 to 14 and 15 to 19 year olds) for both males and females. The reasons for this decline are not certain, though undoubtedly efforts by the Government of Vietnam to address road safety have had an effect together with the improving crashworthiness of motor vehicles as the average age of the car fleet decreases. There is also a trend towards more motorised transport with

increasing age. This is especially the case with motorcycles. For the 10 to 14 year-old cohort, pedestrians represent a much higher number of fatalities than in the older cohorts. As with all countries, male fatalities are higher than female figures by a factor of between three for 10 to 14 year olds to six for 20 to 24 year olds.

The results for serious injuries differ significantly from fatalities with there being more than ten times as many serious injuries as fatalities by 2050. While fatalities are all expected to decline, depending on the cohort, serious injuries either stabilise or increase gradually. The exception being urban males in the 15 to 19 and 20 to 24 age cohorts where serious injuries are expected to rapidly increase.

As with fatalities, motor cyclists make up most of the serious injuries, though there are more motor vehicle occupants and cyclists represented in serious injuries than fatalities. This high number of motor cyclists represents a particular road safety challenge for Vietnam, however, other modes are also significant.

The modelling predicts the number of deaths and serious injuries averted due to the interventions for males and females in the three age groups as shown in Table 2, Table 3, Table 4 and Table 5.

Table 2: Percentage reduction in fatalities and serious injuries due to interventions, annual by 2030

	10 to 14	15 to 19	20 to 24	Total
Deaths averted				
Male	54.4%	63.3%	57.3%	59.7%
Female	54.8%	62.3%	56.7%	58.9%
Persons	54.5%	63.2%	57.2%	59.6%
Disability averted				
Male	50.7%	57.6%	53.9%	55.0%
Female	52.5%	58.1%	53.3%	55.0%
Persons	51.4%	57.8%	53.8%	55.0%

Table 3: Annual reduction in fatalities and serious injuries due to interventions, annual by 2030

	10 to 14	15 to 19	20 to 24	Total
Deaths averted				
Male	91	793	856	1,740
Female	36	148	141	325
Persons	127	940	997	2,064
Disability averted				
Male	956	3,374	3,499	7,830
Female	588	1,171	1,025	2,783
Persons	1,544	4,545	4,524	10,613

Table 4: Percentage reduction in fatalities and serious injuries due to interventions aggregated, 2022–2030

	10 to 14	15 to 19	20 to 24	Total
Deaths averted				
Male	40.5%	48.9%	43.5%	45.7%
Female	41.3%	47.7%	43.1%	44.9%
Persons	40.7%	48.7%	43.5%	45.5%
Disability averted				
Male	38.7%	45.5%	42.1%	43.0%
Female	39.7%	44.7%	40.8%	42.1%
Persons	39.1%	45.3%	41.7%	42.7%

Table 5: Aggregated reduction in fatalities and serious injuries due to Interventions, 2022–2030

	10 to 14	15 to 19	20 to 24	Total
Deaths averted				
Male	689	5,664	5,957	12,310
Female	256	1,076	975	2,307
Persons	945	6,740	6,932	14,617
Disability averted				
Male	6,065	20,694	21,222	47,981
Female	3,891	7,772	6,766	18,429
Persons	9,956	28,466	27,988	66,410

The fatality and serious injury information along with the costs of the interventions modelled is incorporated within the economic model described in detail in the main body of the report. The economic benefits associated with the reduced deaths and disability is compared to the costs and expressed in terms of benefit-cost ratios. The results are shown in Table 6.

Table 6: Summary economic results, discount rate 3%

Economic benefit, million USD (NPV)	Deaths	$5,459
Economic benefit, million USD (NPV)	Disability	$33,405
Economic benefit, million USD (NPV)	Deaths plus disability	$38,864
Cost, million USD (NPV)		$1,463
Benefit-cost ratio		
Economic benefit	Deaths	3.7
Economic benefit	Deaths plus disability	26.6

Current Road Safety Situation

In 2018, road traffic accidents resulted in approximately 25,000 deaths in Vietnam (WHO 2018). Injuries from road traffic accidents are the third leading cause of premature death, higher than deaths caused by lung cancer, tuberculosis or HIV/AIDS (IHME 2019). Approximately 2,150 children die on the roads of Vietnam each year (the equivalent of 5 children dying per day). As of 2017, road crashes are the fourth leading cause of death among Vietnamese children ages 5–14 (Vu and Nguyen 2018). In 2019 according to Global Burden of Disease data, there were 291 fatalities for 10 to 14 year olds, 1591 for 15 to 19 year olds and 2188 for 20 to 24 year olds (total 4188 for 10 to 24 year olds).

Motorcycles account for approximately 95% of all registered vehicles in Vietnam (WHO 2018), and motor cyclists account for approximately 70% of Vietnam's road crash fatalities (VNTSC 2016). In 2006, before helmet laws were put in place, motorcycle helmet use in Vietnam was less than 30% on average and 10% on city roads (Hung, Stevenson et al. 2006). After motorcycle helmets became mandatory in December 2007, helmet use increased to over 90% in some places (Passmore, Nguyen et al. 2010), but showed some decline in the following years. However, helmet use continues to be high in some locations and demographics, with more than 80% for motorcycle drivers wearing helmets (WHO 2018), and motorcycle-related fatalities per 10,000 motorcycles decreased by 46% (UNESCAP) that is considered to be primarily due to increased helmet wearing.

A feature of road users in Vietnam is the large number of young people, aged in their late teens and early twenties (Kitamura, Hayashi et al. 2018). Young people are involved in 40% of road traffic accidents and have a disproportionately high number of deaths (Vietnam News 2018).

National Strategy Road Traffic Safety (NSRTS)

The National Road Safety Strategy for ensuring road traffic order and safety for the period 2021–2030 and a vision to 2045 has numerous elements to it. These include implementing the five pillars of road traffic safety (State management, Infrastructure, Transportation, Traffic Participants, Traffic Accident Response) in order to achieve a modern traffic safety system, ensuring a road traffic system that is safe, transparent, friendly with the environment, contributing to socio-economic development, ensuring national defence and security and international integration. The overall objective of the NSRTS is to reduce road traffic deaths and injuries by 5–10% every year (MOTV 2018).

Road Safety Performance Review

The United Nations Economic and Social Commission for Asia and the Pacific in conjunction with the Transport Safety Department of the Ministry of Transport in Vietnam undertook a Road Safety Performance Review (RSPR). The objectives of the review included studying and proposing amendments to the 2008 Road Traffic Law to bring it in line with both the needs of the current situation and the international standards of the 1968 Convention on Road Traffic, as well as study and propose amendments to regulations on road traffic safety auditing, inspection and appraisal.

The project assessed the road traffic safety performance of Vietnam in terms of the five pillars of the global plan for the United Nations Decade of Action for Road Safety, which include:

- road safety management capacity;
- the safety of road infrastructure and transport networks;
- the safety of vehicles;
- the safety of road users; and
- post-crash response.

Road Traffic Law

In Vietnam, the *Road Traffic Law* is the highest legal instrument with respect to road safety issues. The first Road Traffic Law was enacted in 2001 and this focussed on road traffic and urban traffic orderliness as opposed to safety issues. The *Road Traffic Law* was updated in 2008 and enacted in July 2009. The 2008 Law placed a greater focus on traffic safety with many regulatory amendments that are more stringent than the 2001 Law. These regulations incorporate measures that have been successfully applied in high-income countries. These include regulations such as helmet use, alcohol samples, and mobile phone use when driving vehicles, and seat belts in motor vehicles that have been implemented with varying degrees of success.

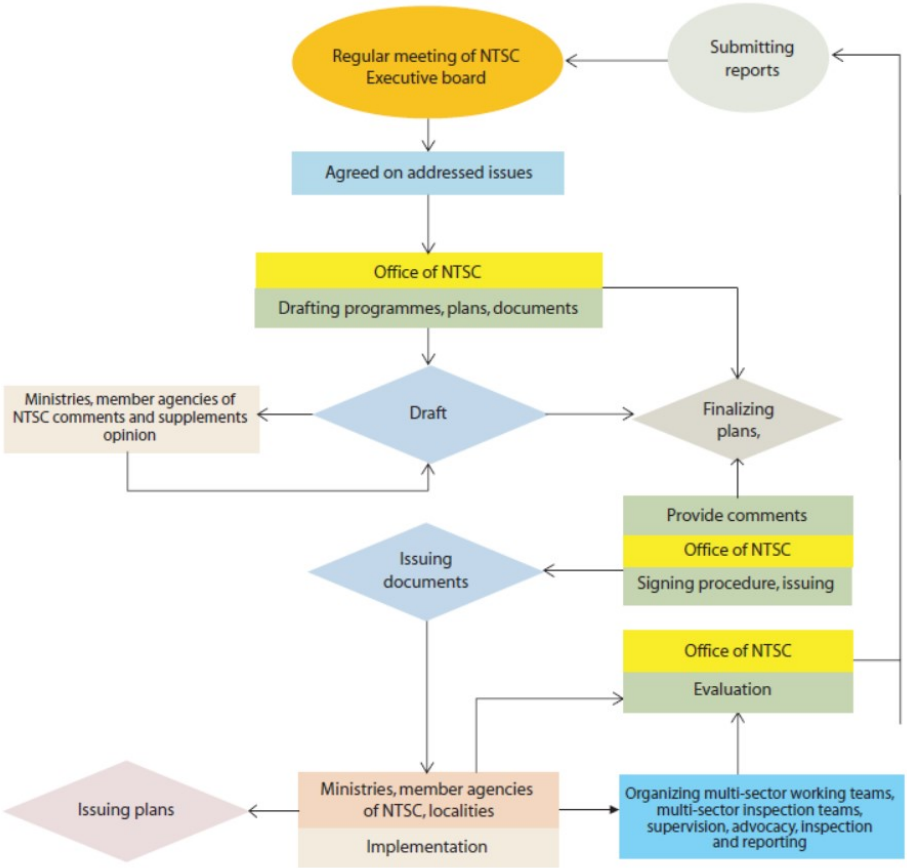
Responsible ministries

Ministry of Transport

The Ministry of Transport (MOT) manages the road, rail, inland waterway, maritime and air transport throughout the country. The MOT formulates strategies and policies on specified activities, functions and duties including road safety. Specifically for road safety, the MOT has the main responsibility for the implementation of projects on traffic safety.

The coordination and structure of the different agencies with respect to road safety are shown in Figure 1.

Figure 1: Coordination between road safety agencies in Vietnam (MOTV 2018 p36)



Ministry of Public Security

The Ministry of Public Security (MPS) is responsible for performing the management of state public order and social safety. In the field of traffic safety, the MPS is responsible for the Traffic Police who:

- organise traffic law public information campaigns, publicity;
- conduct training, granting and renewing motor vehicle licenses;
- control traffic in major urban centres and traffic hubs; and
- administer violations of road laws.

National Traffic Safety Committee (NTSC)

The National Traffic Safety Committee is an interdisciplinary committee that assists the executive level of government in guiding ministries, sectors and localities in the implementation of national strategies and projects on road safety.

Duties and powers of NTSC

These duties and powers include, but are not limited to:

- study and propose interdisciplinary interventions for road safety, as well as coordinate ministries, provinces and municipalities to implement the interventions;

- propose laws on road safety which ministries, agencies and localities implement;
- guide the Traffic Safety Boards of provinces and municipalities in their implementation of plans and interventions for road safety and monitor performance;
- report on road safety status;
- facilitate best practice in road safety;
- facilitate international cooperation in road safety and minimise the impact of traffic accidents; and
- direct research in road safety.

Road Infrastructure

Road infrastructure has increased rapidly in Vietnam since 2010 including several new highways. The road system of Vietnam is divided into six types of roads:

- national highways;
- provincial roads;
- district roads;
- commune roads;
- urban roads; and
- special roads.

Table 7 and Figure 2 show the proliferation of such roads in Vietnam from 2006–2015 in terms of kilometres.

Figure 2: Types of roads in Vietnam, km, 2015

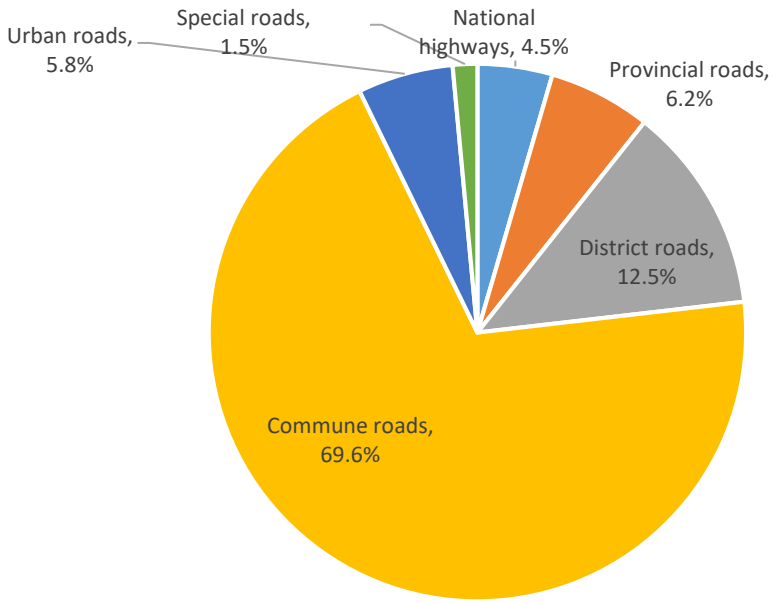


Table 7: Types of roads in Vietnam, km

Year	National highways	Provincial roads	District roads	Commune roads	Urban roads	Special roads
2006	17,295	23,138	54,962	141,442	8,567	6,414
2015	21,109	28,911	58,437	325,858	26,921	6,911

The total length of roads increased by 216,329 km from 2006 to 2015, with the biggest increases seen in commune and urban roads.

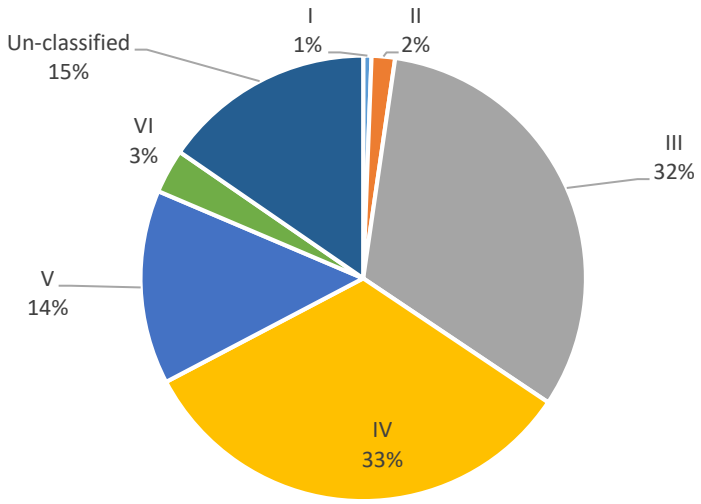
National highway technical grades

The national highway network of Viet Nam consists of 125 main routes with a length of 21,109 km, and is classified into six technical grades – from I to VI – as shown in Table 8 and Figure 3. The technical grades approximate the level of quality of the highways with technical Grade I being the highest quality road.

Table 8: Technical grades of highway network

Grade	I	II	III	IV	V	VI	Un-classified	Total
Length	134	361	6,786	6,937	2,979	670	3,242	21,109
%	0.6	1.7	32.1	32.9	14.1	3.2	15.4	100

Figure 3: Vietnam technical grades of highway network



International Road Assessment Program status

The International Road Assessment Program (iRAP) has assessed Vietnam's road infrastructure according to both distance of roads and the travel on those roads in four different modes: motor vehicles, motorcyclist, cyclist and pedestrian. The results are shown in Table 9 and Table 10. This assessment shows most travel for motor vehicle occupants, motor cyclists and cyclists is on 2- and 3-star roads, whereas pedestrians overwhelmingly travel on 1-star roads.

Table 9: IRAP star rating of roads in Vietnam, % of travel

	1-star	2-star	3-star	4-star	5-star
Motor vehicle	13.9%	22.7%	38.8%	17.2%	7.3%
Motor cyclist	19.7%	24.3%	41.9%	12.1%	2.1%
Cyclist	24.2%	30.4%	31.1%	9.3%	4.9%
Pedestrian	65.9%	21.0%	12.1%	1.0%	0.0%

Table 10: IRAP star rating of roads in Vietnam, % of road length

	1-star	2-star	3-star	4-star	5-star
Motor vehicle	18.2%	28.6%	37.0%	11.7%	4.5%
Motor cyclist	30.3%	30.6%	31.0%	7.0%	1.0%
Cyclist	29.8%	32.8%	25.5%	7.6%	4.4%
Pedestrian	71.4%	18.1%	9.8%	0.8%	0.0%

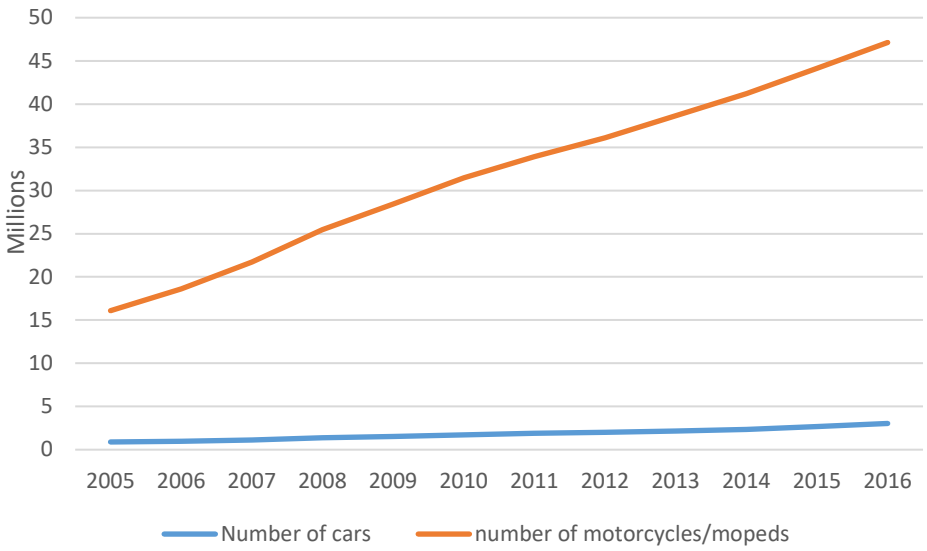
Motorized road vehicles

Since 2010, the number of motorised vehicles in Vietnam (2, 3 and 4 wheel vehicles) has increased rapidly, with a large percentage of private owners. By far the largest increase has been in motorcycles and mopeds. Motorized road vehicles are for the most part concentrated in big cities, the Mekong and the Red River Deltas (notably the two largest cities, Ha Noi and Ho Chi Minh City) (Table 11 and Figure 4).

Table 11: Number of motorised vehicles

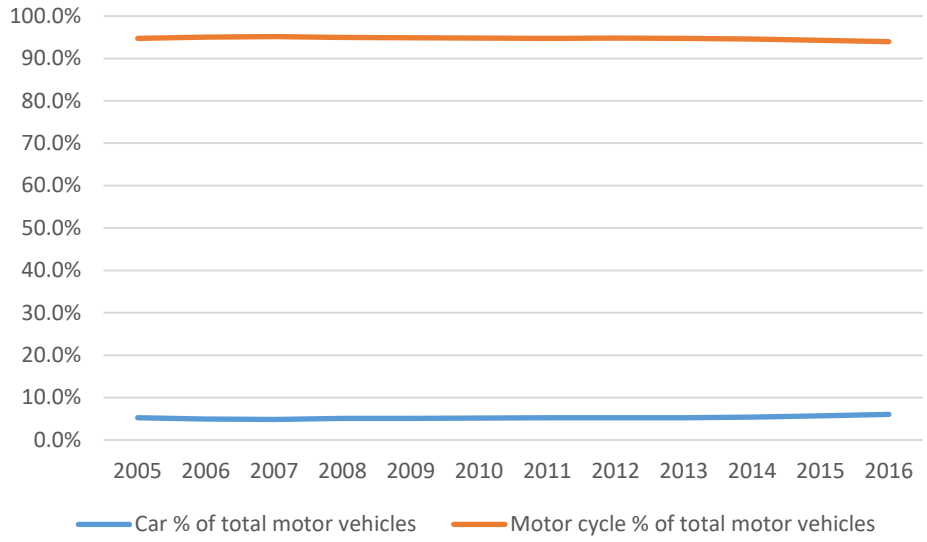
Year	Number of cars	Increase over previous year	Increase rate (%)	Number of motorcycles/mopeds	Increase over previous year	Increase rate (%)	Total vehicles
2005	891,104	116,280		16,086,644	2,710,625		1,7094,028
2006	972,912	81,808	9.18	18,615,960	2,529,316	15.72	1,9670,689
2007	1,106,617	133,705	13.74	21,721,282	3,105,322	16.68	2,2961,618
2008	1,361,645	255,028	23.05	25,481,039	3,759,757	17.31	2,7097,735
2009	1,535,987	174,342	12.80	28,431,079	2,950,040	11.58	3,0141,421
2010	1,713,908	177,921	11.58	31,452,503	3,021,424	10.63	3,3344,344
2011	1,882,972	169,064	9.86	33,925,839	2,473,336	7.86	3,5977,885
2012	1,992,589	109,617	5.82	36,102,943	2,177,104	6.42	3,2205,155
2013	2,147,750	155,161	7.79	38,643,091	2,540,148	7.04	4,0946,010
2014	2,349,667	201,917	9.40	41,212,965	2,569,874	6.65	4,3764,558
2015	2,663,269	313,062	13.35	44,128,822	2,915,857	7.08	4,7105,166
2016	3,033,527	370,258	13.90	47,131,928	3,033,106	6.87	5,0535,727

Figure 4: Motorised vehicles in Vietnam



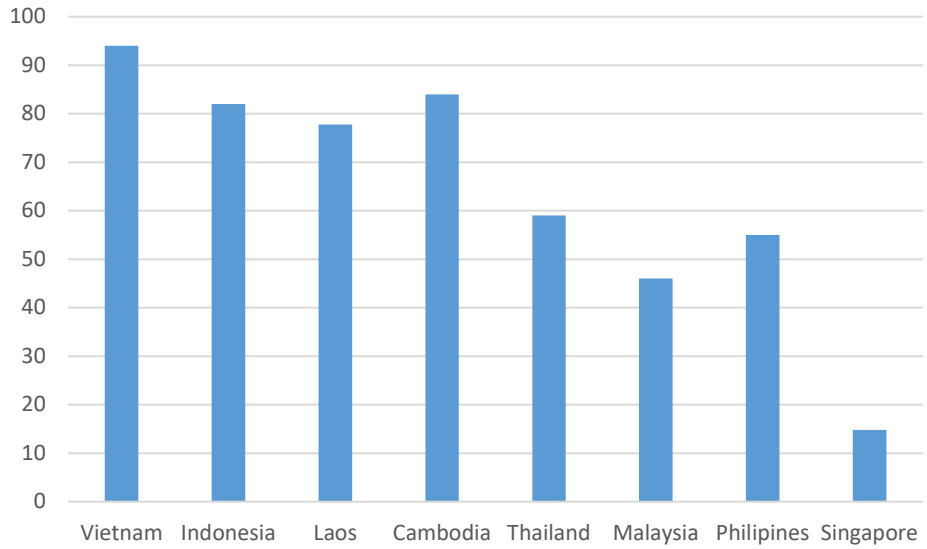
The overall percentage of cars and motor cycles relative to the total number of motor vehicles has remained quite constant with motorcycles consistently making up approximately 95% of all motorised vehicles (Figure 5).

Figure 5: Cars and motorcycles as % of total



This percentage of motorcycles and mopeds in Vietnam is highest in the South East Asian region as shown in Figure 6. La, Van Duong et al. (2017) found the high number of private motorbikes was a consequence of the government motorcycle promotion strategies that they found hinders efforts to reduce road traffic accidents. For example, the Ministry of Transport has repeatedly requested the government to reduce the number of private motorcycles across the country, while at the same time the Ministry of Industries and Trade approved a national plan for the development of motorcycle industry for the period 2006–2020 that has led to an average annual increase of 2 million vehicles.

Figure 6: Motorcycles, % of all motor vehicles, South East Asian countries



Age of vehicles

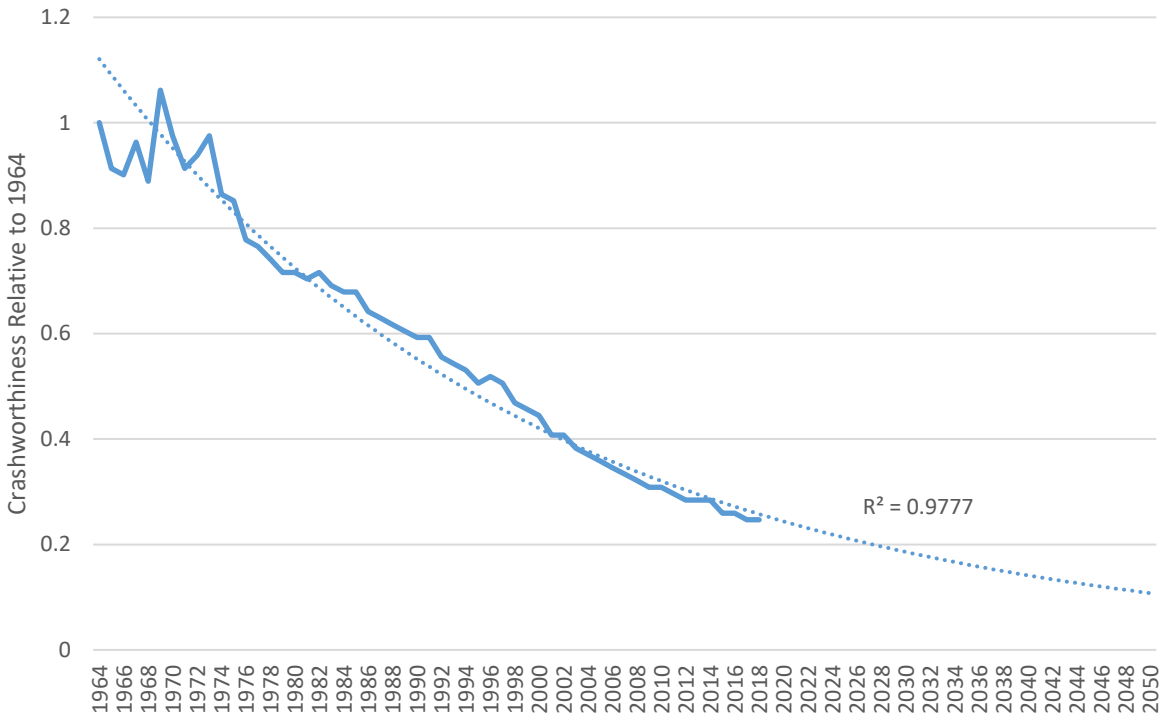
Since the implementation of a government directive in 2004 regulating the age of trucks and passenger vehicles, the average age of vehicles is under 10 years. Vehicles older than 10 years are mainly passenger vehicles, which are not included in the current age-limit regulations for private cars (Table 12).

Table 12: Average age of vehicles

Type of vehicle	2015	2016
Average age of vehicle		
Under 10 years	1,604,741	1,899,099
From 10 to 15 years	224,871	288,788
From 15 to 20 years	98,806	107,740
Over 20 years	173,383	176,797
Age of passenger vehicle		
Under 12 years	92,588	101,909
From 12 to 15 years	14,705	19,735
From 15 to 17 years	4,177	6,270
From 17 to 20 years	6,960	6,914

The age of passenger vehicles is monitored by government agencies. The registry agency always sends an update or notifies car owners when their vehicle registration has expired with strong police enforcement. Consequently, the average age of the vehicle fleet in Vietnam has decreased with a commensurate increase in the safety of the cars according to crashworthiness calculations (see Figure 7). There has been a marked improvement in the age and quality of passenger vehicles on the road, with vehicles aged 12 years or less accounting for over 75% of all vehicles.

Figure 7: Crashworthiness vs year of manufacture, relative to 1964 (Newstead, Watson et al. 2020)



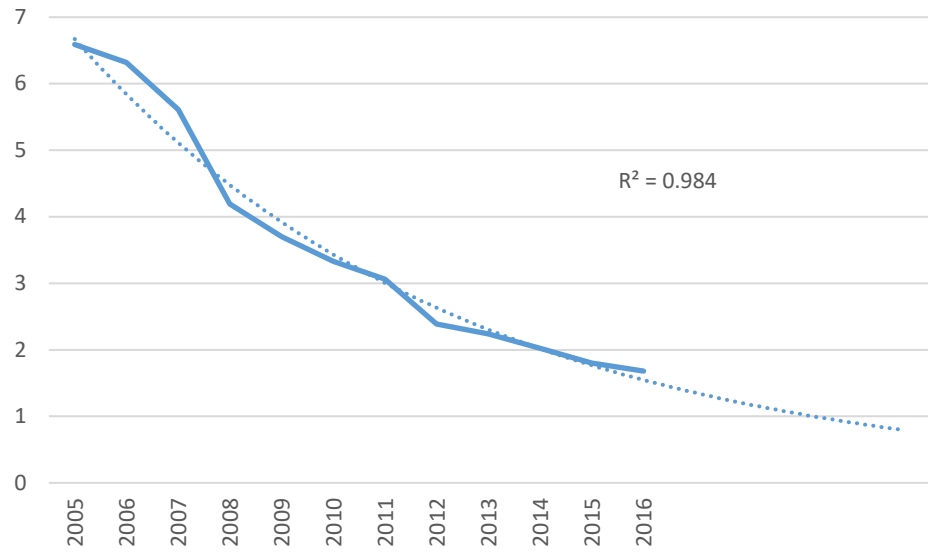
Road fatalities per 10,000 motorized vehicles

The number of fatalities per motorised vehicle has steadily declined in Vietnam from 6.6 per 10,000 vehicles in 2006 to 1.68 in 2016. Given most 95% of these vehicles are motorcycles or mopeds, helmet laws are assumed to have been the significant driver of this reduction (Table 13 and Figure 8), however, as discussed below, helmet wearing and quality appears to vary markedly across Vietnam both geographically and demographically.

Table 13: Fatalities per 10,000 motorised vehicles

Year	Road fatalities	Number of motorized vehicles	Fatalities per 10,000 vehicles
2005	11,184	16,977,748	6.59
2006	12,373	19,588,872	6.32
2007	12,800	22,827,899	5.61
2008	11,234	26,842,684	4.19
2009	11,094	29,967,066	3.70
2010	11,029	33,166,411	3.33
2011	10,950	35,808,811	3.06
2012	9,117	38,095,532	2.39
2013	9,156	40,790,841	2.24
2014	8,788	43,562,632	2.02
2015	8,442	46,792,091	1.80
2016	8,417	50,165,455	1.68

Figure 8: Fatalities per 10,000 motorised vehicles



As can be seen when comparing Figure 7 and Figure 8, they both follow a similar trajectory that may explain some of the decreases in motor vehicle fatalities. The reduction in passenger vehicle age is correlated with a reduction in crashworthiness, thus making them safer and it is expected that as the car fleet becomes more modern there will be a commensurate reduction in fatalities per number of vehicles.

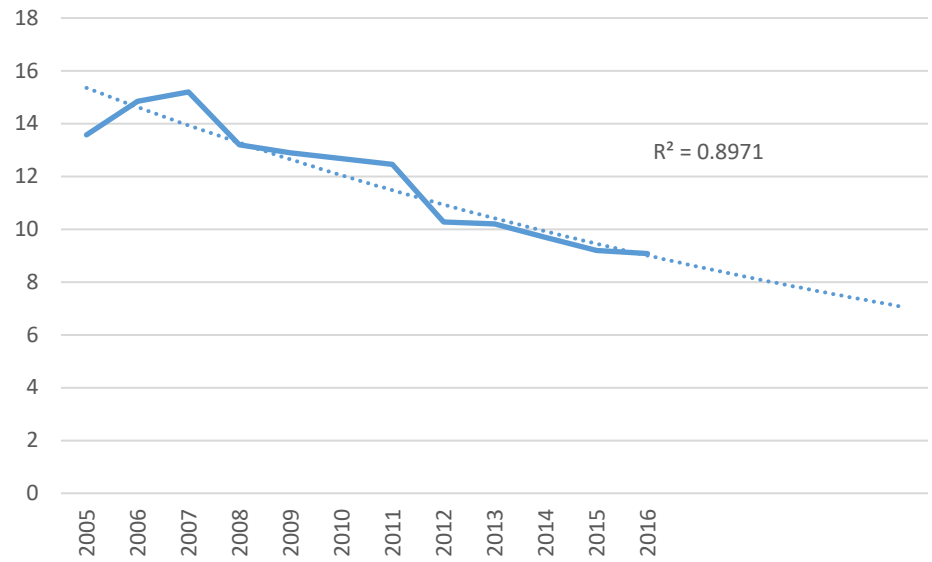
Fatalities per 100,000 population

While fatalities per 100,000 have also declined, they have not declined to the same extent as fatalities per motor vehicle. This can be explained by the dramatic rise in the number of motor cycles and mopeds that has increased at a greater rate than the population (Table 14 and Figure).

Table 14: Fatalities per 100,000 population

Year	Population (1,000 people)	Fatalities	Fatalities per 100,000 population
2005	82,392	11,184	13.57
2006	83,311	12,373	14.85
2007	84,218	12,800	15.20
2008	85,118	11,234	13.20
2009	86,025	11,094	12.90
2010	86,974	11,029	12.68
2011	87,860	10,950	12.46
2012	88,809	9,117	10.27
2013	89,759	9,156	10.20
2014	90,728	8,788	9.69
2015	91,713	8,442	9.20
2016	92,700	8,417	9.08

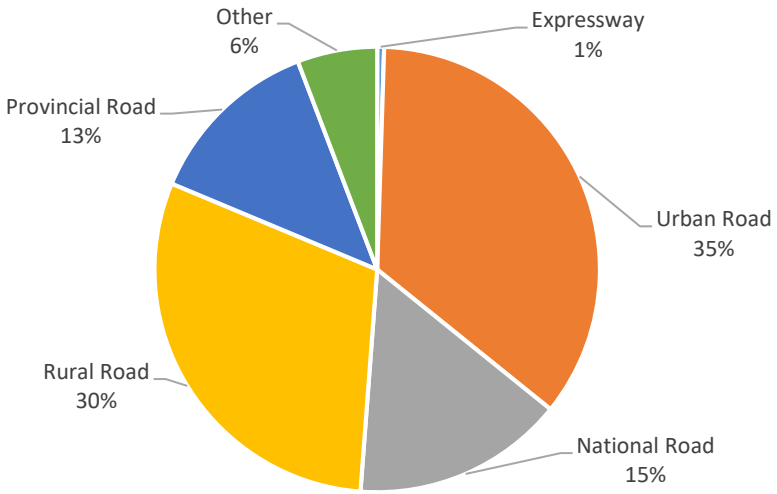
Figure 9: Fatalities per 100,000 population



Traffic accidents on different types of roads

The highest number of fatalities – 36% of total deaths – occur on national highways that represent only 15.4% of the total kilometres of road. This disproportionately high level is assumed to be due to the high speeds and high transport densities that exist along these routes. Urban roads account for 34% of fatalities, with many of these fatalities occurring where urban roads join national highways (Figure 10).

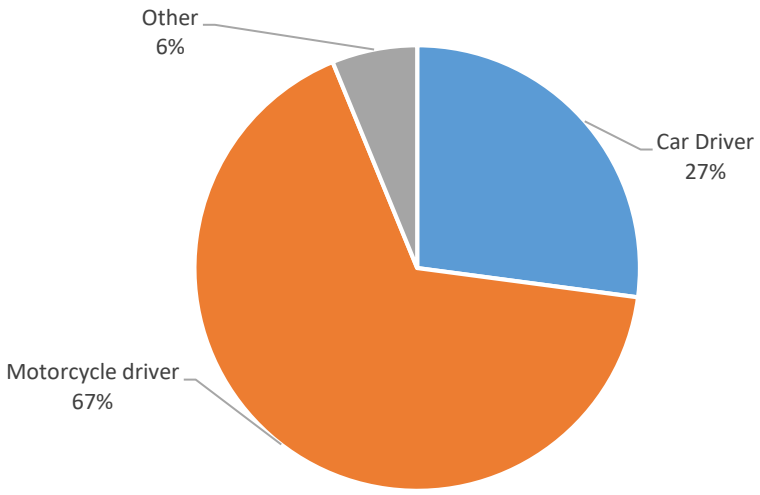
Figure 10: Accidents on road types



Road traffic accidents by type of vehicle

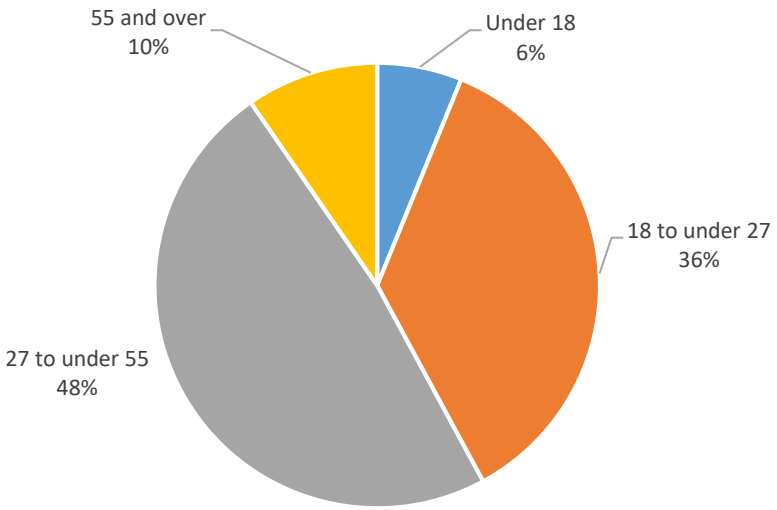
Motorbikes or mopeds account for approximately 67% of the total accidents. Given they make up 95% of all vehicles, this number is lower than expected due to their high proportion of vehicles and the vulnerable nature of riding motorcycles (Figure 11).

Figure 11: Accident by type of vehicle



The data shown suggests approximately 42% of accidents involve drivers under 27. As this data is not grouped according to 5-year cohorts, it is not possible to compare with Global Burden of Disease data (Figure 12).

Figure 12: Accident by age of driver



Cause of accidents

Analysis of the cause of road traffic accident data recorded by the police in 2016 suggests the main cause of traffic accidents was lane violation (25–30%). Speed violation was recorded as the second most common cause during that period (10–13%). Alcohol was considered to cause 4–5% of accidents. However, this figure is considered to significantly underestimate the true situation as traffic police do not have equipment to test blood alcohol levels, but rather such tests are required to take place in medical clinics. The delay in testing leads to erroneous negative results for alcohol involvement in accidents. People under the influence of alcohol also violate other traffic rules such as speeding, lanes violation, etc., leading to the cause of these traffic accidents being attributed to speeding or wrong lane violations, whereas in fact alcohol may be the prime cause.

Motorcycle helmets

In 2000, helmet wearing laws were introduced making helmet use compulsory for motorcycle riders on certain major roads and highways. In 2003, a fine of 10,000–20,000 Vietnamese Dong (approximately 1 USD) was introduced for not wearing a helmet. Hung, Stevenson et al. (2006) conducted an observational study in Hai Duong province that found 29.9% of motorcyclists wore helmets, with males and adults being more likely to wear helmets compared to females and the young (Bao, Bachani et al. 2017).

Hung, Stevenson et al. (2006) found that helmet use remained low at 23.3%, despite a high prevalence of helmet ownership. Since the beginning of widespread helmet enforcement in Vietnam in December 2007, there has been no difference in enforcement levels or initiatives among provinces. However, it was in 2010 that Ninh Binh and Ha Nam provinces were supported by the 'Road Safety in 10 Countries' initiative to strengthen police capacity in enforcement, implement social marketing campaigns (Bao, Bachani et al. 2017).

Bao, Bachani et al. (2017) found low child helmet use rates, which decreased over the study period despite increasing overall helmet use. In May 2010, the government of Vietnam passed Decree 34, which mandated that children over the age of 6 years must wear helmets while on motorcycles.

However, as of December 2014, child helmet use was 36% and 35% in Ha Nam and Ninh Binh, respectively, while correct child helmet use was only 28% and 30%.

While the implementation of mandatory helmet wearing has generally been considered successful, it has not been without issues. The following concerns have been encountered during the implementation of these helmet regulations:

- the low rate of people wearing helmets in rural and mountainous regions;
- helmets that do need meet safety standards; and
- parents do not insist their children wear helmets.

Consequently, while the reported rate for motorcycle helmet wearing is reported as over 90%, there is significant variation between different parts of the country, different age cohorts as well as driver and pillion.

Helmet quality

For those who do wear helmets, quality is still a major concern, as poor quality helmets are estimated to account for anywhere between 22% (WHO) and 80% (WHO 2012) of those being used in Vietnam (Hung, Stevenson et al. 2008, Ackaah, Afukaar et al. 2013). Substandard helmets undermining the efficacy of increased helmet use and while international or regional quality standards exist in Vietnam, seals are often fraudulent and there are low levels of understanding among the community (Li, Adetunji et al. 2020). In their study, Li, Adetunji et al. (2020) found the prevalence of substandard helmets peaked at 47% in Ha Nam and 18% in Ninh Binh over the course of their project, however, this has since declined to 11% and 5%.

Speed

As in most settings, excessive speed is a significant risk factor for road traffic accidents in Vietnam, where it is estimated 25% of all accidents are caused by excessive speed (MOTV 2018). More fatalities are attributed to excessive speed on national highways due to the inherent high speeds and the large amount of traffic on the highways. In addition, there is a significant amount of fatalities in urban setting where they join the national highways.

Seat belts

Both the road traffic laws of 2001 and 2008 state “seat belts must be worn by drivers and front seat passengers in cars”. These laws also include certain levels of punishment for failing to wear a seatbelt that are considered very minor in their severity. Consequently, due to the low level of punishment and lack of attention to this safety interventions by road safety agencies and police, seat belt wearing rates are very low in Vietnam (MOTV 2018).

Road safety capacity building

In the field of road safety, Vietnam is still considered to lack highly trained personnel such as engineers and traffic planning and management specialists, traffic enforcement specialists, traffic safety training experts, psychologists, media professionals and assessment experts. Very few universities and academies have courses that specialize in road traffic safety, although there are some schools that specialize in this subject, but do not meet actual requirements (MOTV 2018).

Some road safety agencies have a very limited number of road safety experts, however, even these staff often lack proper training. Most staff at local Traffic Safety Boards work part-time and many lack formal training in traffic safety law, law enforcement, media and traffic management. The lack

of high-quality human resources personnel in road safety is a significant long-term problem that is likely to require substantial sustained investment (MOTV 2018).

The National Road Safety Strategy by 2020 and a Vision to 2030 contains the following proposals for human resources development in traffic safety:

- to improve undergraduate and postgraduate education related to traffic safety;
- to establish a post-graduate training system that includes training at international institutions;
- human resources development through official development assistance (ODA) projects;
- human resources development through projects supported by international donors on traffic safety; and
- promotion of applied research and development in the field of traffic safety (MOTV 2018 p37).

Vehicle safety

As of 2015, there were 132 testing centres and motor vehicle registry branches in Vietnam, with 261 local centres in 63 provinces and municipalities. Over 2.5 million vehicles are inspected every year (approximately 5% of all motorised vehicles). With respect to crashworthiness, this data is not currently collected in Vietnam.

Life of vehicles

The legal life of motor vehicles is specified in the Traffic Road Law 2008 with the life being calculated from the date of manufacture. The life of different vehicle types is as follows:

- not to exceed 25 years, for cargo automobiles;
- not to exceed 20 years, for passenger automobiles; and
- not to exceed 17 years, for passenger automobiles transformed from other vehicles before 1 January 2002.

This has implications for the safety of the motor vehicle fleet due to the evolution of crashworthiness of motor vehicles through time (see Figure 7).

Publicity and education on road safety

According to the Road Safety Performance Review (MOTV 2018 p61), traffic regulation awareness is still low, and is considered the leading cause of traffic accidents where mistakes made by road users account for more than 80% of total traffic accidents. The MOTV (2018) states that the Vietnamese Government considers the best solution to this are public education campaigns.

Publicity, education at schools

The NTSC coordinates with the Ministry of Education and Training (MOET) in order to include traffic safety education in the school curriculum. A policy of implementing traffic safety education in schools was initiated in the early 1990s.

Education and dissemination of traffic safety law in society

The Vietnamese Government considers public information campaigns to be the most effective intervention for reducing the number of traffic accidents in the long term. These activities occur regularly on a widespread and continuous basis and in different media. However, the general

efficacy of such measures is not considered to be high (UNESCAP 2018). Enforcement of traffic laws are also not effectively combined, and this is compounded by a limited budget for the dissemination of information.

Driver training, driver licensing

There are numerous categories of driving licenses in Vietnam:

- Category A1–3: motorcycle licences of various engine capacity;
- Category A4: small tractors;
- Category B1: non-professional drivers of cars and small trucks;
- Category B2: professional drivers of cars and small trucks;
- Category C: large trucks;
- Category D: medium buses;
- Category E: large buses; and
- Category F: large buses and trucks with trailers.

The training requirements for the various licenses are shown in Table 15 and Table 16.

Table 15: License A1–4 training requirements

Criteria for calculation of subjects	Unit	License type		
		A1	A2	A3, A4
Road Traffic Law	Hour	8	16	28
Common structures and repairs	Hour	–	–	4
Transport profession	Hour	–	–	4
Driving techniques	Hour	2	4	4
Driving practice	Hour	2	12	40
Number of hours for driving practice/learner	Hour	2	12	8
Number of kilometres of driving practice/learner	Km	–	–	60
Number of learners/car	Learner	–	–	5
Number of hours/ learner/training course	Hour	12	32	48
Total number of hours/training course	Hour	12	32	80

Table 16: License B1, B2, C training requirements

Criteria for calculation of subjects	Unit	B1		B2	C
		Automatic	Manual		
Road Traffic Law	Hour	90	90	90	90
Common structures and repairs	Hour	8	8	18	18
Transport profession	Hour	–	–	16	16
Driving ethics and traffic etiquette	Hour	14	14	20	20
Driving techniques	Hour	24	24	24	24
Total number of hours of driving practice/car	Hour	340	420	420	752
Number of hours for driving practice/learner	Hour	68	84	84	94
Number of kilometres of driving practice/learner	Km	1,000	1,100	1,100	1,100
Average number of learners/car	Learner	5	5	5	8
Number of hours/learner/training course	Hour	204	220	252	262
Total number of hours/training course	Hour	476	556	588	920

Methods of training

The method of training for driving licenses A1, A2, A3, A4 and B1 is self-taught in theoretical subjects; however, applicants must register at training institutions for training and examination for

practical elements of the training requirements. For A4 and B1 applicants, they are assessed and given their license on successful completion of their test, whereas, applicants for B2, C, D, E and F-type driving licenses must be trained centrally at the authorized centre and must be certified for primary training certification. There is no Graduated Licensing Scheme program in Vietnam.

Vulnerable road users

Vulnerable road users are highly susceptible to injuries and fatal injuries as is acknowledged by the NTSC. According to population data for Vietnam (2014), the number of people considered to be vulnerable traffic participants is high:

- under 15 years of age – 23.5%;
- over 65 years of age – 7.1%; and
- 6.7 million people in Vietnam have disabilities, 7.8% of the population.

However, vulnerable road users are generally considered to include pedestrians, cyclists and motor cyclists (AGORS 2020). If this definition were used in Vietnam, vulnerable road users would include more than 90% of road users. The Vietnamese Government appear to only include pedestrians in this category and the Road Safety Performance Review Vietnam (RSPR) suggests vulnerable road users (pedestrians) are not a safety focus in Vietnam. Despite this, according to research quoted in the RSPR (MOTV 2018), fatalities amongst pedestrians accounted for 14% of all casualties from traffic accidents and iRAP analysis suggests more than 70% of pedestrian travel is on 1-star infrastructure. This compares with the Ngo, Rao et al. (2012) study who found 11% of all fatalities were pedestrians. The GBD data for 2019 found 24.5% of 10–14 year old fatalities were pedestrians, 8.9% for 15 to 19 year olds and 8.8% for 20 to 24 year olds. Clearly, 10 to 14 year olds have limited options in terms of transport and are more heavily reliant on walking as a mode of transport than other age cohorts.

The RSPR suggests the cause of vulnerable road user fatalities are the vulnerable road users themselves. Vulnerable road users are deemed to lack awareness of traffic laws or do not observe the laws properly leading to careless crossing of roads; not using pedestrian overpasses; cycling after drinking alcohol; and carelessly turning their vehicles or changing direction, entering the blind spots of cars, etc.

The AIP Foundation has also reported many children walk to school in an unsafe manner which results in a significant number being involved in crashes (Brondom and Florian 2012). A case study on pedestrian safety in Dong Nai Province found:

- all pedestrian road crash injury cases occurred among children ages 16 years and younger at the provincial general hospital;
- at the local paediatric hospital, a quarter of road crash injuries were pedestrians; and
- an estimated 5,900 to 7,800 primary students walking to and from school in the province were injured by a vehicle in 2011. (Brondom and Florian 2012)

These results are consistent with the recommendations in the RSPR report that includes the following measures:

- campaigns and education on traffic safety: these campaigns and education programmes need to be implemented for both vulnerable traffic participants and other road users, with a particular emphasis on humanity, understanding, and helping to support the disadvantaged in society; and

- improving road infrastructure, prioritizing traffic organization and helping and protecting vulnerable road users where possible with a focus on the use of advanced technologies in this area.

Enforcement

Traffic violations in Vietnam are considered to be high with a requirement for law enforcement to reduce these violations (MOTV 2018). There are numerous government authorities that enforce traffic laws that include the following:

- traffic police;
- Public Order Police, Rapid Reaction Police, Mobile Police, Police Guard, Police Administrative Management of Social Order and Safety, Commune Police, and Ward Police;
- Commune Police and Town Police, where there is no regular police unit, are mobilized as required; and
- transport inspectors.

Drinking alcohol and driving

According to La, Van Duong et al. (2017) drinking alcohol is a deeply engrained cultural habit in Vietnam with many survey respondents believing a moderate amount of alcohol helps improve metabolism, which is good for their health. Beer is considered a de facto non-alcoholic drink as it has a relatively low alcohol concentration. Alcohol and beer were often observed being served with meals at breakfast, lunch and dinner during their survey. Men were often seen drinking beer before returning to work or home. La, Van Duong et al. (2017) found that while some people viewed drinking was not acceptable while driving a car, it was acceptable when driving a motorcycle (La, Van Duong et al. 2017).

Despite this, a report by the International Alliance for Responsible Drinking indicates Vietnamese people have started to consider responsible drinking (MOTV 2018). However, such behavioural and cultural changes are likely to take decades. As stated previously, drinking alcohol is part of the culture in Vietnam; the Vietnamese drink at important events and holidays, as well as for business-related events. Refusing an offered drink is considered unfriendly and socially inappropriate leading to difficulties in reducing alcohol consumption before driving a motor vehicle or motor cycle.

Excess alcohol

The use of alcohol over certain limits while driving was banned in 2001 (BAC limit 0.05). Despite this, practical difficulties in enforcing this law such as providing the relevant authorities with sufficient alcohol breath analysers – have led to this law being widely flouted. Estimates are that excess alcohol consumption is responsible for nearly 4000 fatalities per year (MOTV 2018).

In 2011, another resolution to strengthen alcohol enforcement was issued; however, this has also been ineffective. Despite district level traffic police forces increasingly being equipped with alcohol breath analysers it is still inadequate for effective enforcement. As of 2015, 48 out of 63 traffic police forces in the provinces and municipalities of Vietnam had been trained to test for alcohol concentrations that has led to a significant decrease in the number of car drivers – in particular commercial car drivers – violating alcohol regulations. However, this is not the case for

motorcyclists, and as motor cycles make up 95% of all motor vehicles in Vietnam, this means overall there has been little effect on alcohol levels for the majority of motor vehicles users (MOTV 2018).

Mobile phone distraction

While mobile phone use while driving a car has been a subject of much research (Ismeik, Al-Kaisy et al. 2015, Beck and Watters 2016), mobile phone use while riding a motorcycle has only been investigated in recent research. It was observed that the prevalence of mobile phone use while riding in three Mexican cities was 0.64% (Pérez-Núñez, Hidalgo-Solórzano et al. 2013), which highlights the high level in Vietnam when compared to 8.66% in Hanoi, Vietnam (Truong, Nguyen et al. 2016). About 40% of high school students in Vientiane, Laos (Phommachanh, Ichikawa et al. 2016) and nearly 81% of university students in Hanoi and Ho Chi Minh City reported using a mobile phone while riding a motorcycle (Truong, De Gruyter et al. 2017). Effects of gender, risk perceptions, and social networks on mobile phone use while riding have also been highlighted (De Gruyter, Truong et al. 2017). Mobile phone use while riding can also be affected by situational factors. For example, motorcycle riders would be more likely to use a mobile phone while stopping at an intersection compared to while moving through the intersection (Truong, Nguyen et al. 2016, Truong, Nguyen et al. 2019). Results showed that around 5% of motorcycle riders reported having experienced a crash/fall when they were using a mobile phone for calling, with 3.8% of riders indicating that they were injured while doing so (Truong, Nguyen et al. 2019).

Government of Vietnam Goals and Plans 2020

The Government of Vietnam has recently recommitted to various road safety goals by 2030. These mainly concern helmet wearing rates for children, especially in some provinces with a low rate. The goal is to increase helmet wearing rates among children in Vietnam to over 80% by 2030, as well as enforcing helmet quality (RTWRT 2019).

The main challenges for this is the low rate of helmet wearing in some provinces: 20 provinces out of total 63 in Vietnam had the children helmet wearing rate below 66% with three provinces with a rate of helmet wearing below 50% in three provinces (RTWRT 2019).

AIP Pilot: Slow Zones Safe Zones

The AIP Foundation implemented a two-year S*low Zones, Safe Zones* speed reduction program in Gia Lai Province, Vietnam, with the support of Fondation Botnar, the Global Road Safety Partnership (GRSP), Nissan Motor Corporation, Federation Internationale de l'Automobile (FIA) and Kova Paint Company (AIP Foundation 2020). In 2020, Phase One of the program was completed. Phase One included the following interventions: comprehensive school zone safety modifications including speed bumps, road markings, speed reduction signs, and footpaths.

Before the intervention, some vehicles were driving as fast as 70–80 km/h, much higher than the international recommended speed for school zones, 30 km/h. The safety modifications were validated by assessments like the Star Rating for Schools (SR4S), which determined that both pilot schools successfully increased their safety rating to 5 stars. Speed reduction results were comparably significant, with maximum speed at both target schools reduced by as much as 18–21 km/h. Surveys were undertaken regarding attitudes to speed reduction regulations, driver behaviour around schools, as well as the effectiveness of the public awareness campaign which statistically significant

results. The combination of public awareness campaigns and physical infrastructure interventions saw the greatest reduction in speeds and student self-reported road accidents.

RSPR proposed solutions and conclusions

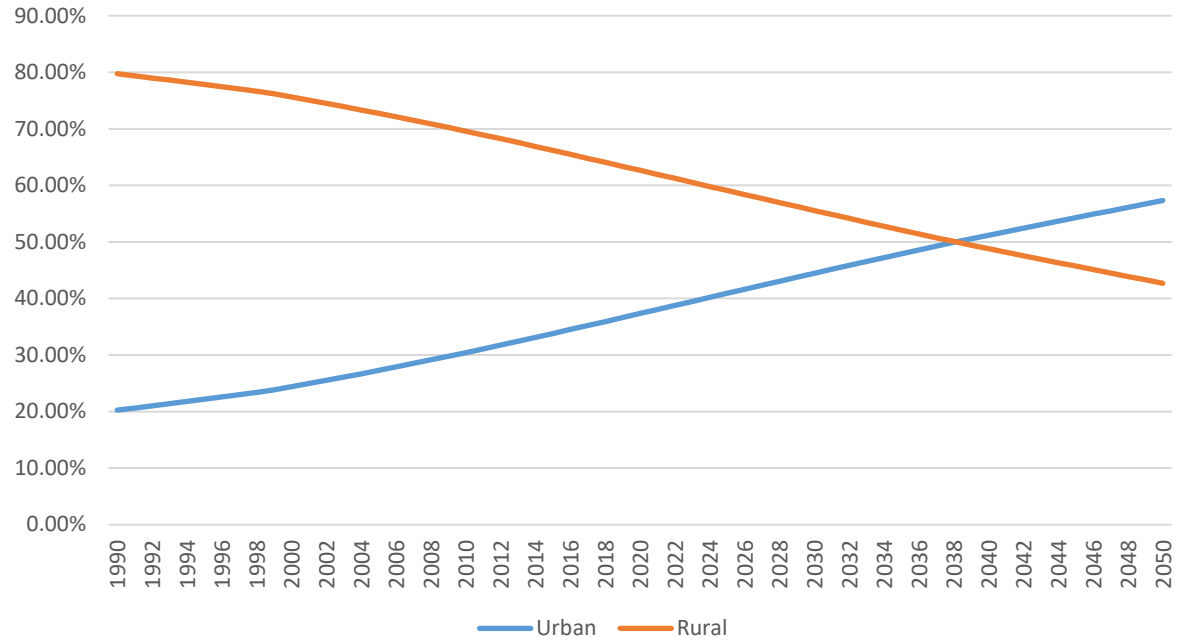
In recent decades, the Vietnam road system has developed rapidly with a gradual improvement in quality, especially on the expressway system. However, the road system is still considered to be inadequate with respect to improved road safety. The proposed solutions for road safety include the following:

- Transport infrastructure for motor vehicles and motorbikes:
    - to limit traffic accidents related to motor vehicles and motorbikes, separation of lanes reserved for such vehicles on national highways and urban roads, and to implement them for motor vehicles and motorbike passing through highways and intersections such as overpasses.
- Traffic safety on expressways:
    - address issues concerning splitting, merging and passing between lanes. Traffic accidents involving these manoeuvres on expressways are often very fatal.
- Traffic safety assessment, black spot improvement and road maintenance and management to improve accident prevention. (MOTV 2018)

Urbanisation

Since economic reforms were introduced in 1986, Vietnam has transformed its economy leading to significant per capita growth. The decades of rapid economic growth in Vietnam have been accompanied by urbanization. In 1986 fewer than 13 million residents, or 20% of Vietnam's population lived in urban areas, however, by 2017 this had increased to 30 million (35% of the population). The urbanization process has been associated with population growth in urban areas (World Bank 2020). The rapid urbanisation process is expected to continue according to the UN World Urbanization Prospects (UNDESA 2018), with the majority of the population living in urban areas by the late 2030s (Figure 13). The increased rates of urbanisation in Vietnam have implications for road traffic accidents due to the differing rates of fatalities and serious injuries in urban and rural areas, which has implications for where and what interventions should be considered.

Figure *13: Vietnam urbanisation projection*

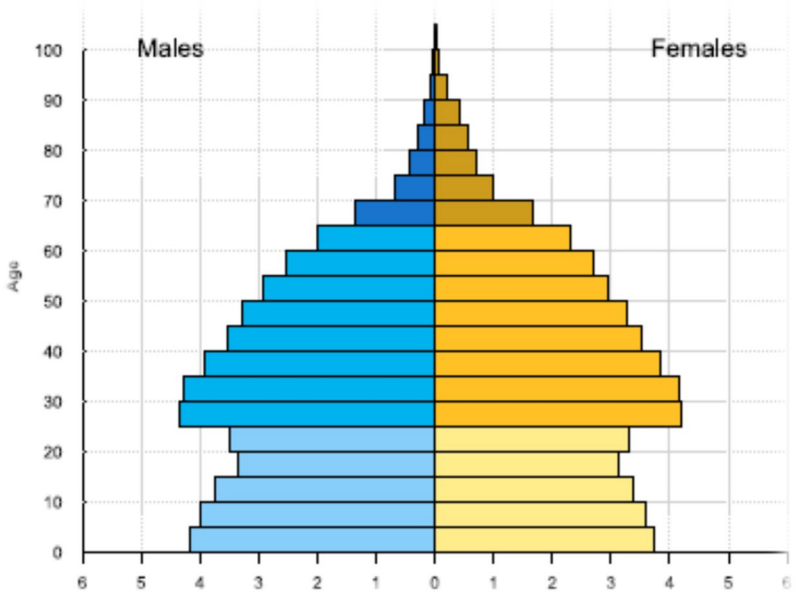


Population

Unlike an idealised population pyramid with triangle form and wide base, the shape of Vietnam's population pyramid in recent years has transformed to have narrower base and expanded centre that is indicative of the size of the labour force in Vietnam. Statistics from Vietnam's General Statistic Office reveal that proportion of people between 15–64 years old and over-65 years old in Vietnam's total population has rapidly increased by 12.4 (56.1% to 68.5%) and 2.1 (4.7% to 6.8%), respectively, for 20 years from 1989 to 2010. This is due to significant deceleration in birth rate in recent years, as well as higher life expectancy.

Vietnam possesses a slightly uneven gender balance with the ratio between female and male being approximately 97.7 %. Difference in gender is more apparent up to the age of 15, with more male children than female children, while in the over-65s, the reverse occurs with more females than males (UNDESA 2018, Gov of Vietnam 2021) (Figure 14).

Figure *14: Vietnam demographics, population in 2020 (UNDESA 2019 p2)*



As of 2019, the total population of Vietnam is approximately 96.2 million people, with the 10–24 age cohort circa 20.6 million (21.4%). The population had grown significantly since 1979 when the population was 52.7 million (Figure 15 and Figure 16).

Figure 15: Vietnam female population 10 to 24 years old

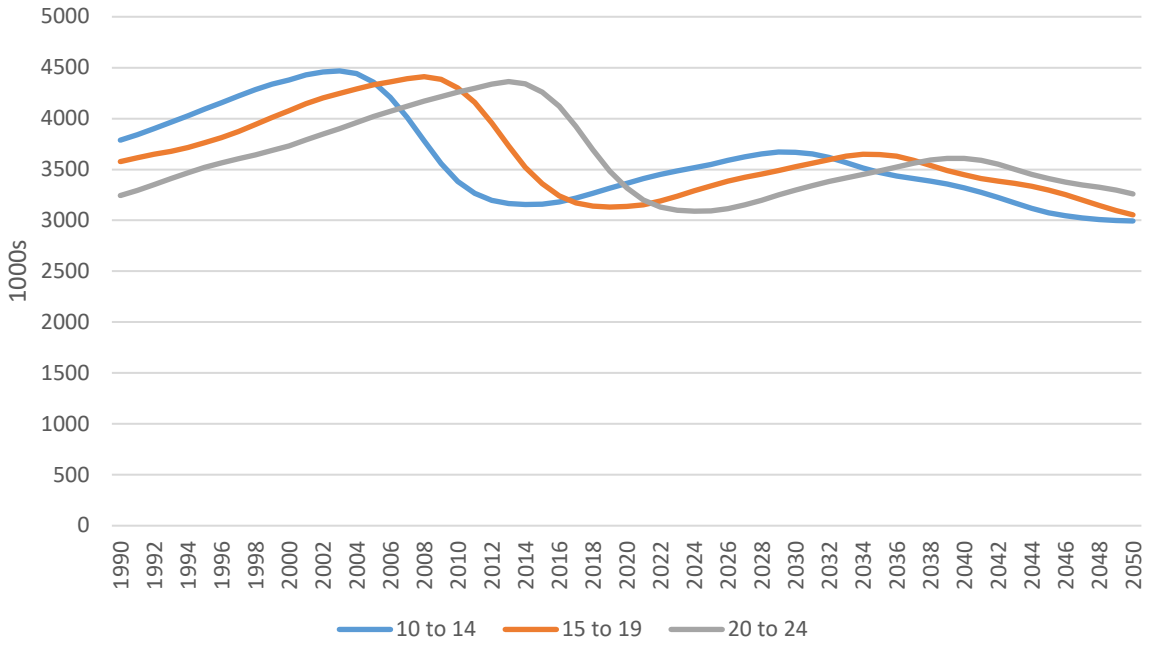
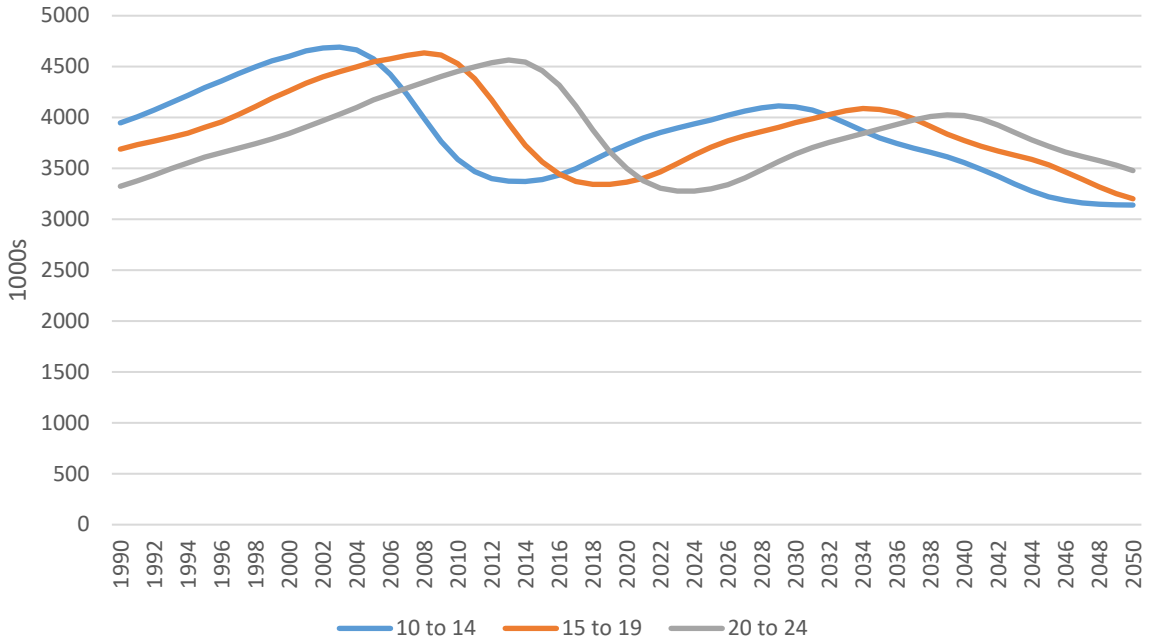


Figure *16: Vietnam male population 10 to 24 years old*



Modelling Interventions Using the Road Safety Intervention Model

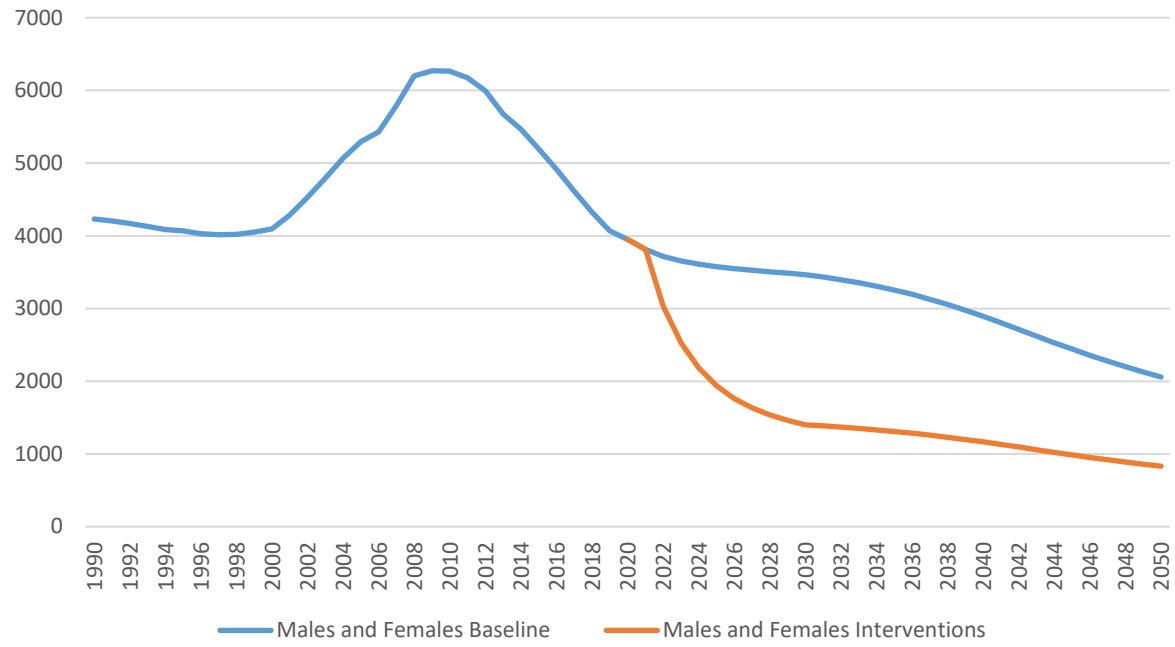
We used the Road Safety Intervention Model (RSIM) to estimate the impact of a range of interventions on road traffic fatalities and injuries in Vietnam. We assume that interventions are introduced in 2022 and increase over time reaching a maximum in 2030 where they maintain that effect until 2050.

The interventions and the way they are incorporated into the model are described in the main Report. While no new interventions specific to Vietnam have been introduced, changes have been made to the effectiveness of different interventions, as well as baselines. Specific changes are shown with the specific effectiveness for Vietnam for each intervention shown in Table 1.

Fatalities

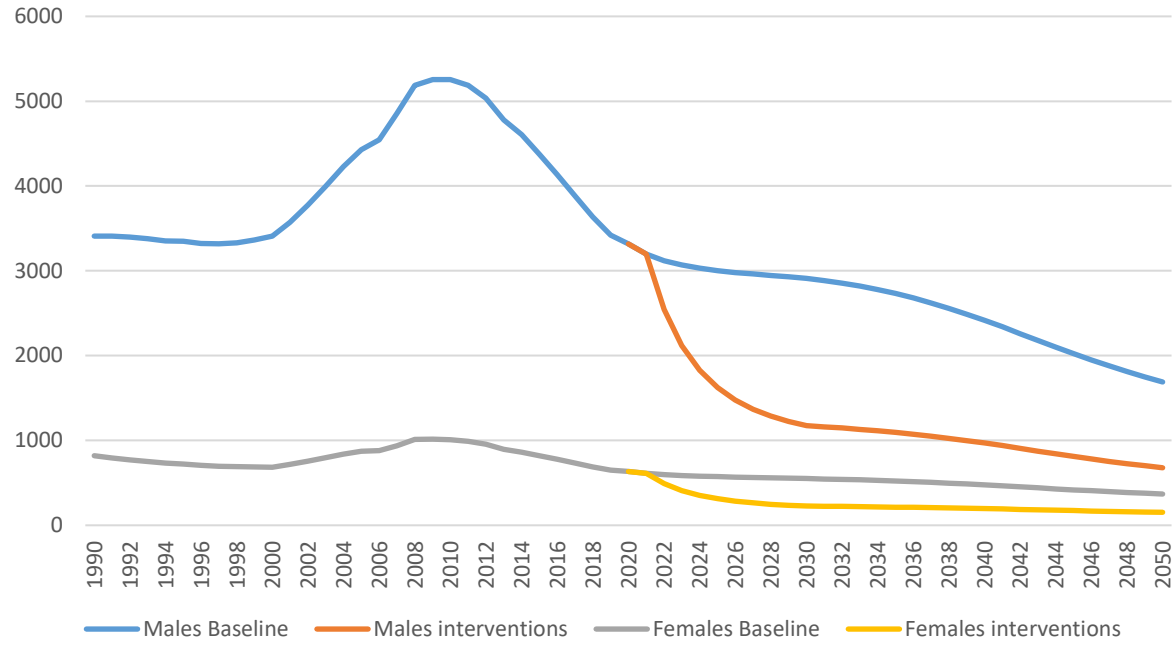
Fatalities due to road traffic accidents have reduced substantially since 2010 and are forecast to continue to decline. Implementation of all the interventions leads to a 61.0% reduction in the annual figure for fatalities from a projected baseline in 2030 of 3464 to 1351. Total baseline projections and all intervention projections are shown in Figure 17. While the baseline projections are expected to fall, the interventions illustrate the substantial number of lives saved each year.

Figure *17: Total baseline and intervention fatalities for 10–24 cohort*



The projected baseline and intervention number of male and female road traffic fatalities in Vietnam is shown in Figure 18, illustrating the disparity between male and female fatalities in the 10 to 24 age cohort. The difference between males and females was more than a factor of four in 1990, this increased to a factor of five by 2019 and baseline projections suggest a factor of four and a half by 2050.

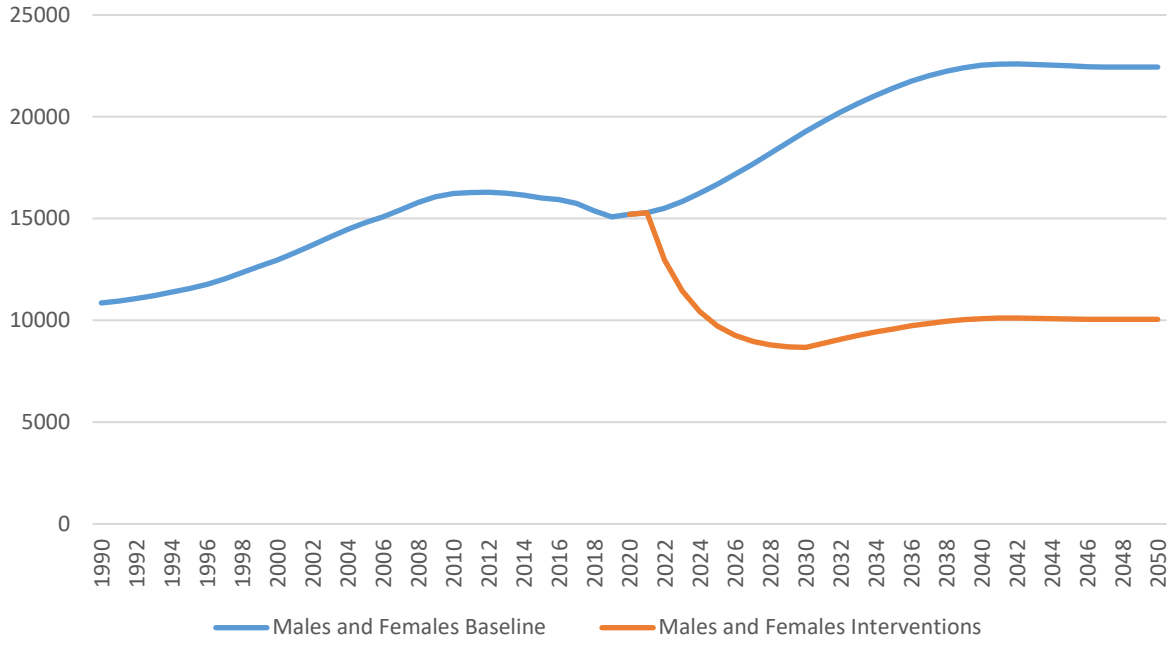
Figure *18: Male and female baseline and intervention fatalities*



Serious injuries

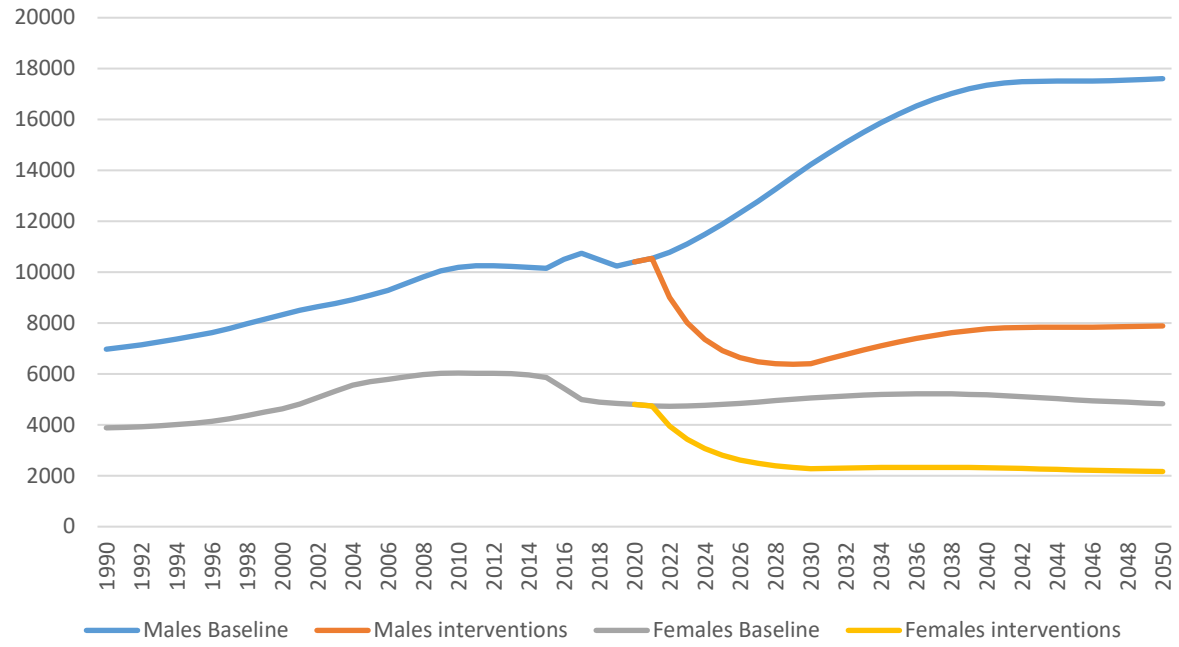
Serious injuries increased from 1990 to approximately 2010 where they levelled off. However, the projected baseline number of serious injuries is expected to increase to 2040 where it will again plateau. Serious injuries for 10 to 24 year olds rise from approximately two and half times that of fatalities from 1990 to 2020 to nearly a factor of four by 2019, five and a half by 2030 and nearly eleven by 2050 (Figure 19).

Figure *19: Total baseline and intervention serious injuries*



The incidence of male and female serious injuries for the 10 to 24 age cohort is shown in Figure 20 and clearly shows the forecast increase in serious injuries is a male phenomenon. Male serious injuries are forecast to increase significantly from 2020 to 2040, while female serious injuries are expected to remain stable. The interventions have a substantially larger effect on male serious injuries compared to female serious injuries.

Figure *20: Male and female baseline and intervention serious injuries*



10 to 14 Cohort

Fatalities

The baseline total male fatalities for this age cohort shows a steep decline in the number of fatalities since 2005 for both males (360 in 2019 to 67 in 2050) and females (114 in 2005 to 40 in 2050) (Figure 21 and Figure 22). The total number of female fatalities is consistently lower for females than males across all age groups, however, the 10 to 14 cohort have the closest values both as a ratio and in absolute terms.

As expected in Vietnam, the 10 to 14 year old age cohort, where the main form of transport is walking as well as being pillions on motor cycles, fatalities in these modes make up a considerable portion of the total fatalities. In 2019, motor cyclists made up approximately 25% for both males and females, with pedestrians approximately 20% for males and slightly less for females. Given the relatively low numbers of motor vehicles as a mode in Vietnam, motor vehicle occupant fatalities make up larger than expected amount for males (25%), but even more for females (~30%) with very similar figures for the other modes (cyclist and motor cyclist). Due to motor cyclists, motor vehicle occupants and pedestrians making up the vast majority of fatalities, interventions aimed at these modes will have the greatest effect, e.g., improved infrastructure, seat belt wearing and speed compliance.

Figure *21: Total male fatalities 10–14 years old*

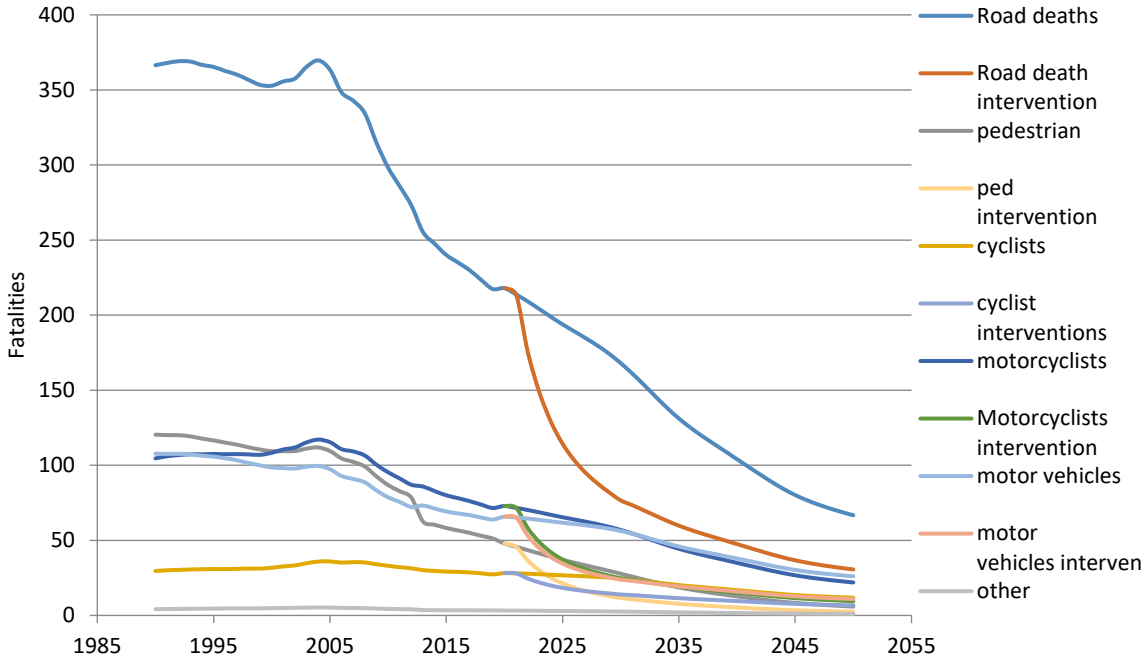
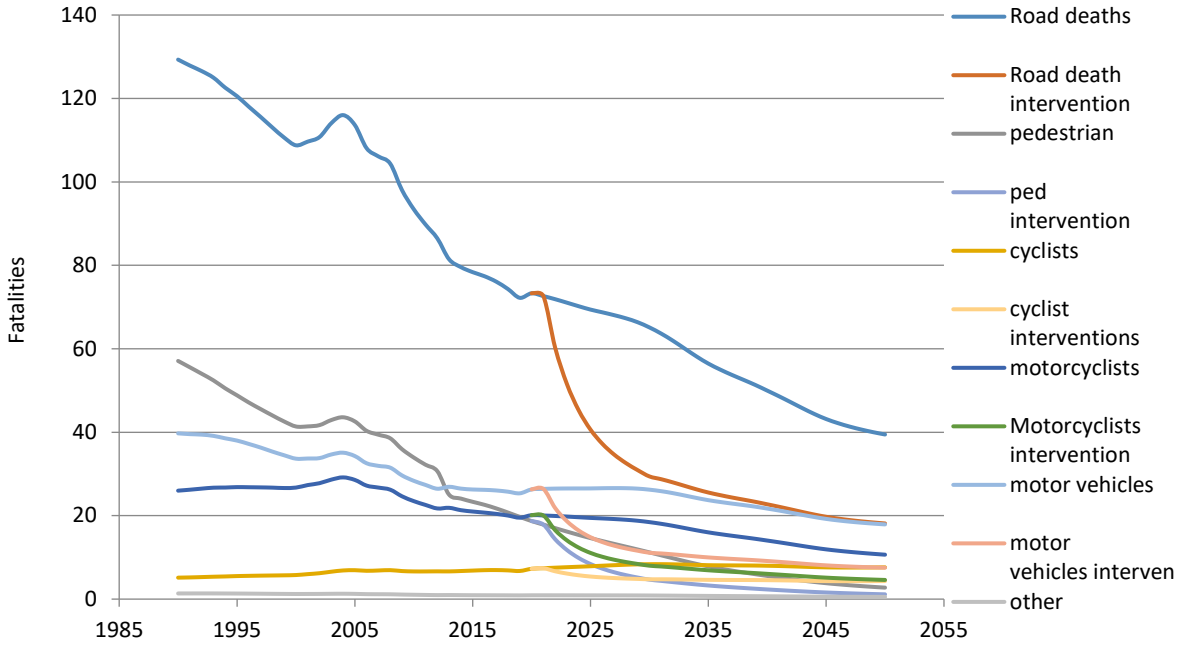


Figure 22: Total female fatalities 10–14 years old



Urban and rural

The fatalities for 10 to 14 males are expected to decline (Figure 23), while females are expected to slightly rise till 2030 and then decline (Figure 24); and currently urban areas make up a minority of 10 to 14 fatalities despite the increasing urbanisation. Rural fatalities are expected to rapidly decline

in the coming decades for both males and females, even without additional interventions (Figure 25 and Figure 26).

Figure 23: Urban male fatalities 10–14 years old

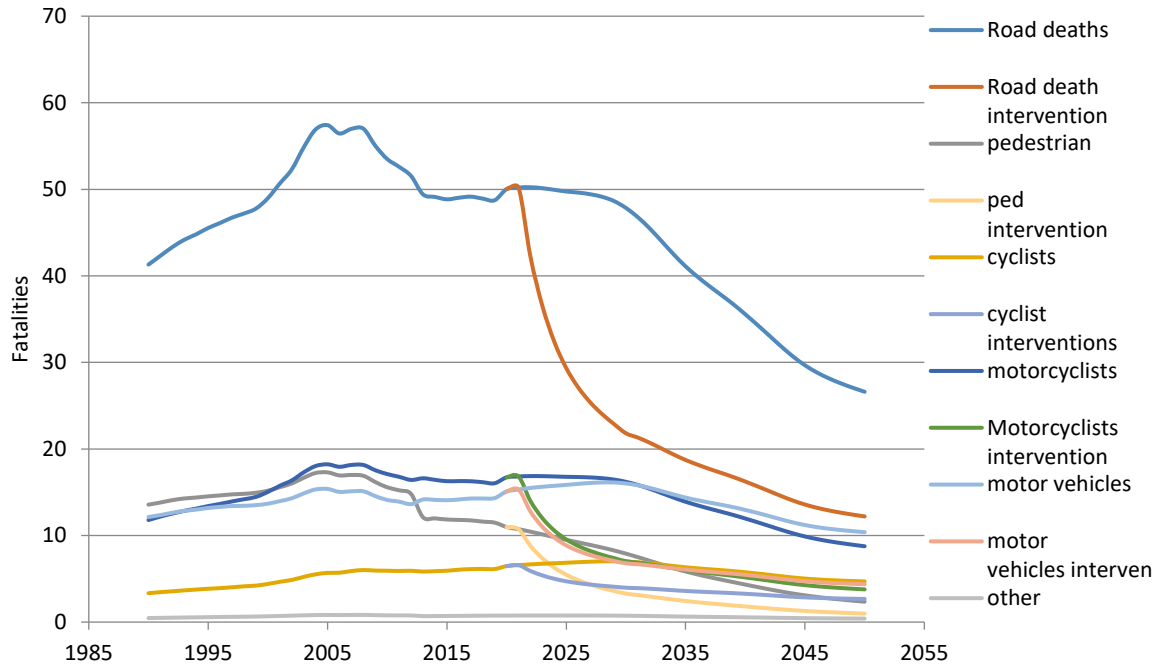


Figure 24: Urban female fatalities 10–14 years old

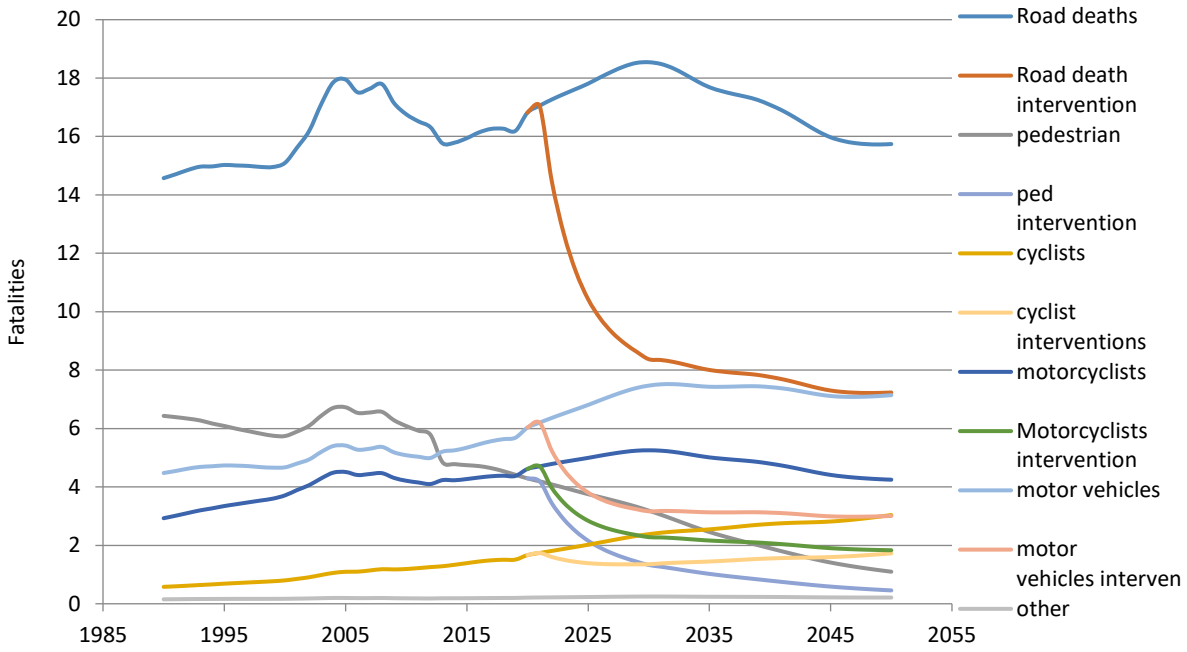


Figure 25: Rural male fatalities 10–14 years old

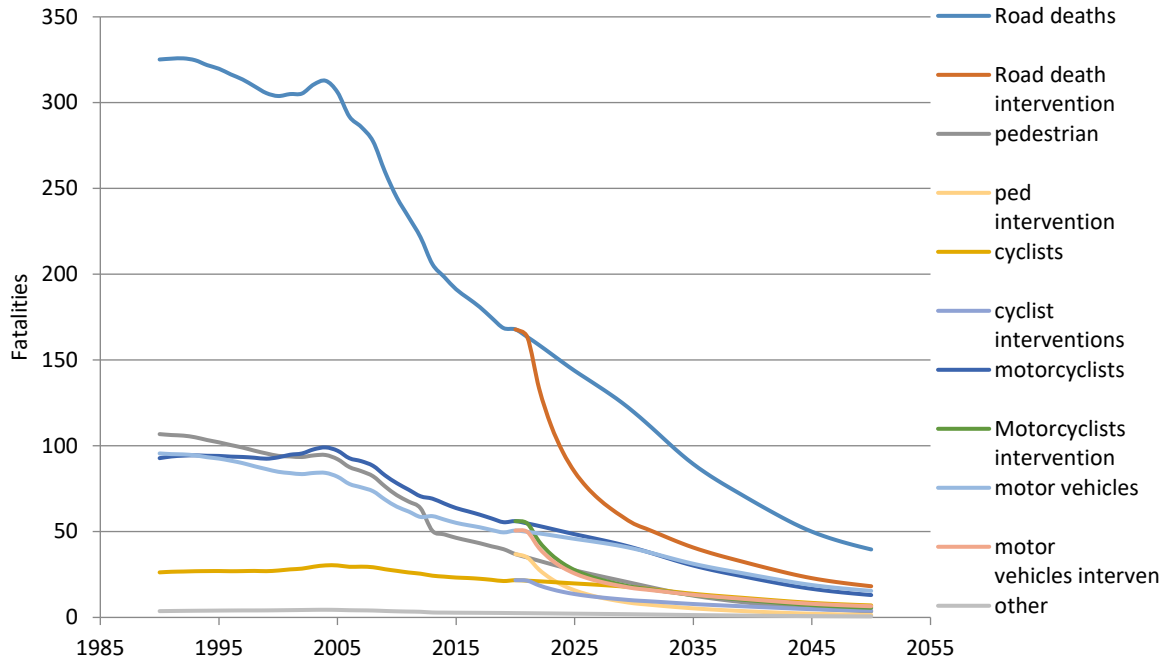
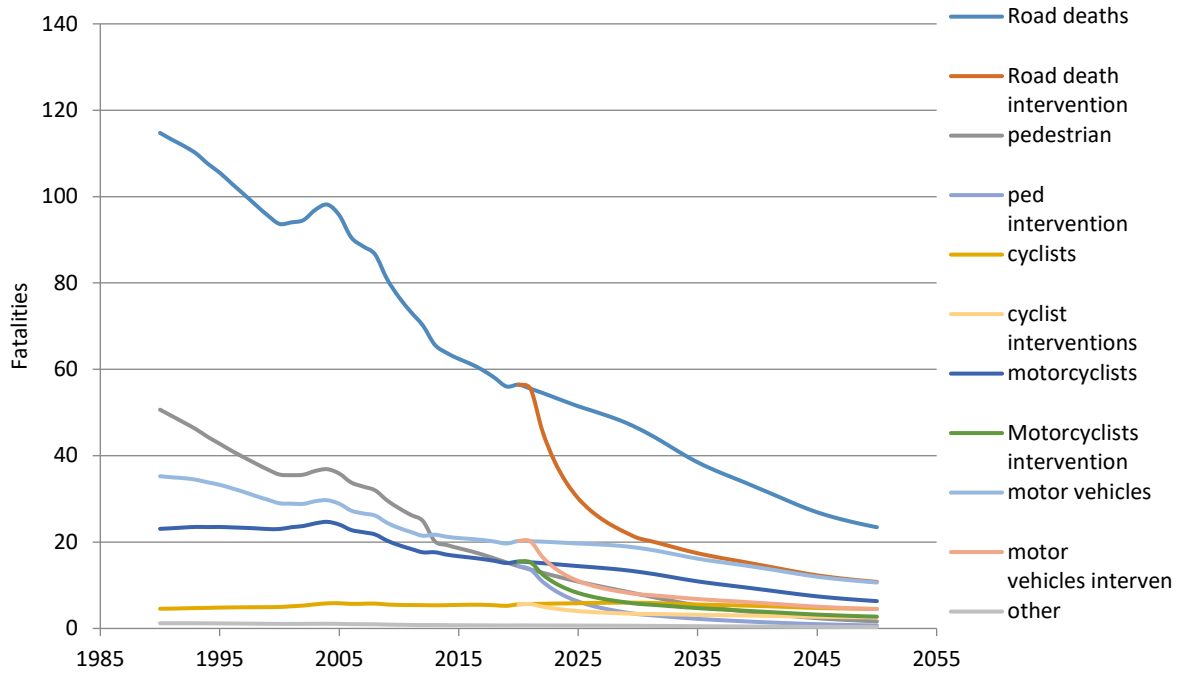


Figure 26: Rural female fatalities 10–14 years old



Serious injuries

The pattern and composition of serious injuries is substantially different to fatalities in Vietnam. Serious injuries are expected to rapidly increase for 10 to 14 year old males from 1530 in 2019, to 1900 in 2030 when they are expected to level off. For females, serious injuries are expected to remain relatively constant between 1000 and 1100 (Figure 27 and Figure 28).

As the population of 10 to 14 year olds is forecast to remain relatively stable, the increase in serious injuries is due to an increasing rate per 100,000. For both males and females, the rate and hence number of serious injuries for motor cycle riders is expected to increase. The same is true for male motor vehicle occupants though to a lesser extent, however, this is not the case for females. Conversely, cyclist serious injuries are forecast to show a slight decline for males and a steeper decline for females.

Figure 27: Serious and permanent injury total males 10 to 14 years old

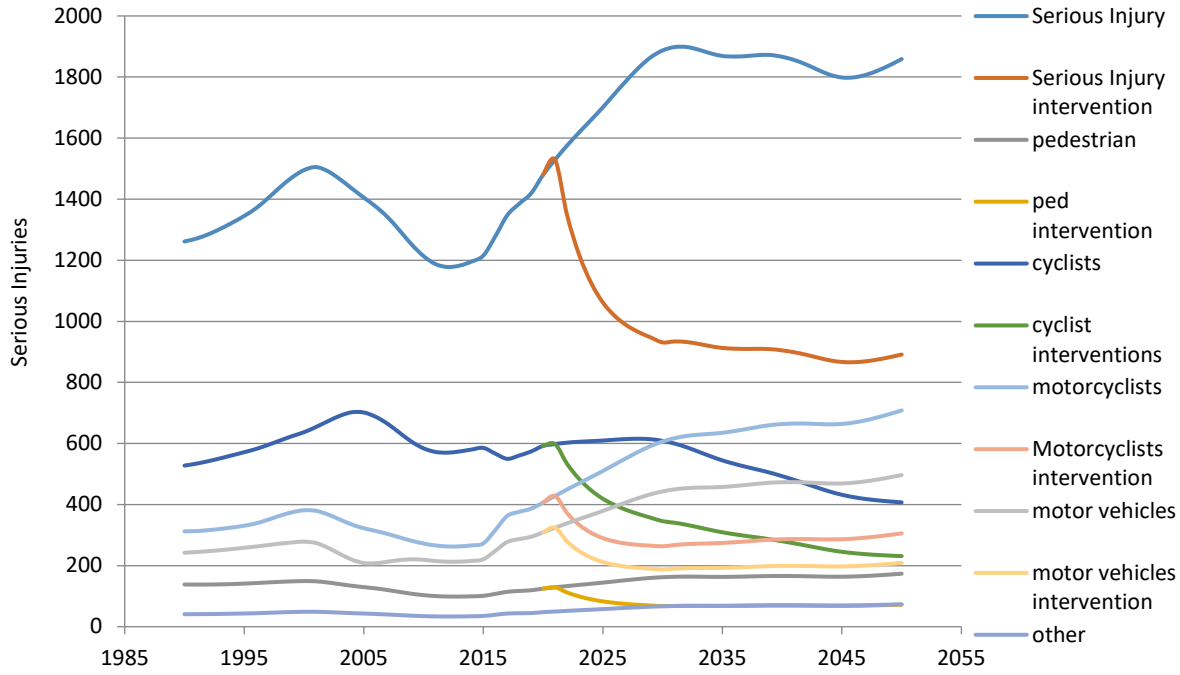
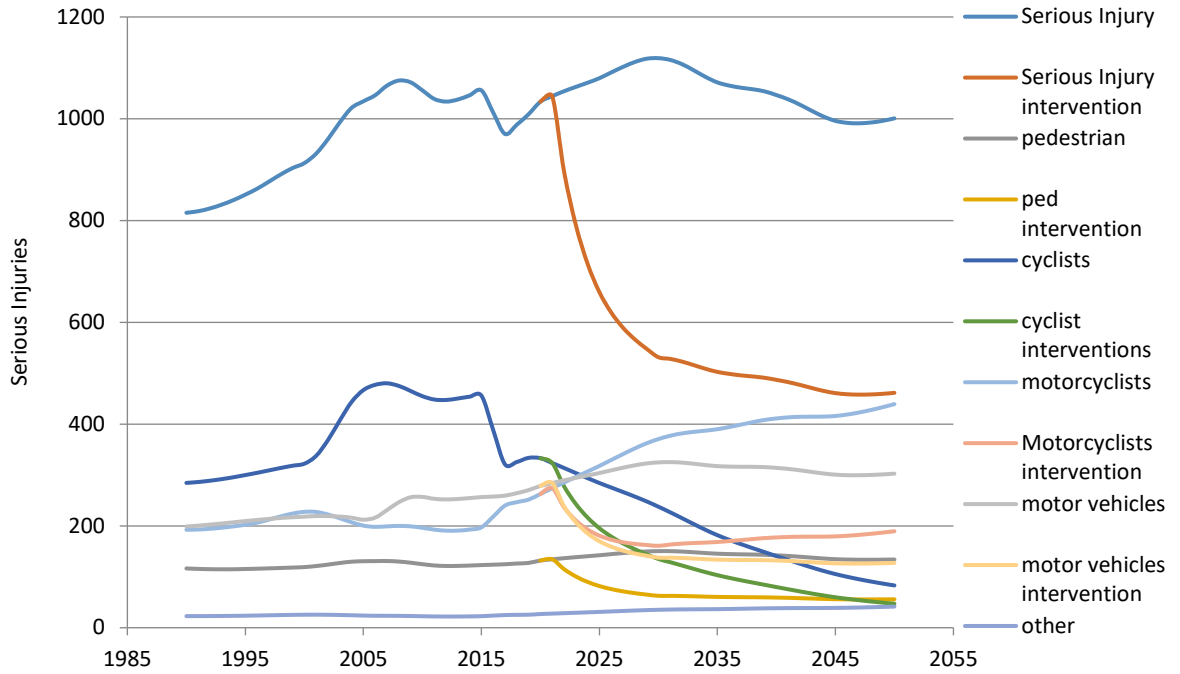


Figure 28: Serious and permanent injury total females 10 to 14 years old



Urban and Rural

Serious injuries are expected to increase in urban settings for both males and females, with the increase expected to come from motor cycle riders as well as motor vehicles occupants. This is partially compensated for by declining serious injuries among cyclists for females (Figure 29 and Figure 30). In rural settings, serious injuries are expected to peak for males by 2030, however, for females these are expected to continue to decline, a trend that has continued since 2008 (Figure 31 and Figure 32).

Figure 29: Serious and permanent injury urban males 10 to 14 years old

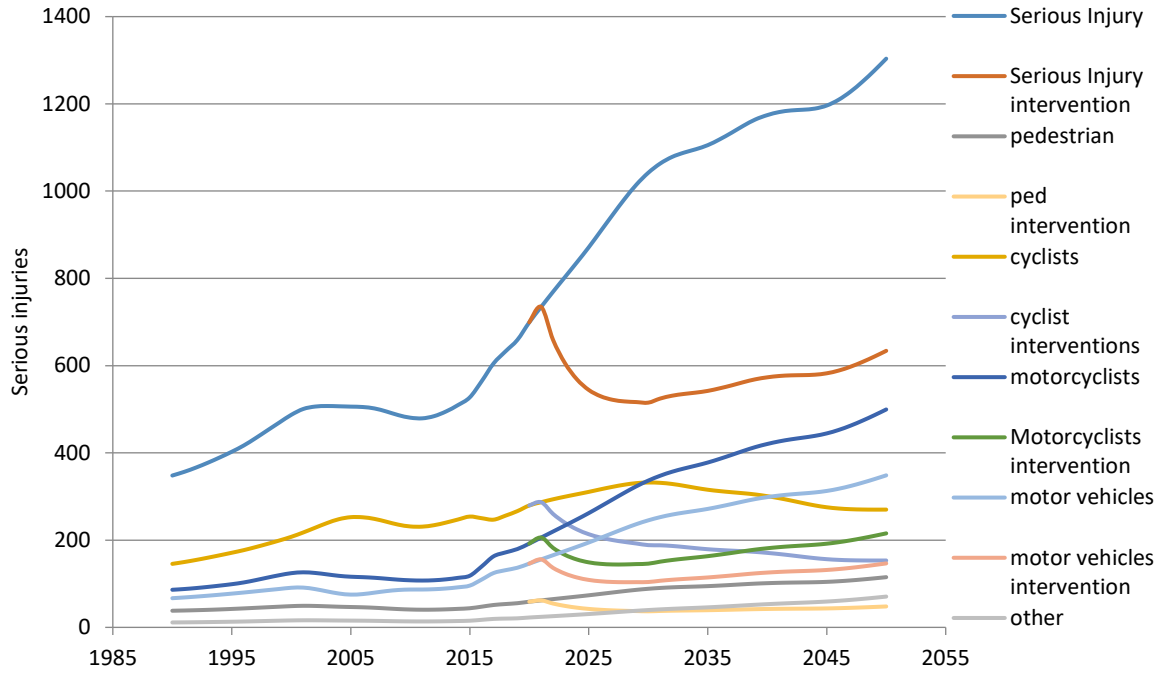


Figure 30: Serious and permanent injury urban females 10 to 14 years old

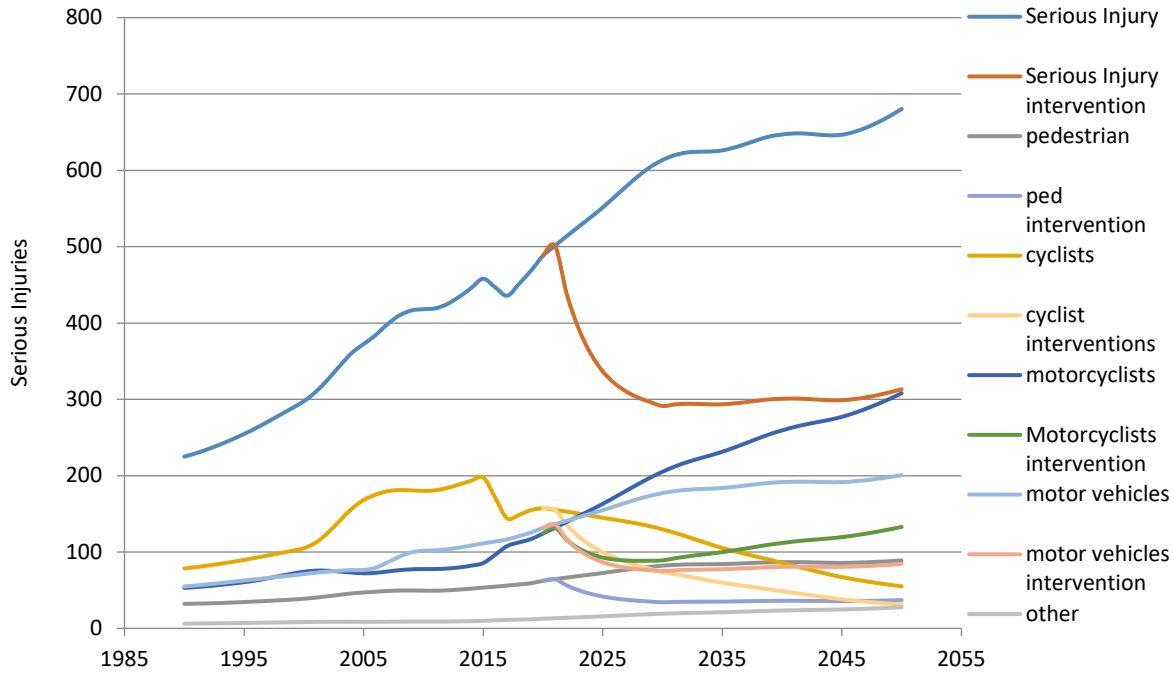


Figure 31: Serious and permanent injury rural males 10 to 14 years old

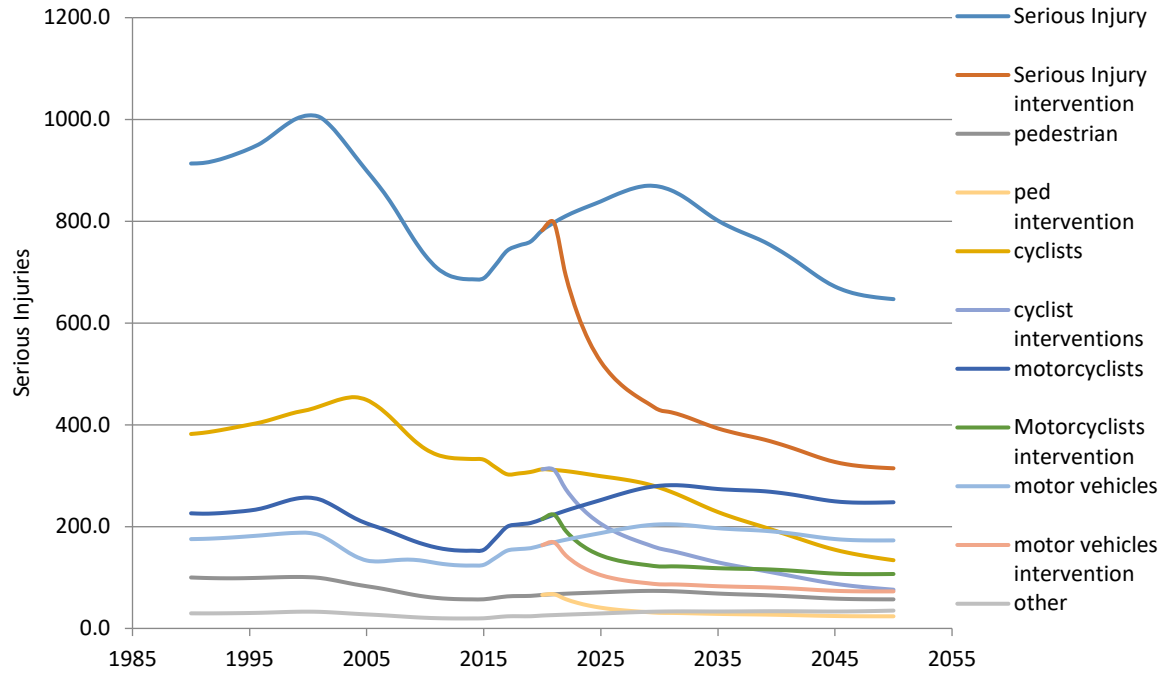
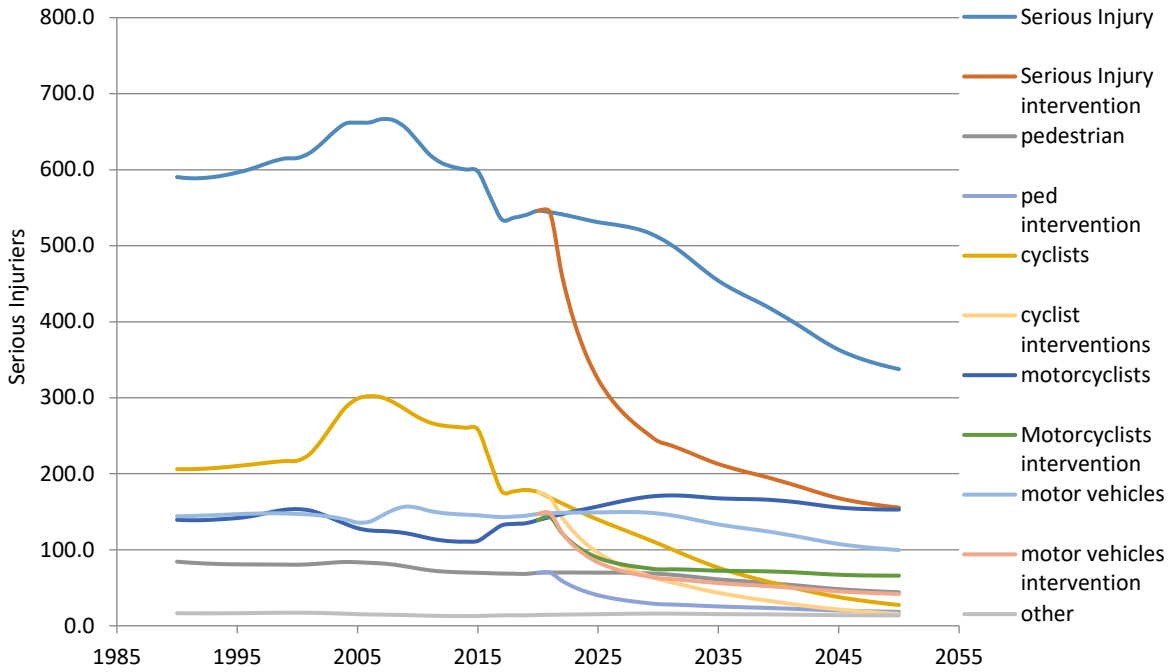


Figure 32: Serious and permanent injury rural females 10 to 14 years old



15 to 19 Cohort

Fatalities

The pattern and trend for fatalities for the 15 to 19 cohort follows a similar trend as the 10 to 14 cohort, showing a decreasing baseline for both and the same main causes of fatalities, namely motor cycle riders and motor vehicle occupants. Baseline fatalities for males are expected to reduce from

1310 in 2019 to 680 in 2050 (Figure 33), while female fatalities are forecast to decline from 270 in 2019 to 130 in 2050 (Figure 34).

Motor cycle fatalities make up a much larger proportion for males, where they make up nearly 60% of all fatalities, while motor vehicle occupants constitute 29%. Females have a slightly more even distribution with 41% of fatalities being motorcyclists, 34% motor vehicle occupants and 18% pedestrians. However, the trends for all modes for both genders are forecast to decline which combines with a relatively stable population leads to a reduction in fatalities.

Figure 33: Fatalities total males 15 to 19 years old

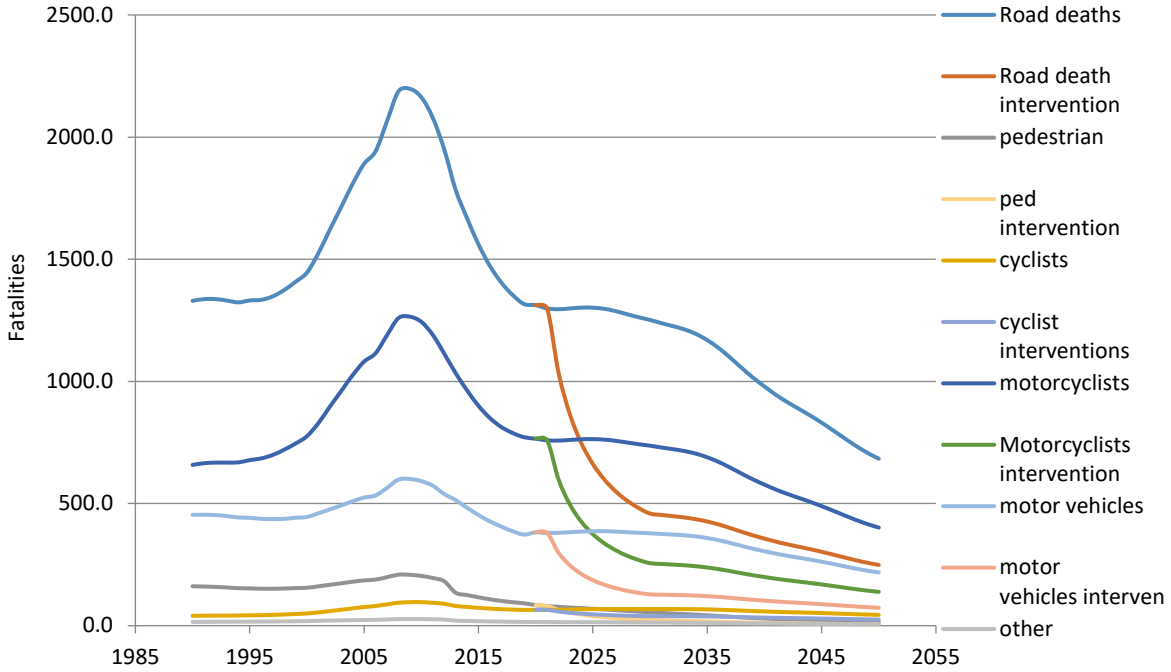
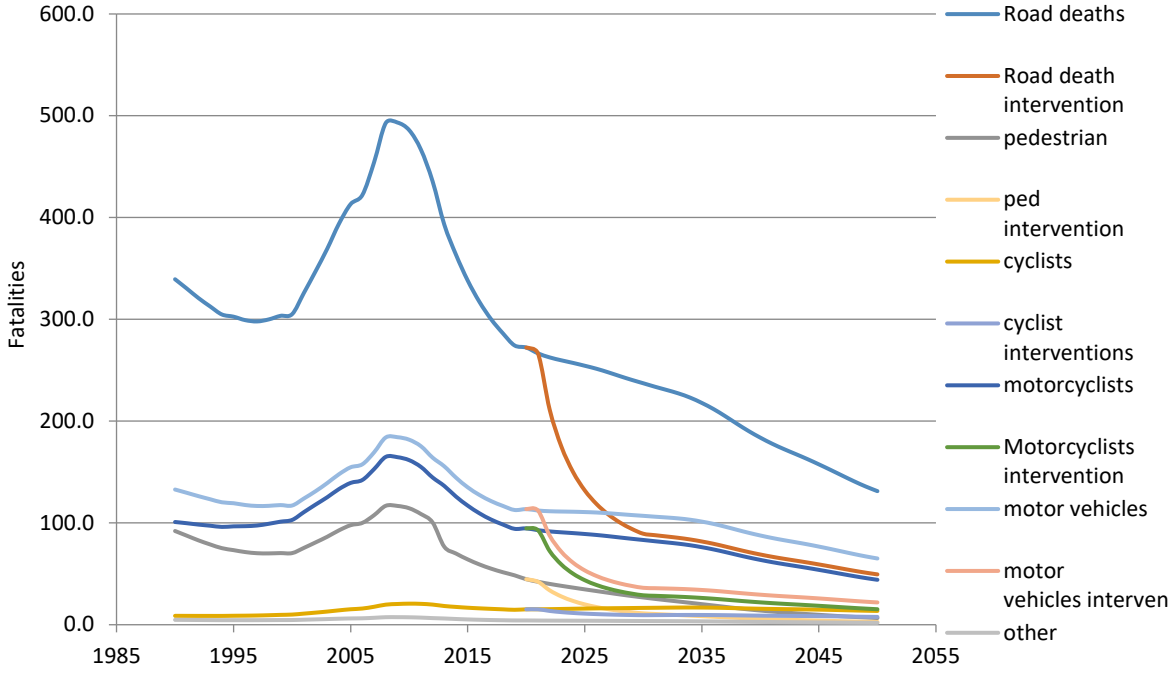


Figure 34: Fatalities total females 15 to 19 years old



Urban and Rural

Both male and female base case urban fatalities are expected to increase gradually to 2035 due to increasing urbanisation, then decline as the effect of reducing rates become larger than the effect of increasing urbanisation (Figure 35 and Figure 36). Conversely, rural fatalities are expected to rapidly decline due to the combined effect of population flows from rural to urban areas, together with declining fatality rates for all modes (Figure 37 and Figure 38).

Figure 35: Fatalities urban males 15 to 19 years old

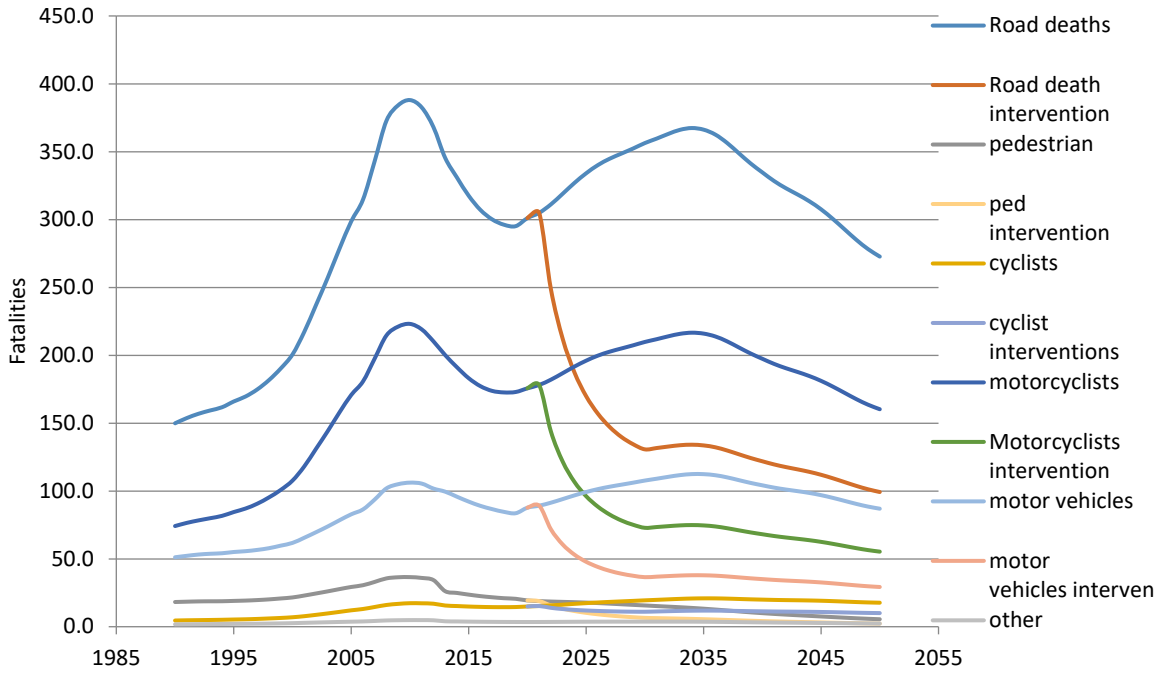


Figure 36: Fatalities urban females 15 to 19 years old

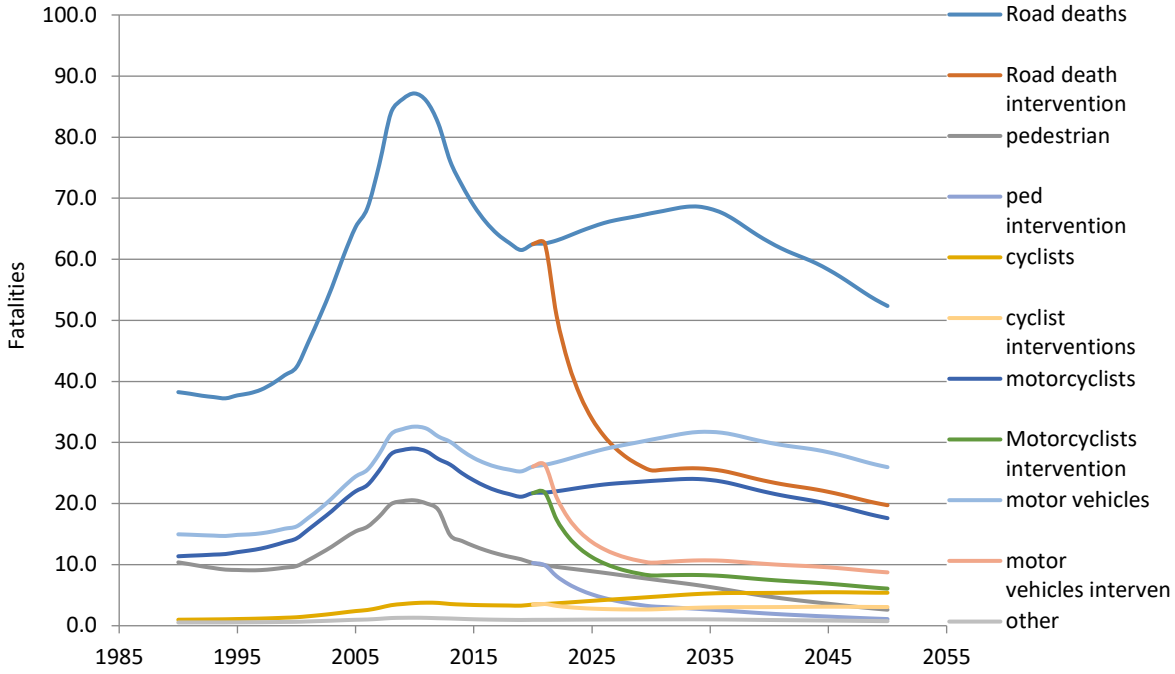


Figure 37: Fatalities rural males 15 to 19 years old

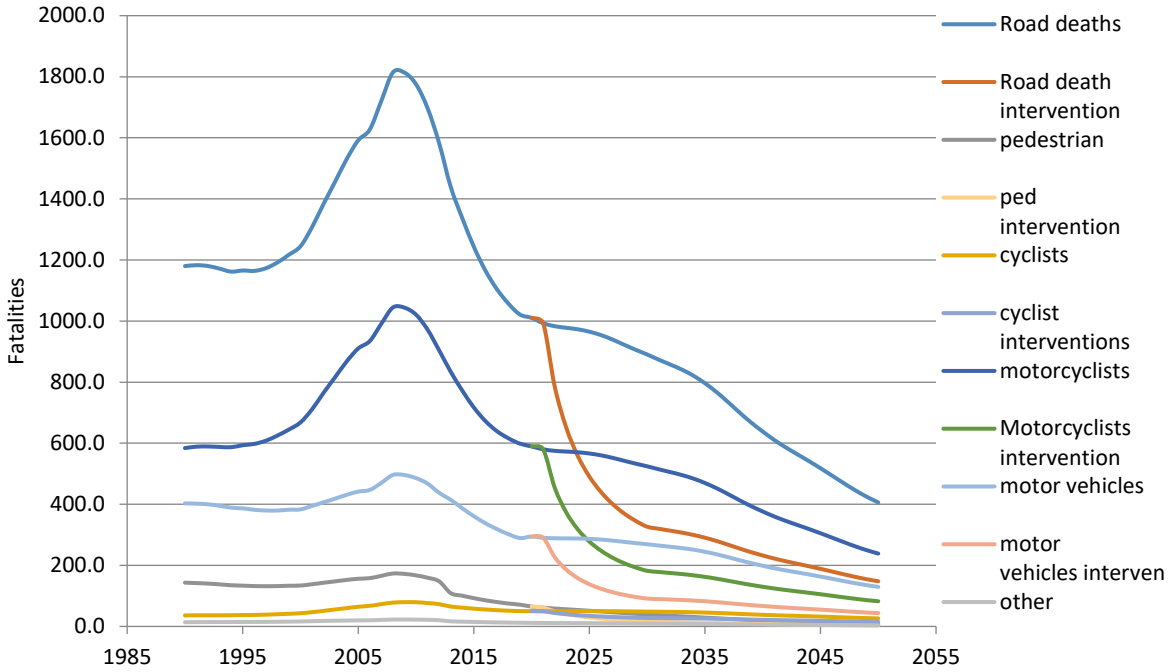
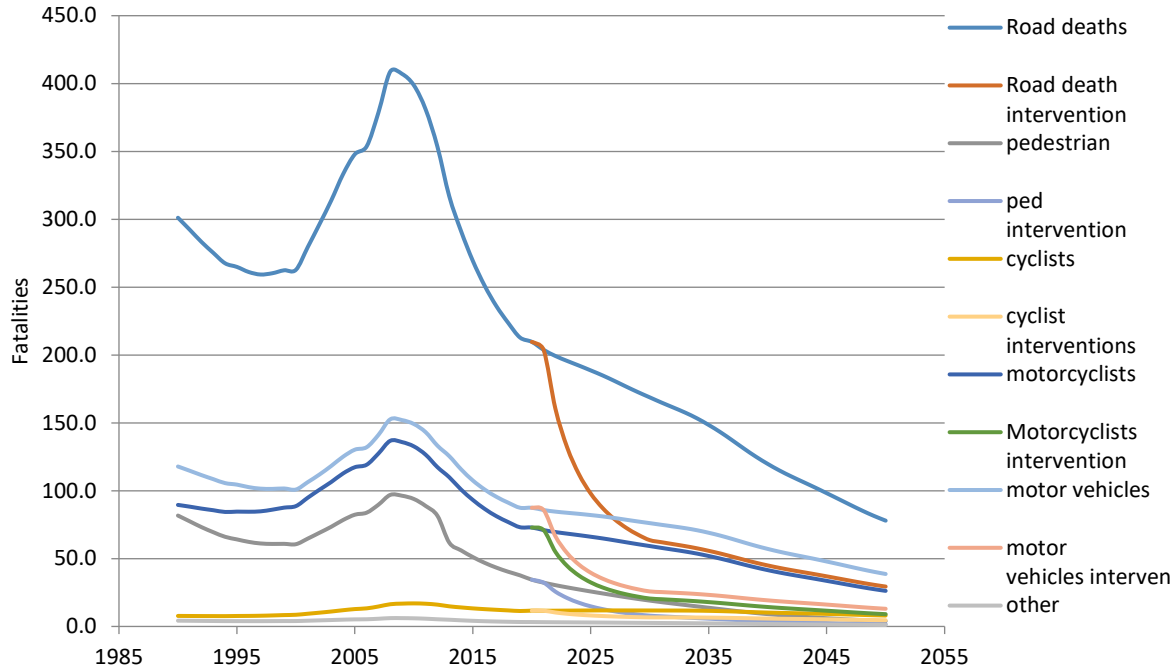


Figure 38: Fatalities rural female 15 to 19 years old



Serious injuries

Baseline serious injuries for 15 to 19 males are expected to nearly double between 2019 and 2035, from approximately 3700 to nearly 7000 per annum due to some increasing mode rates and increasing population (Figure 39). This increase is due to increasing serious injuries from motorcycles, cyclists and motor vehicles. This contrasts with females who gradually increase from 1800 in 2019 to 2100 in the mid-2030s, then gradually decline (Figure 40). This decline is a combination of increasing motor vehicle serious injuries, stable motorcyclist injuries and declining

cyclist injuries. Pedestrian serious injuries are expected to remain stable at approximately 250 out to 2050.

Figure 39: Serious and permanent injury total males 15 to 19 years old

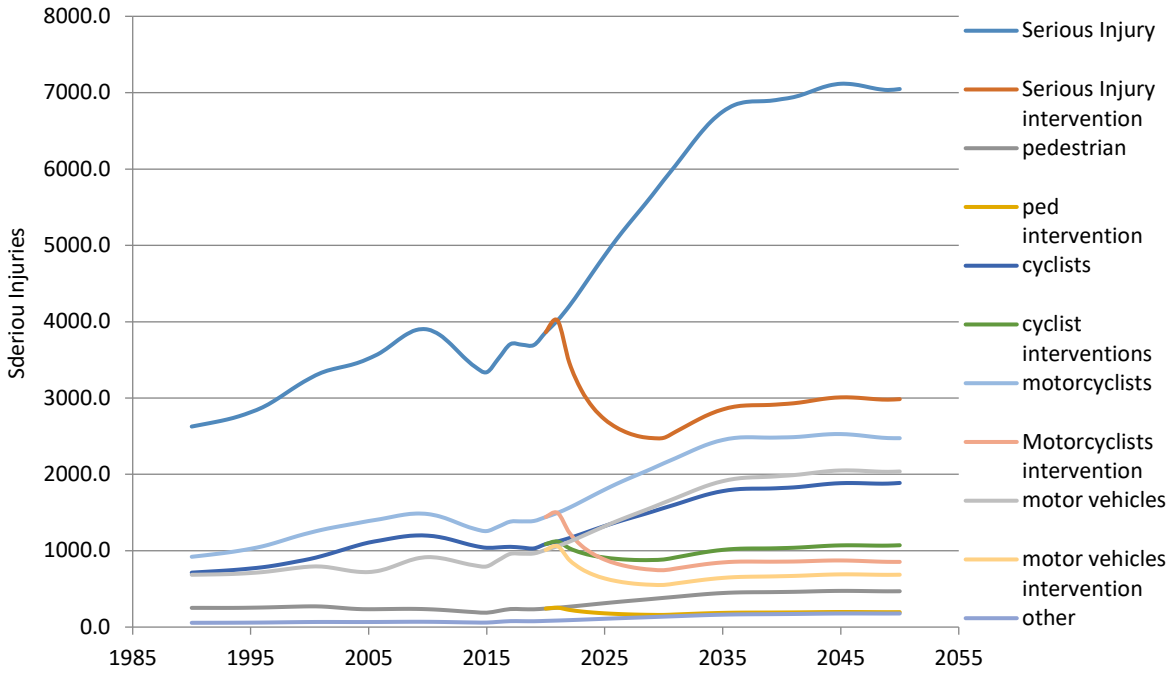
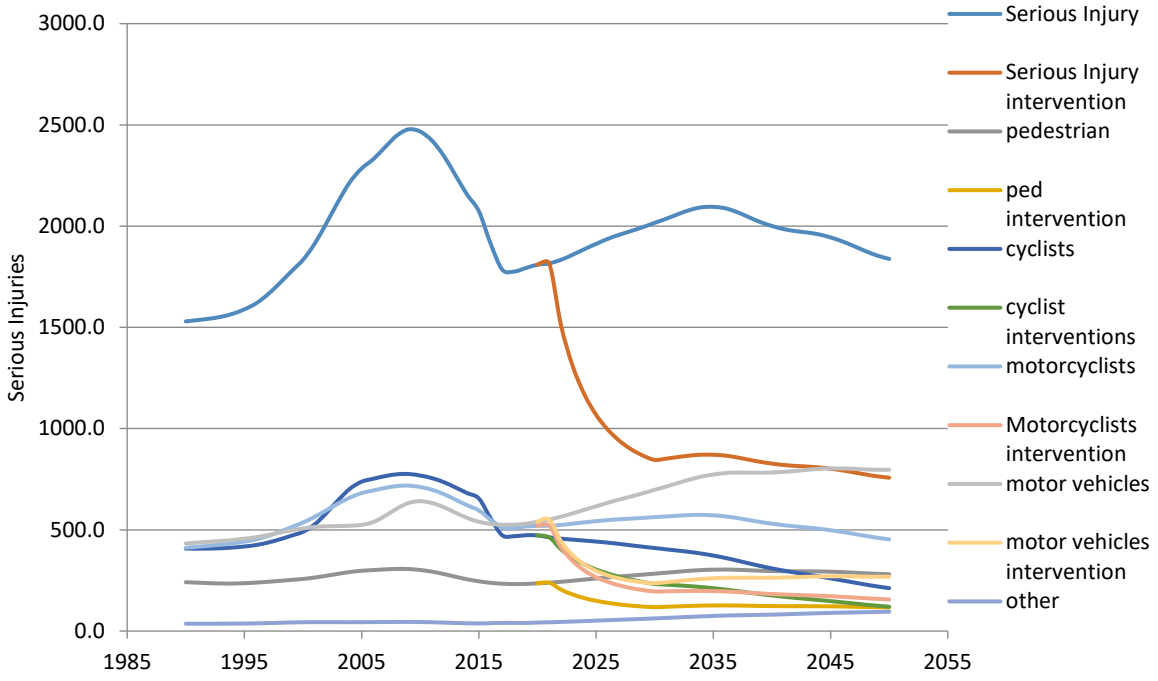


Figure 40: Serious and permanent injury total females 15 to 19 years old



Urban and Rural Serious Injuries

Urban serious injuries are expected to triple for males from 1700 in 2019 to 5500 in 2050, that is entirely due to increased urbanisation (Figure 41). This compares with females where the number of serious injuries increases by fifty% between 2019 with 830, to 1200 in 2035 where they level off (Figure 42).

Serious injuries for males are due to a significant increase in motorcyclists, with gradual increase in serious injuries from motor vehicle occupants and cyclists. This contrasts with females, where motor vehicles increasing significantly with motorcyclists levelling off and cyclists' serious injuries gradually declining.

The forecast for rural serious injuries contrasts considerably with expected urban figures, with the trend for males being similar to urban females with an increase by fifty% from 2019 to 2035 (Figure 43), while rural female serious injuries are forecast to decline by one third from 950 in 2019 to 600 by 2050 (Figure 44).

Figure 41: Serious and permanent injury urban males 15 to 19 years old

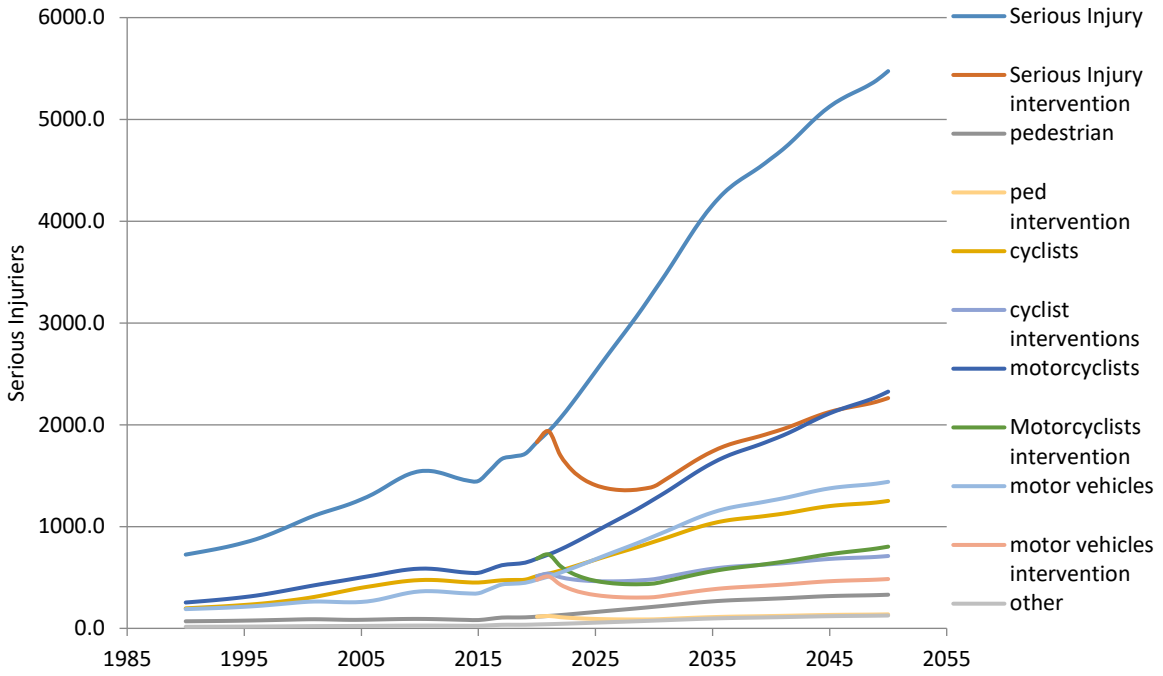


Figure 42: Serious and permanent injury urban females 15 to 19 years

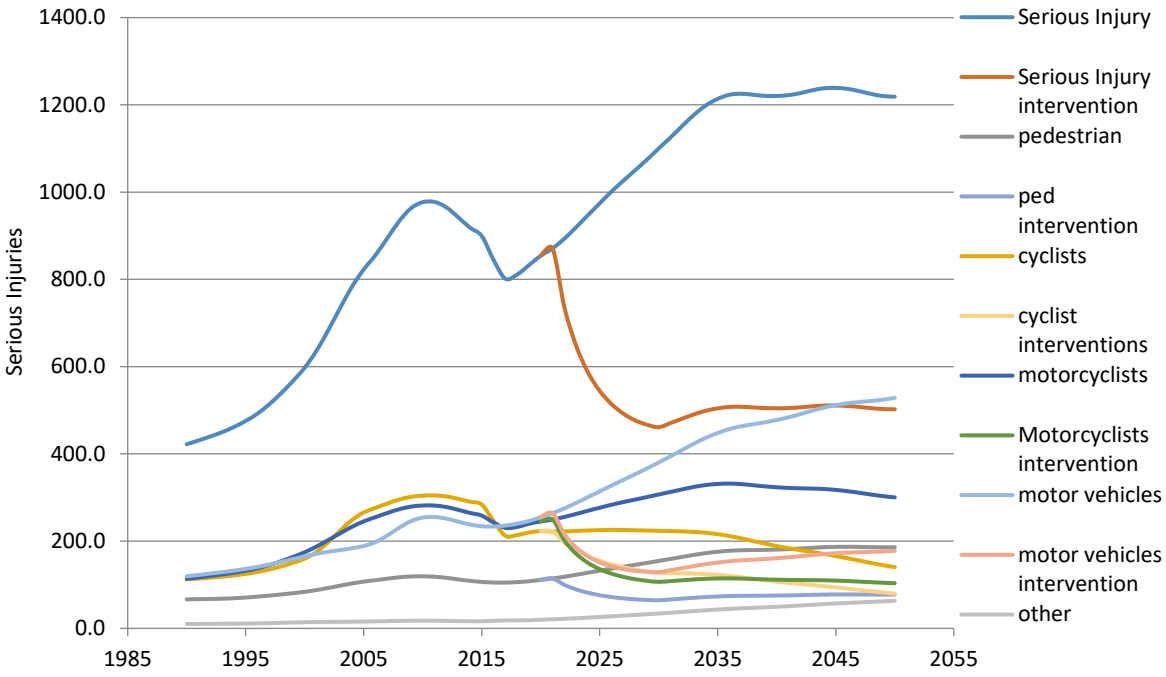


Figure 43: Serious and permanent injury rural males 15 to 19 years old

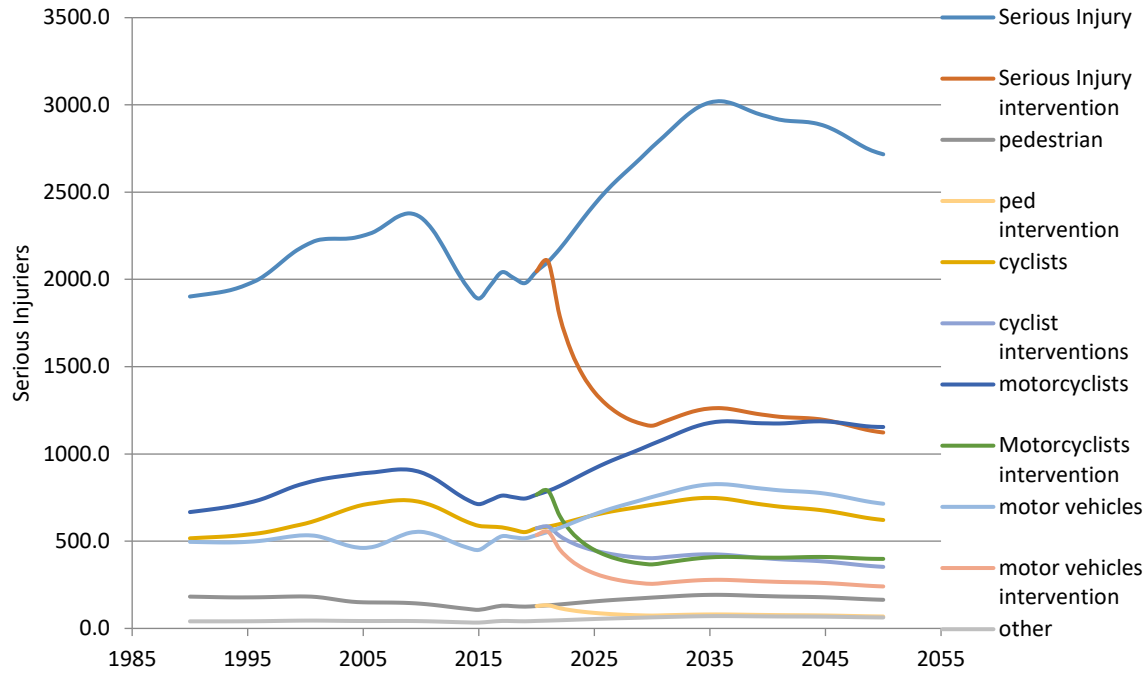
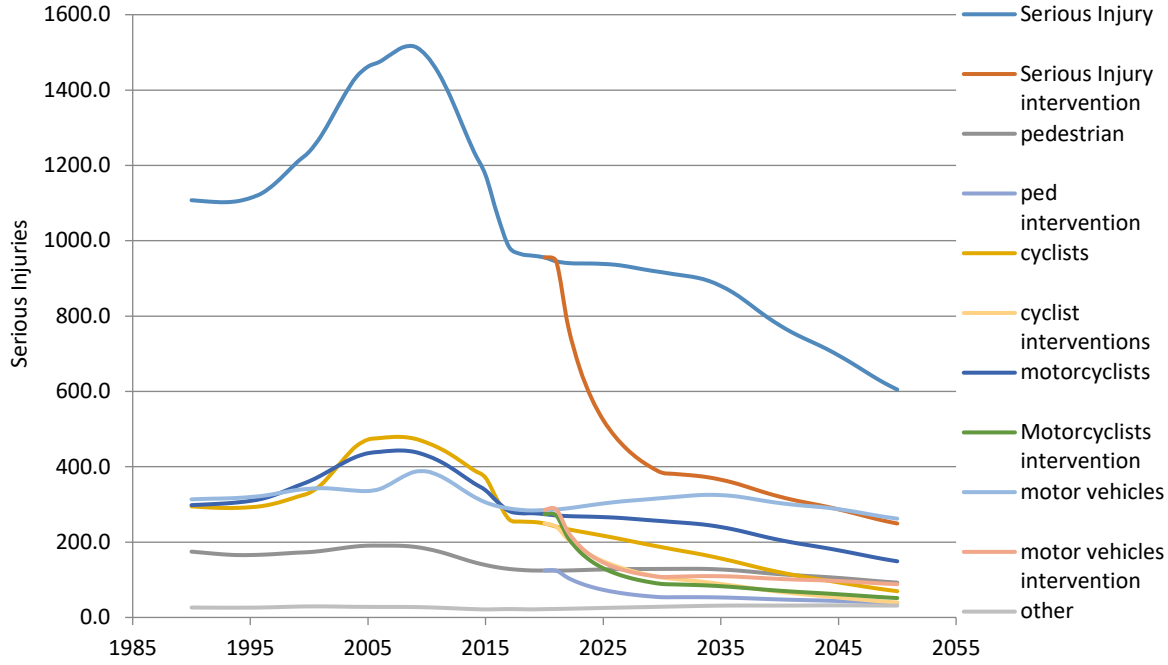


Figure 44: Serious and permanent injury rural females 15 to 19 years old



20 to 24 Cohort

The baseline fatality rates for all modes for males in the 20 to 24 age cohort are expected to continue to steeply decline following a trend that began in 2011, however, this decline becomes less steep from 2023. Male fatalities decline from 1900 in 2019 to 940 in 2050. Motorcyclists represent 57% of serious injuries for males while motor vehicles are 30% in 2019 (Figure 45). For females,

fatalities are expected to decline from 300 in 2019 to 200 in 2050, with more fatalities being motor vehicle occupants (41%) and motor cyclists (35%) being the main causes (Figure 46).

Figure *45: Fatalities total males 20 to 24 years old*

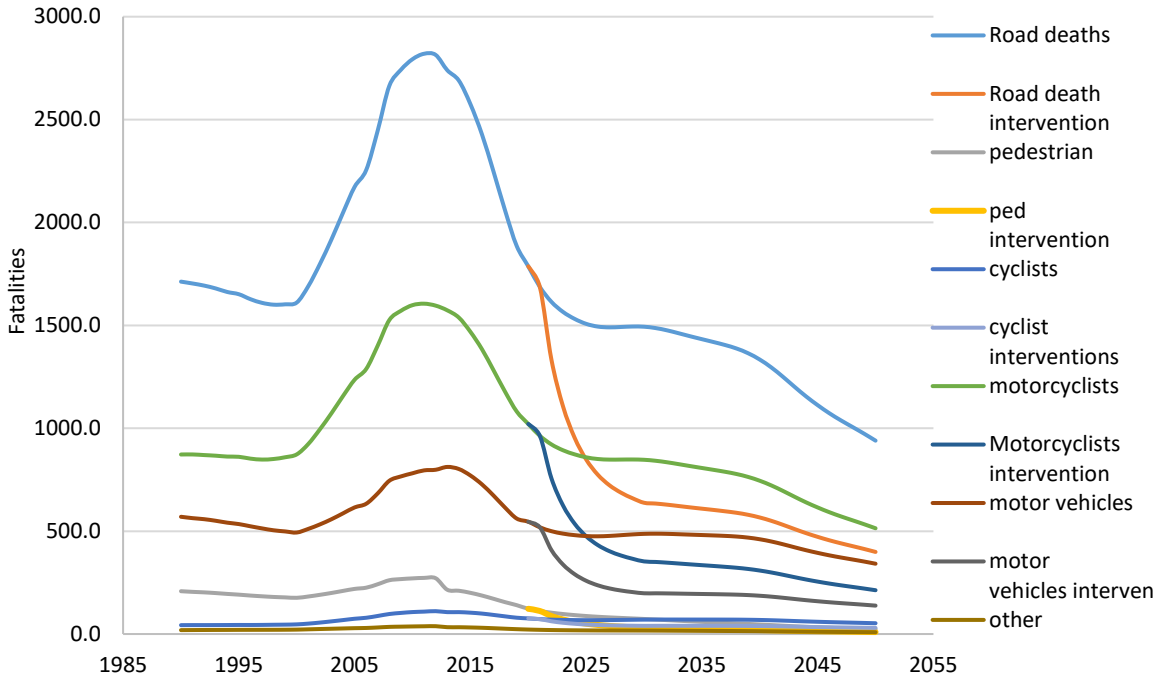
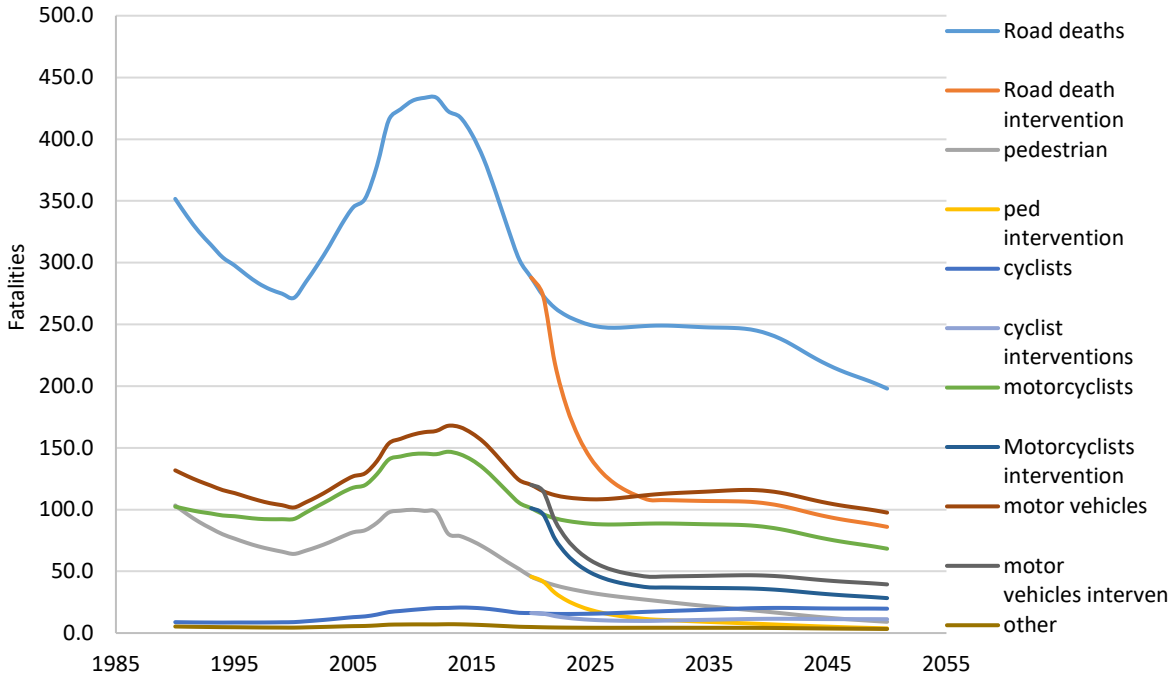


Figure 46: Fatalities total females 20 to 24 years old



Urban and rural fatalities

The increasingly urban nature of Vietnam is expected to lead to an increase in 20 to 24 fatalities for both males and females until the 2040s. In urban settings, for males this an increase from just under 400 per annum to just over 450 (Figure 47). For females, the numbers are much lower with

approximately 65 in 2019 to just over 80 in 2050 (Figure 48). The opposite is the case in rural settings with much larger numbers expected to decline rapidly for both males and females. Fatalities for males are expected to reduce from 1450 in 2019 to 550 in 2050 (Figure 49). For females, these figures are 230 (2019) to 120 (2050) (Figure 50).

Figure 47: Fatalities urban males 20 to 24 years old

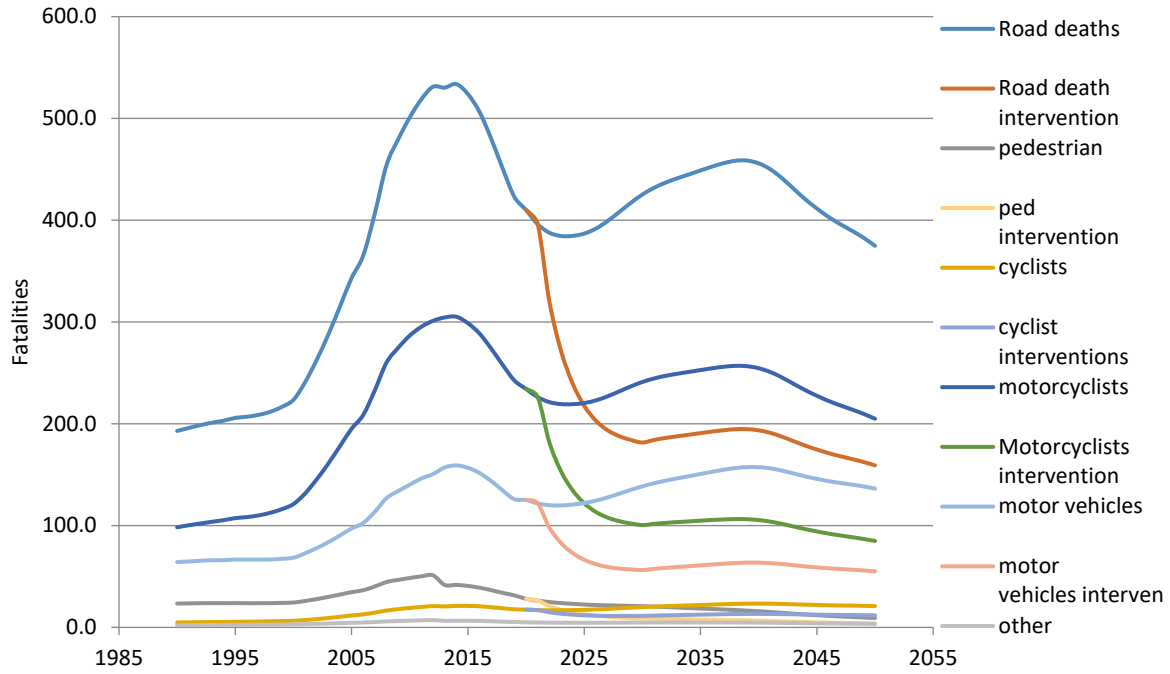


Figure 48: Fatalities urban females 20 to 24 years old

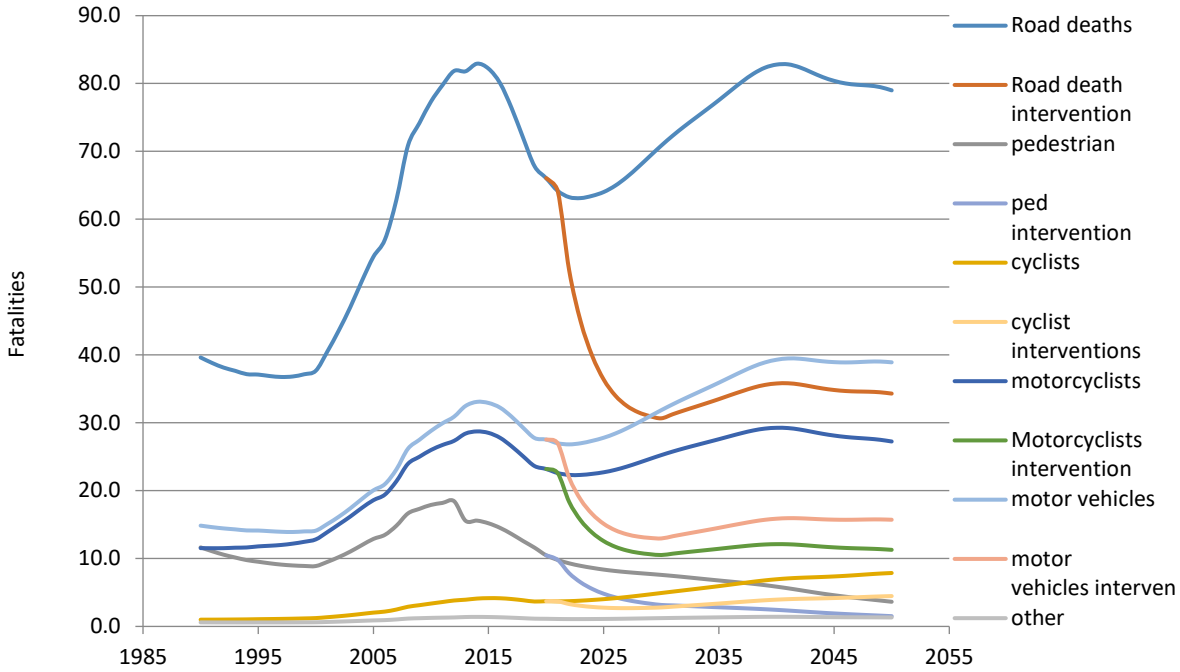


Figure 49: Fatalities rural males 20 to 24 years old

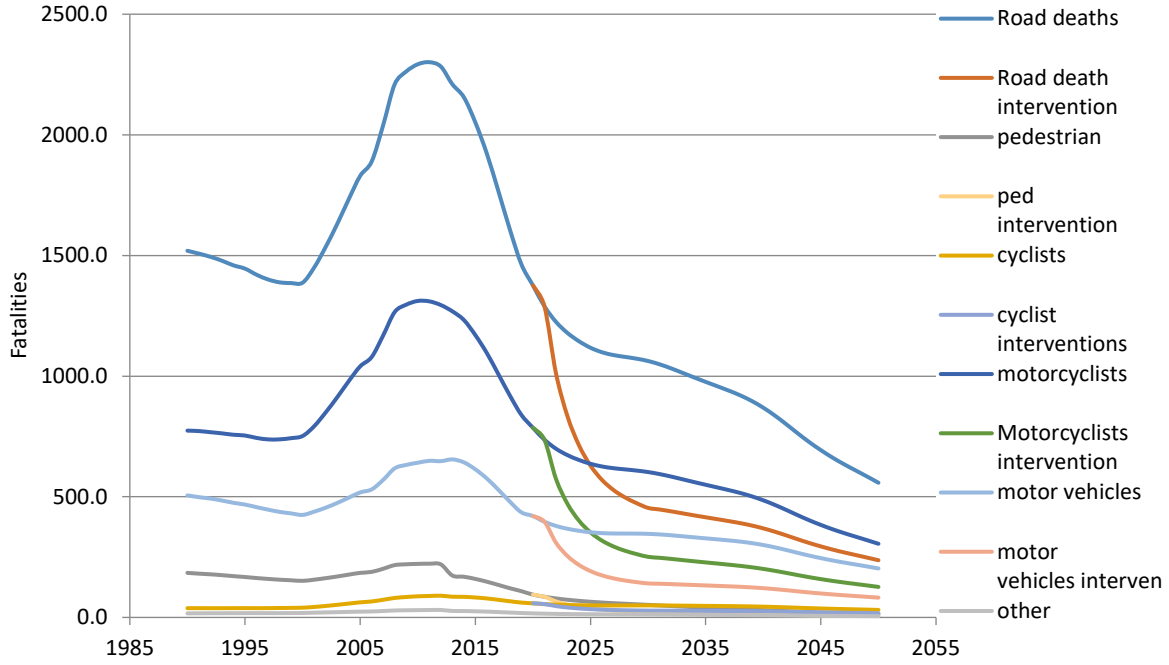
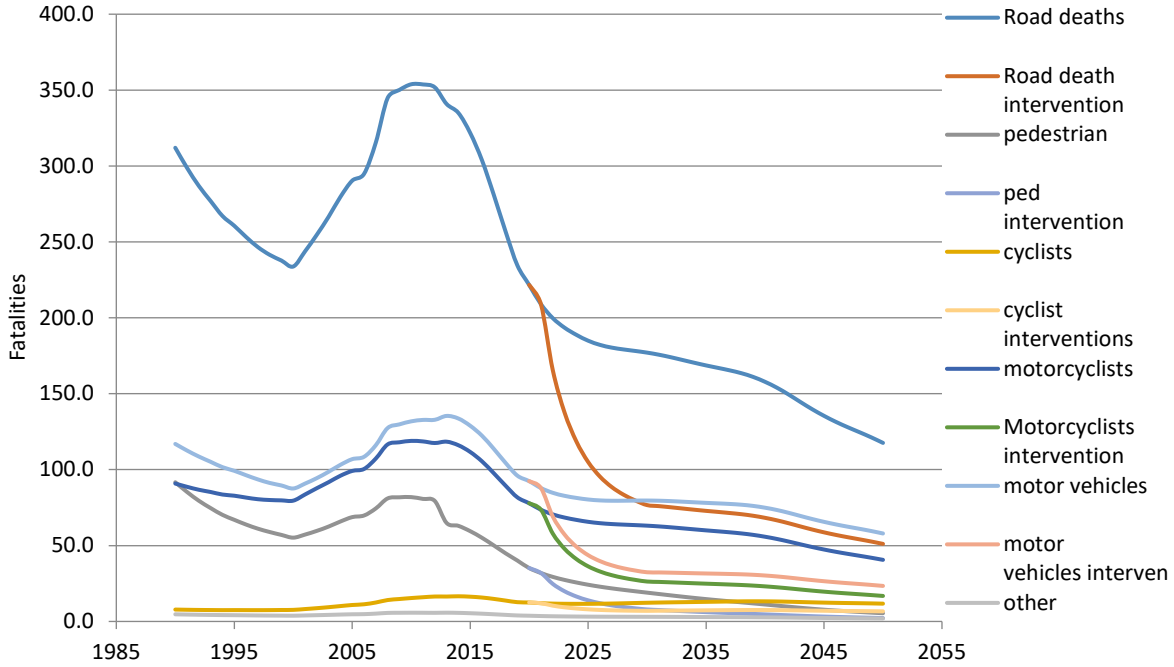


Figure 50: Fatalities rural females 20 to 24 years old



Serious injuries

The baseline number of serious and permanent injuries are expected to increase for males, but stabilise for females in the coming decades for 20 to 24 year olds. For males, these rise from approximately 5000 in 2019 to 8500 by 2040 (Figure 51), and for females they are expected to stabilise around 2000 with a peak of 2100 in 2040 (Figure 52). However, the distribution of serious

injury modes is different between males and females, with similar percentages for motor cyclists, motor vehicle occupants and cyclists for males with all three modes increasing. Females, however, are expected to see an increase in serious injuries to motor vehicle occupants, a stable figure for cyclists and a reduced figure for motorcyclists.

Figure 51: Serious and permanent injury total males 20 to 24 years old

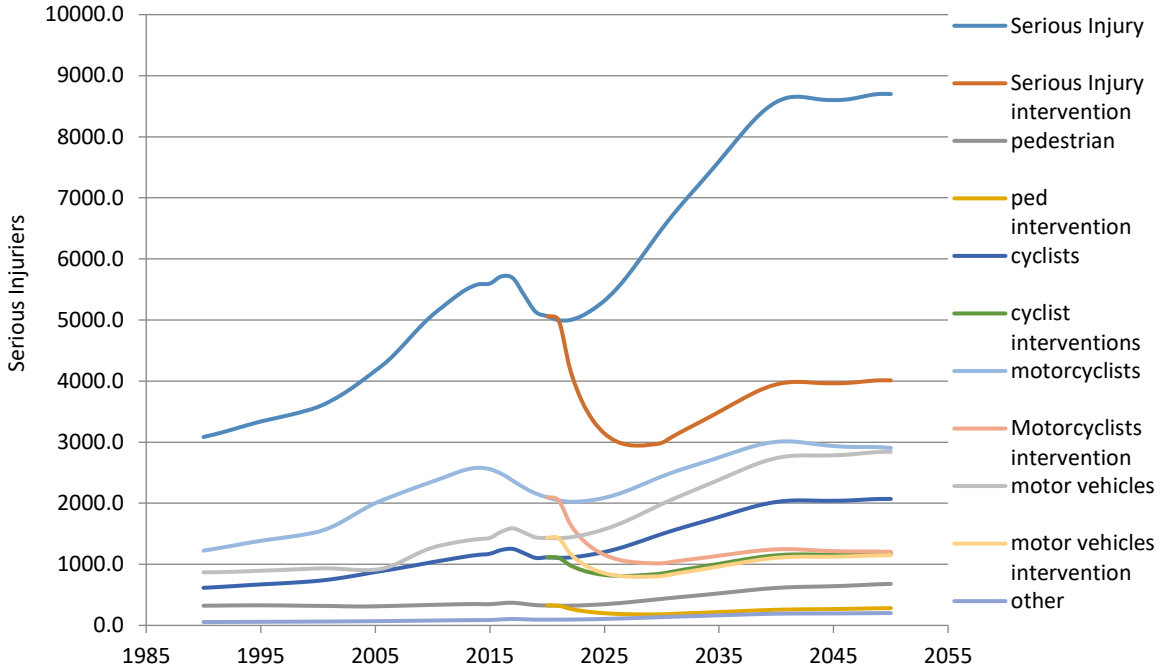
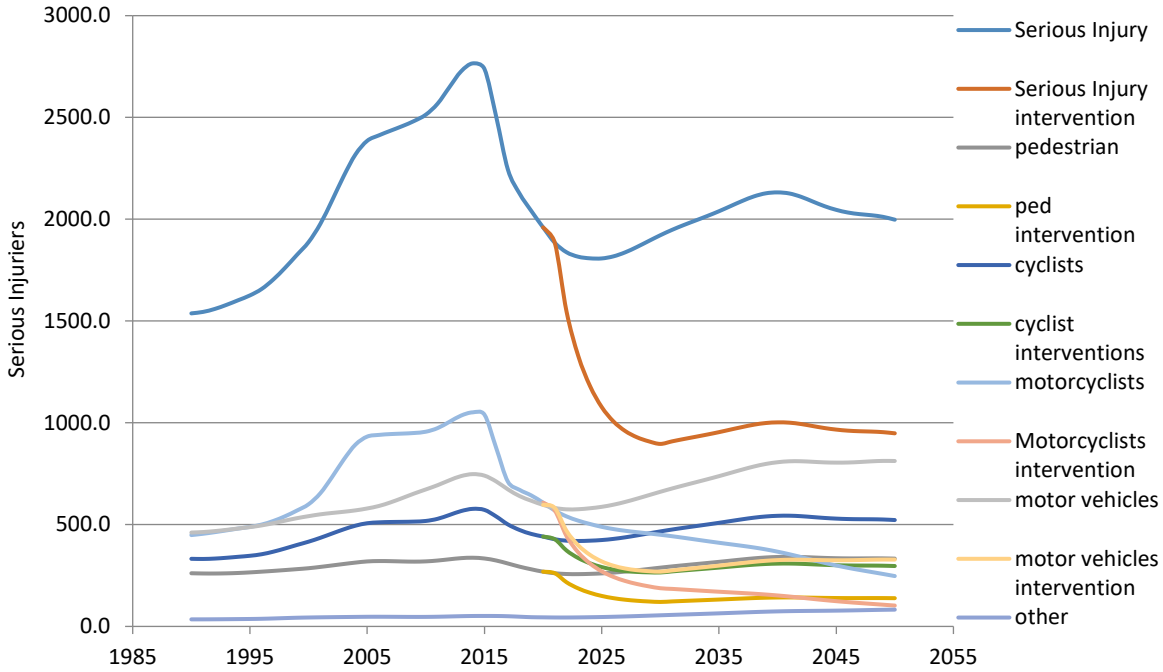


Figure 52: Serious and permanent injury total females 20 to 24 years old



Urban and rural serious injuries

Serious injuries are expected to increase at a substantial rate in urban settings for males with the same distribution of cyclists, pedestrians and motor vehicle occupants being the main source of serious injuries (Figure 53). Serious injuries in urban settings for females are also expected to increase, but less dramatically out to 2040 then level off (Figure 54). Serious injuries in rural settings are expected to gradually rise for males (Figure 55) and gradually decline for females (Figure 56).

Figure *53: Serious and permanent injury urban males 20 to 24 years old*

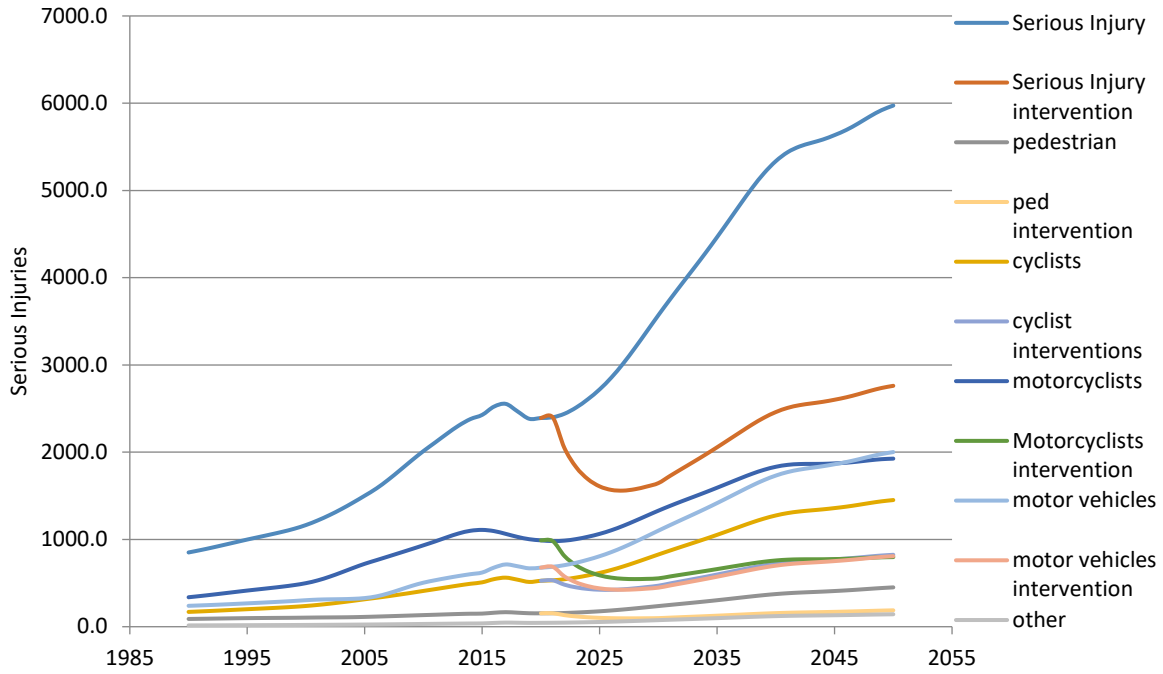


Figure 54: Serious and permanent injury urban females 20 to 24 years old

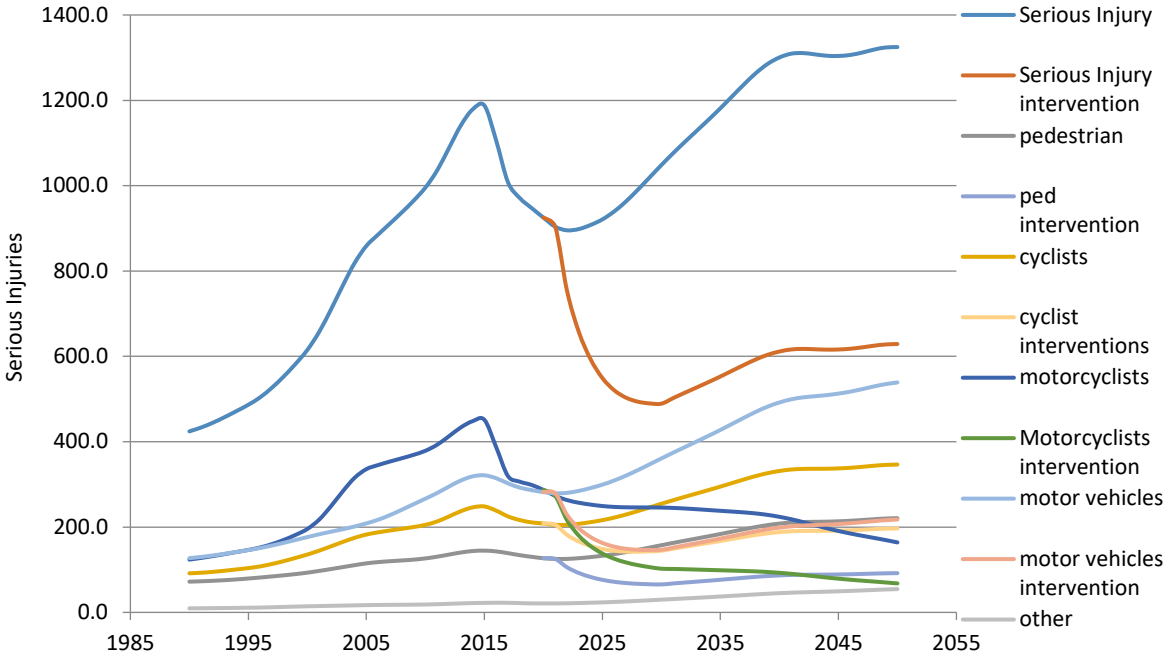


Figure *55: Serious and permanent injury rural males 20 to 24 years old*

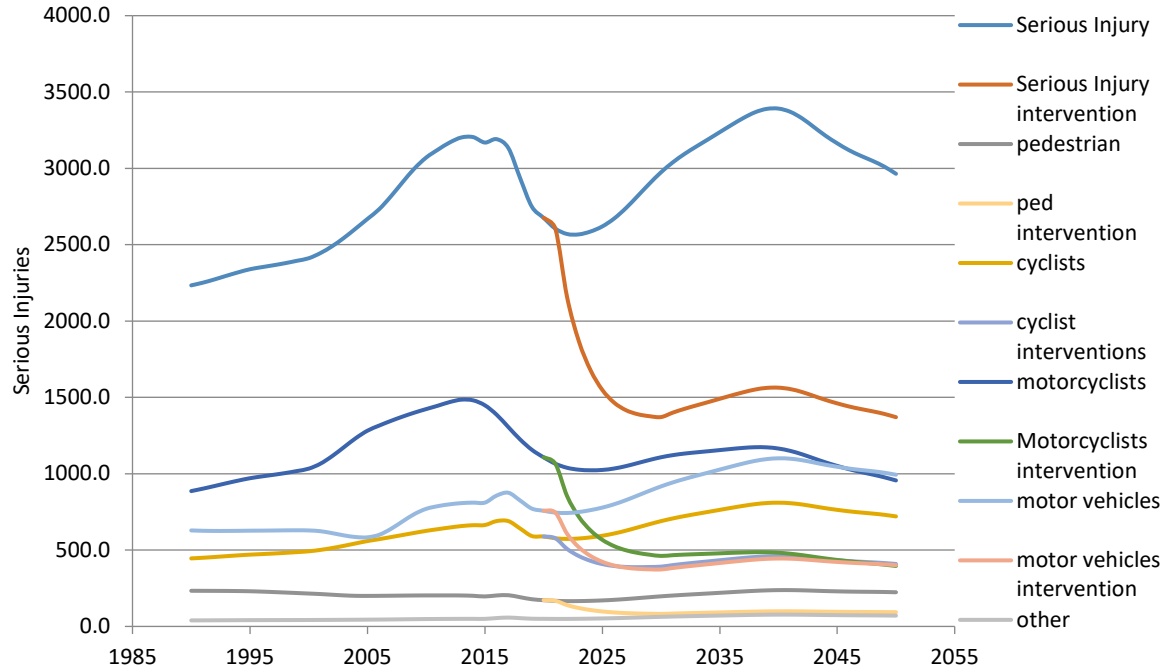
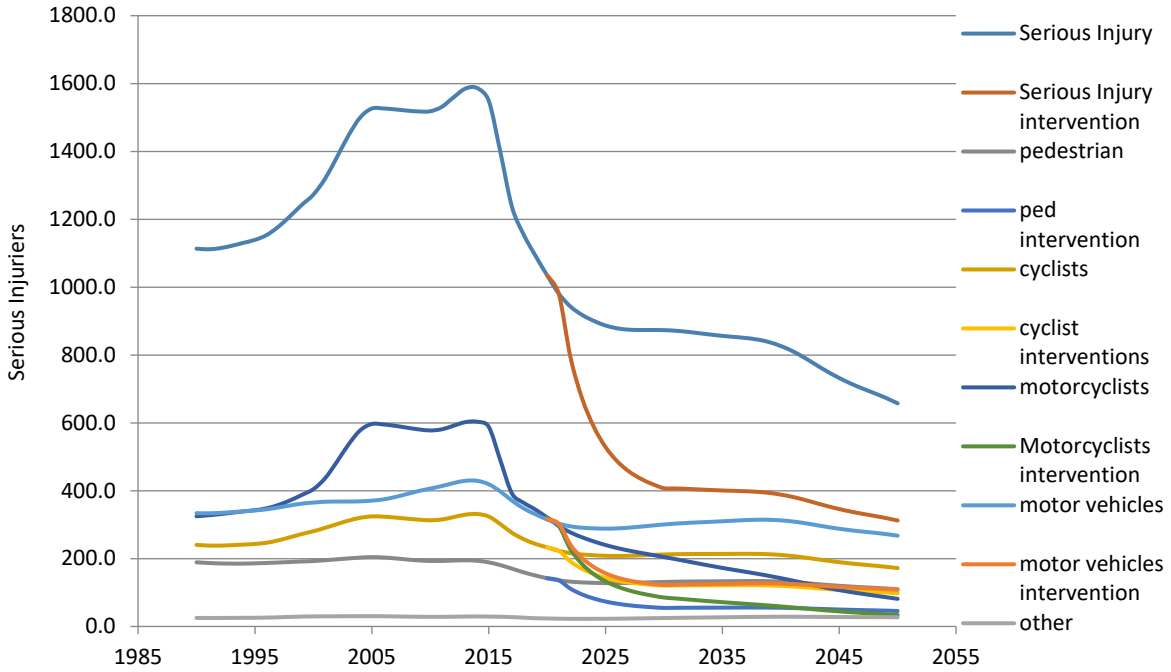


Figure 56: Serious and permanent injury rural females 20 to 24 years old



Economic Analysis and Optimisation Model

The costs of the all interventions have been calculated out to 2030 with economic benefits estimated from reduced fatalities and averted serious injuries averted. Net present values were calculated using a 3% discount rate. These calculations are used to estimate benefit-cost ratios (BCRs) for reduced deaths, averted serious injuries, and both deaths and serious injuries for all of Vietnam, as well as disaggregated urban and rural results. These results show a high BCR of 3.7 for all interventions for the whole country. This means that for every $1 dollar invested, it will return a benefit of $3.70. When the benefits from serious injuries averted are included, this figure rises to 26.6, i.e., every $1 dollar invested gives an economic benefit of $26.60 (Table 17). Given the baseline trend for fatalities to slightly decrease while the baseline serious injuries are expected to increase, this result is expected.

Table 17: Economic benefits all interventions

	Benefits	
Economic benefit, million USD (NPV)	Deaths	$5,459
Economic benefit, million USD (NPV)	Disability	$33,405
Economic benefit, million USD (NPV)	Deaths plus disability	$38,864
Cost, million USD (NPV)		$1,463
Benefit-cost ratio		
Economic benefit	Deaths	**3.7**
Economic benefit	Deaths plus disability	**26.6**

When the results are separated into urban and rural areas, this shows a decreased BCR for urban area fatalities (BCR 2.5), but an increased BCR when serious injuries are included (33.1) (Table 18). The reverse is true for rural areas (4.7 and 22.6) (Table 19).

Table 18: Economic benefits urban areas

	Benefits	
Economic benefit, million USD (NPV)	Deaths	$1,695
Economic benefit, million USD (NPV)	Disability	$20,354
Economic benefit, million USD (NPV)	Deaths plus disability	$22,049
Cost, million USD (NPV)		$667
Benefit-cost ratio		
Economic benefit	Deaths	**2.5**
Economic benefit	Deaths plus disability	**33.1**

Table 19: Economic benefits rural areas

	Benefits	
Economic benefit, million USD (NPV)	Deaths	$3,738
Economic benefit, million USD (NPV)	Disability	$14,267
Economic benefit, million USD (NPV)	Deaths plus disability	$18,006
Cost, million USD (NPV)		$796
Benefit-cost ratio		
Economic benefit	Deaths	**4.7**
Economic benefit	Deaths plus disability	**22.6**

Optimisation model

The optimisation model has been constructed in two ways, with different objective functions for each. Firstly, to achieve a certain age reduction in fatalities or serious injuries at minimum cost, secondly for a given financial constraint, minimise fatalities or serious injuries. For Vietnam, a 50% reduction was specified for both fatalities and serious injuries and 0.15% of GDP for the second objective function.

Minimise cost for percentage reduction model

With a 50% reduction in fatalities goal achieved with least cost, the optimisation model selected the following interventions to achieve that figure:

- motorcycle helmet enforcement;
- alcohol limit enforcement;
- motorcycle infrastructure;
- speed enforcement;
- public awareness campaigns; and
- graduated licensing scheme.

The multiplicative nature of the interventions means that each added intervention has a diminishing return, and consequently only two interventions can achieve most of the reduction shown. All the other interventions only achieve an additional 10% reduction in fatalities.

It should be noted that while the goal of this configuration of the model is reduced fatalities, the interventions also reduce serious injuries, in this case a 42% reduction.

This optimisation solution achieves a 50.9% reduction in fatalities in 2030 from 3,464 to 1,702, with a BCR of 9.0 for fatalities and 58.0 when serious injuries are included (Table 20).

Table 20: Minimise cost with 50% reduction in fatalities

	Benefits	
Economic benefit, million USD (NPV)	Deaths	$4,585
Economic benefit, million USD (NPV)	Disability	$24,858
Economic benefit, million USD (NPV)	Deaths plus disability	$29,443
Cost, million USD (NPV)		$508
Benefit-cost ratio		
Economic benefit	Deaths	**9.0**
Economic benefit	Deaths plus disability	**58.0**

With a 50% reduction in serious injuries goal achieved with least cost, the optimisation model selected the following interventions to achieve that figure:

- motorcycle helmet enforcement;
- alcohol limit enforcement;
- motorcycle infrastructure;
- cyclist infrastructure;
- pedestrian infrastructure;
- speed enforcement;
- public awareness campaigns; and
- seat belt enforcement.

This optimisation solution achieves a 50.5% reduction in serious injuries by 2030, from a projected 19,285 to 9,555 serious injuries with BCRs of 6.4 and 45.9. These interventions also reduced the forecast number of fatalities by 53.4% from a projected 3,464 to 1,615 (Table 21).

Table 21: Minimise cost with 50% reduction in serious injuries

	Benefits	
Economic benefit, million USD (NPV)	Deaths	$5,106
Economic benefit, million USD (NPV)	Disability	$31,330
Economic benefit, million USD (NPV)	Deaths plus disability	$36,436
Cost, million USD (NPV)		$794
Benefit-cost ratio		
Economic benefit	Deaths	**6.4**
Economic benefit	Deaths plus disability	**45.9**

Minimum fatalities/injuries for percentage GDP model

With a constraint of 0.15% of GDP to minimise fatalities goal, the optimisation model selected the following interventions:

- motorcycle helmet enforcement;
- alcohol limit enforcement;
- motorcycle infrastructure;
- pedestrian infrastructure;
- speed enforcement;
- public awareness campaigns;
- graduated licensing scheme;
- seat belt enforcement; and
- car safety standards.

This optimisation solution achieves a 56.8% reduction in fatalities in 2030 from 3,464 to 1,497 with a BCR of 6.6 for fatalities and 43.5 when serious injuries are included. This solution also reduced serious injuries from 19,285 to 9,954, a 48.4% reduction (Table 22).

Table 22: Minimise fatalities with 0.15% GDP constraint

	Benefits	
Economic benefit, million USD (NPV)	Deaths	$4,999
Economic benefit, million USD (NPV)	Disability	$28,193
Economic benefit, million USD (NPV)	Deaths plus disability	$33,192
Cost, million USD (NPV)		$763
Benefit-cost ratio		
Economic benefit	Deaths	**6.6**
Economic benefit	Deaths plus disability	**43.5**

With a constraint of 0.15% of GDP to minimise serious injuries goal, the optimisation model selected the following interventions:

- alcohol limit enforcement;
- motorcycle infrastructure;

- pedestrian infrastructure;
- cyclist infrastructure;
- speed enforcement;
- public awareness campaigns;
- graduated licensing scheme;
- seat belt enforcement; and
- car safety standards.

This optimisation solution achieves a 52.2% reduction in serious injuries by 2030 from 19,285 to 9,920, with a BCR of 6.3 for fatalities and 45.3 when serious injuries are included. This solution also reduced serious injuries from 19,285 to 9,954, a 48.4% reduction (Table 23).

Table 23: Minimise serious injuries with a 0.15% GDP constraint

	Benefits	
Economic benefit, million USD (NPV)	Deaths	$4,885
Economic benefit, million USD (NPV)	Disability	$30,432
Economic benefit, million USD (NPV)	Deaths plus disability	$35,316
Cost, million USD (NPV)		$779
Benefit-cost ratio		
Economic benefit	Deaths	**6.3**
Economic benefit	Deaths plus disability	**45.3**

Summary and Conclusion

This case study has drawn upon available evidence from both published research, survey work and intervention programs undertaken in Vietnam as part of AIP Vietnam's programs to make the journey to school a safer one. AIP's pilot programs have shown the effectiveness of infrastructure and public awareness in reducing speeds around schools, with a commensurate reduction road traffic accidents. Due to several UN funded road safety reviews, there is a considerable amount of data describing the road safety situation in Vietnam, as well as the areas that the Government of Vietnam sees as a priority. Given the very large share of motorcycles amongst motorised traffic in Vietnam, the Government of Vietnam has placed an emphasis on helmet wearing and helmet quality that are seen as key goals. Less focus is placed on the safety of cyclists and pedestrians, with education and public awareness seen as a key solution. However, the modelling approach taken in this study highlights the benefits of adopting a suite of interventions to address the safety of vulnerable road users.

The results for each age cohort show a general downwards trend in the number of fatalities for all age groups (more so for ages 10 to 14 and 15 to 19) for both males and females. The reasons for this decline are not certain, though undoubtedly efforts by the Government of Vietnam to address road safety have had an effect together with the improving crashworthiness of motor vehicles as the average age of the car fleet decreases. There is also a trend towards more motorised transport with increasing age. This is especially the case with motorcycles. For the 10 to 14 year old cohort, pedestrians represent a much higher number of fatalities than in the older cohorts. As with all countries, male fatalities are higher than female figures by a factor of between three for 10 to 14 year olds to six for 20 to 24 year olds.

The results for serious injuries is in stark contrast to fatalities, with there being more than ten times as many serious injuries as fatalities by 2050. While fatalities are all expected to decline, depending on the cohort, serious injuries either stabilise or increase gradually. The exception being urban males in the 15 to 19 and 20 to 24 age cohorts where serious injuries are expected to rapidly increase.

As with fatalities, motor cyclists make up most of the serious injuries, though there are more motor vehicle occupants and cyclists represented in serious injuries than fatalities. This high number of motor cyclists represents a particular road safety challenge for Vietnam, however, other modes are also significant.

The modelled interventions have an enormous effect on the level of fatalities and serious injuries in Vietnam. When considered as a whole, all interventions are expected to decrease fatalities by 61.1% and serious injuries by 56.6% by 2030, with a BCR 3.7 for fatalities only and 26.6 when serious injuries are included.

The model also disaggregates the results into urban and rural areas, with BCRs for urban areas of 2.6 for fatalities and 33.1 for fatalities and serious injuries, while rural areas had BCRs of 4.7 for fatalities and 22.6 for fatalities and serious injuries.

An optimisation model was also developed with two versions, with each version having two sub-models with a goal for either fatalities or serious injuries. The results of this optimisation model show increased BCRs due to the focus on either percentage reduction in fatalities or serious injuries for least cost, or for a given level of expenditure, the minimisation of fatalities or serious injuries. For the model with a 50% reduction at least cost, these models produced BCRs of 9.0 and 58.0 with a 50% reduction in fatalities goal and 6.4 and 45.9 with a 50% reduction in serious injuries. The models with a 0.15% GDP constraint with minimised fatalities generated a BCR of 6.6 and 43.5 and 6.3 and 45.3 with minimised serious injuries.

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Appendix 1: Number of Fatalities

Table 24: Baseline and intervention fatalities

Year	Males and females	
	Baseline	Interventions
1990	4229	
1991	4204	
1992	4172	
1993	4131	
1994	4084	
1995	4069	
1996	4031	
1997	4014	
1998	4022	
1999	4052	
2000	4094	
2001	4291	
2002	4533	
2003	4794	
2004	5067	
2005	5299	
2006	5427	
2007	5794	
2008	6199	
2009	6270	
2010	6266	
2011	6175	
2012	5994	
2013	5677	
2014	5466	
2015	5197	
2016	4914	
2017	4615	
2018	4324	
2019	4069	
2020	3951	3951
2021	3812	3812
2022	3717	3035
2023	3656	2529
2024	3612	2184
2025	3576	1939
2026	3548	1762
2027	3526	1632
2028	3506	1535
2029	3486	1460
2030	3464	1400
2031	3433	1385
2032	3397	1369
2033	3356	1351
2034	3309	1331
2035	3255	1310
2036	3195	1286
2037	3127	1259
2038	3054	1230
2039	2975	1200
2040	2893	1167
2041	2804	1131
2042	2712	1094
2043	2619	1056

2044	2529	1020
2045	2442	985
2046	2357	951
2047	2277	919
2048	2201	889
2049	2129	860
2050	2059	832

Table 25: baseline and intervention fatalities male and female

Year	Males		Females	
	Baseline	Interventions	Baseline	Interventions
1990	3409		820	
1991	3408		796	
1992	3399		772	
1993	3379		752	
1994	3352		732	
1995	3348		721	
1996	3324		707	
1997	3317		697	
1998	3331		691	
1999	3363		689	
2000	3409		685	
2001	3571		720	
2002	3776		756	
2003	3997		797	
2004	4227		840	
2005	4427		872	
2006	4545		882	
2007	4855		939	
2008	5186		1013	
2009	5254		1016	
2010	5255		1011	
2011	5185		990	
2012	5038		956	
2013	4780		897	
2014	4605		861	
2015	4376		820	
2016	4136		778	
2017	3881		734	
2018	3634		690	
2019	3420		649	
2020	3317	3317	633	633
2021	3199	3199	613	613
2022	3119	2545	598	490
2023	3068	2119	588	409
2024	3032	1830	580	354
2025	3003	1624	573	314
2026	2981	1477	568	286
2027	2962	1368	563	264
2028	2947	1286	559	248
2029	2931	1224	555	236
2030	2913	1173	551	226
2031	2886	1161	546	224
2032	2855	1147	541	222
2033	2820	1131	536	220
2034	2780	1114	529	217
2035	2733	1095	522	214
2036	2681	1074	514	211
2037	2622	1051	506	208

2038	2557	1026	496	204
2039	2489	999	487	201
2040	2417	970	476	196
2041	2339	939	465	192
2042	2259	907	453	187
2043	2178	874	441	182
2044	2099	842	429	178
2045	2024	811	418	173
2046	1950	782	407	169
2047	1880	754	397	165
2048	1814	728	387	161
2049	1751	703	378	157
2050	1690	678	369	154

Appendix 2: Number of Serious Injuries

Table 26: Baseline and intervention serious injuries

Year	Males and females	
	Baseline	Interventions
1990	10856	
1991	10956	
1992	11077	
1993	11219	
1994	11381	
1995	11565	
1996	11768	
1997	12035	
1998	12342	
1999	12660	
2000	12963	
2001	13323	
2002	13707	
2003	14099	
2004	14478	
2005	14798	
2006	15076	
2007	15434	
2008	15795	
2009	16079	
2010	16232	
2011	16280	
2012	16288	
2013	16248	
2014	16158	
2015	16019	
2016	15940	
2017	15739	
2018	15378	
2019	15089	
2020	15208	15208
2021	15287	15287
2022	15506	12962
2023	15843	11444
2024	16247	10425
2025	16685	9729
2026	17169	9268
2027	17681	8973
2028	18214	8797
2029	18755	8706
2030	19285	8672
2031	19771	8878
2032	20235	9075
2033	20669	9260
2034	21067	9431
2035	21425	9587
2036	21748	9730
2037	22017	9848
2038	22235	9950
2039	22407	10030
2040	22530	10086
2041	22588	10113

2042	22597	10116
2043	22573	10103
2044	22536	10084
2045	22503	10069
2046	22467	10055
2047	22444	10048
2048	22436	10048
2049	22437	10051
2050	22442	10056

Table 27: Baseline and intervention serious injuries male and female

Year	Males		Females	
	Baseline	Interventions	Baseline	Interventions
1990	6973		3883	
1991	7057		3899	
1992	7151		3926	
1993	7256		3963	
1994	7372		4010	
1995	7498		4066	
1996	7629		4139	
1997	7791		4244	
1998	7972		4370	
1999	8156		4504	
2000	8329		4634	
2001	8501		4822	
2002	8641		5067	
2003	8773		5326	
2004	8920		5557	
2005	9093		5705	
2006	9287		5789	
2007	9544		5890	
2008	9815		5979	
2009	10047		6032	
2010	10196		6036	
2011	10251		6029	
2012	10258		6030	
2013	10233		6015	
2014	10191		5967	
2015	10151		5867	
2016	10510		5430	
2017	10740		4999	
2018	10488		4890	
2019	10246		4842	
2020	10405	10405	4803	4803
2021	10543	10543	4745	4745
2022	10781	9006	4726	3956
2023	11105	8014	4737	3429
2024	11482	7360	4765	3065
2025	11886	6924	4799	2805
2026	12323	6647	4846	2621
2027	12784	6484	4897	2489
2028	13263	6403	4951	2393
2029	13749	6381	5006	2324
2030	14228	6399	5057	2273
2031	14671	6589	5100	2289
2032	15097	6772	5138	2303
2033	15500	6946	5169	2314
2034	15876	7109	5191	2322
2035	16219	7260	5206	2327

2036	16530	7398	5218	2333
2037	16796	7515	5221	2333
2038	17020	7618	5215	2331
2039	17205	7704	5201	2326
2040	17351	7770	5179	2316
2041	17438	7809	5150	2304
2042	17484	7829	5113	2287
2043	17502	7835	5071	2268
2044	17508	7836	5028	2248
2045	17517	7840	4986	2229
2046	17517	7841	4950	2214
2047	17527	7847	4917	2200
2048	17548	7859	4888	2189
2049	17575	7874	4862	2178
2050	17606	7889	4836	2167

Appendix 3: Transport Mode Trends for Fatalities and Serious Injuries

Figure 57: 10 to 14 year-old male pedestrian fatality rate per 100,000

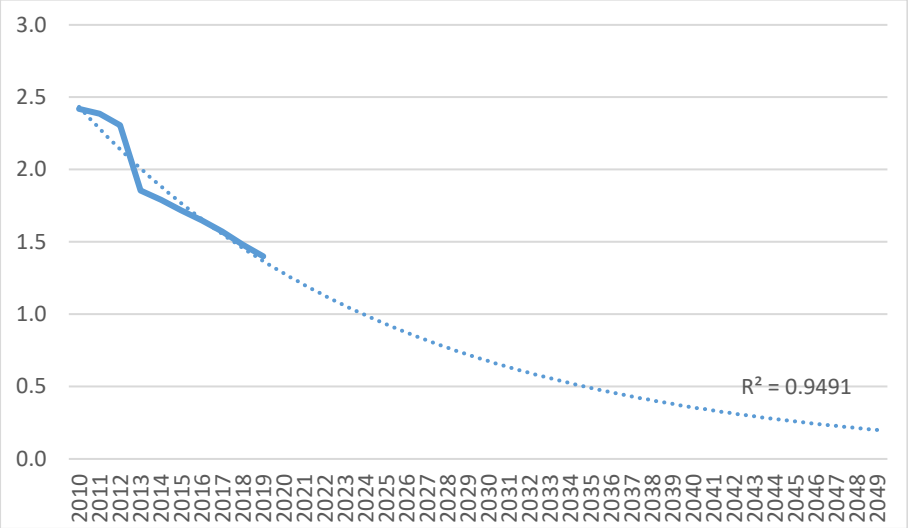

Figure 58: 10 to 14 year-old male cyclist fatality rate per 100,000

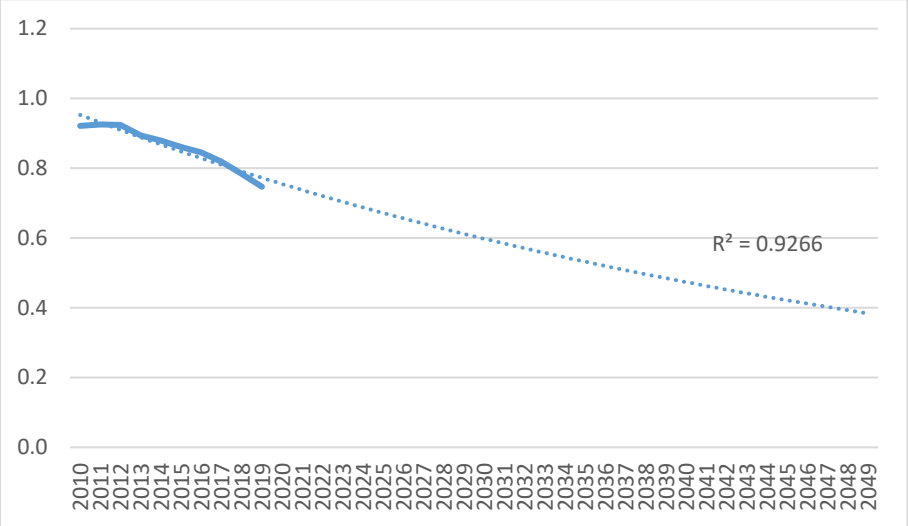

Figure 59: 10 to 14 year-old male motor cyclist fatality rate per 100,000

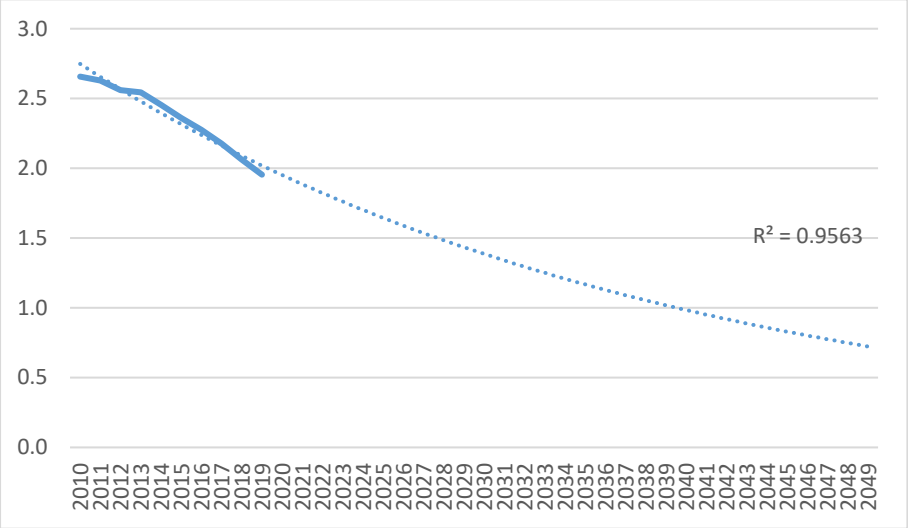

Figure 60: 10 to 14 year-old male motor vehicles fatality rate per 100,000

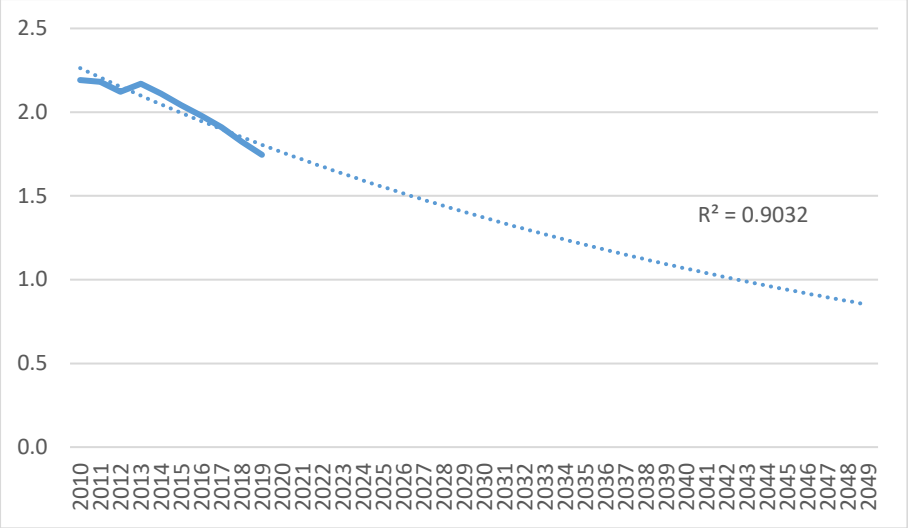

Figure 61: 10 to 14 year-old male other fatality rate per 100,000

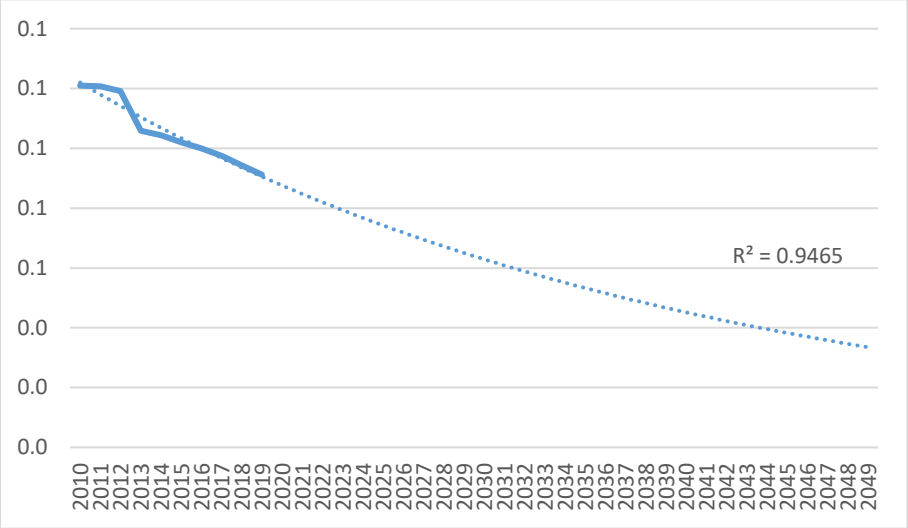

Figure 62: 10 to 14 year-old female pedestrian fatality rate per 100,000

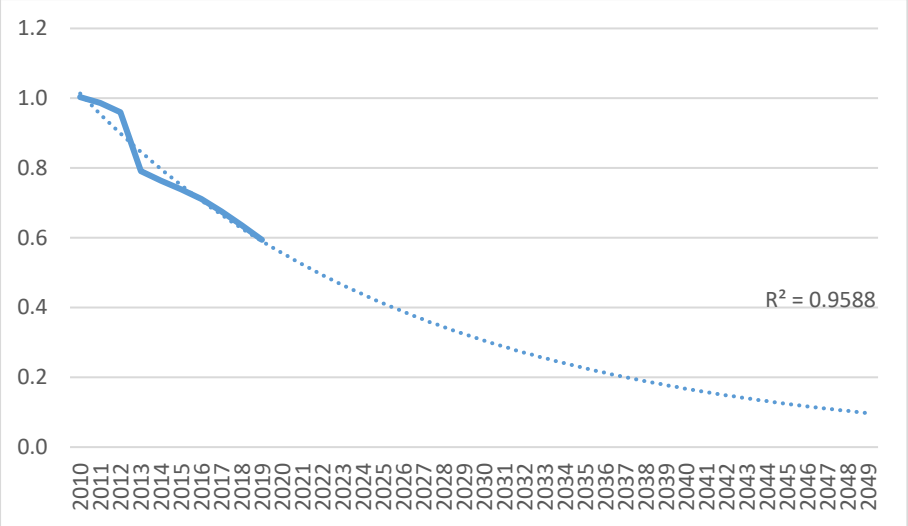

Figure 63: 10 to 14 year-old female cyclist fatality rate per 100,000

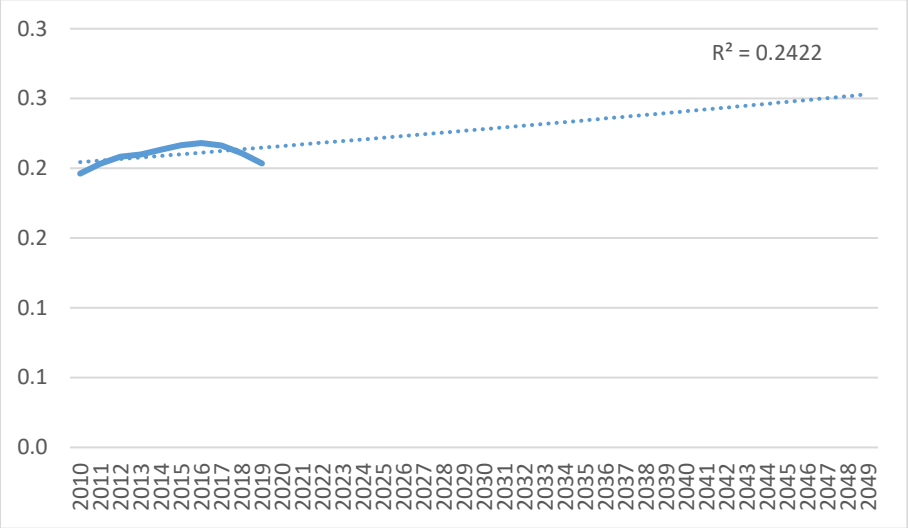

Figure 64: 10 to 14 year-old female motor cyclist fatality rate per 100,000

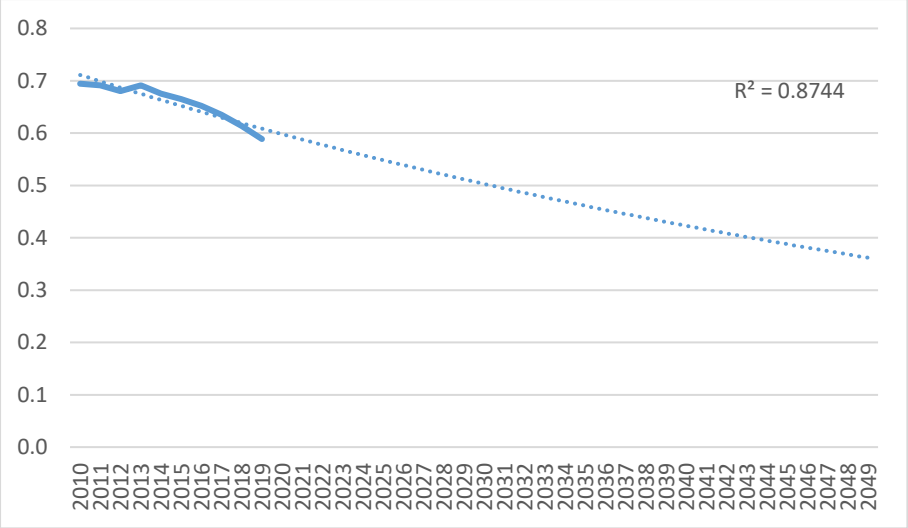

Figure 65: 10 to 14 year-old female motor vehicles fatality rate per 100,000

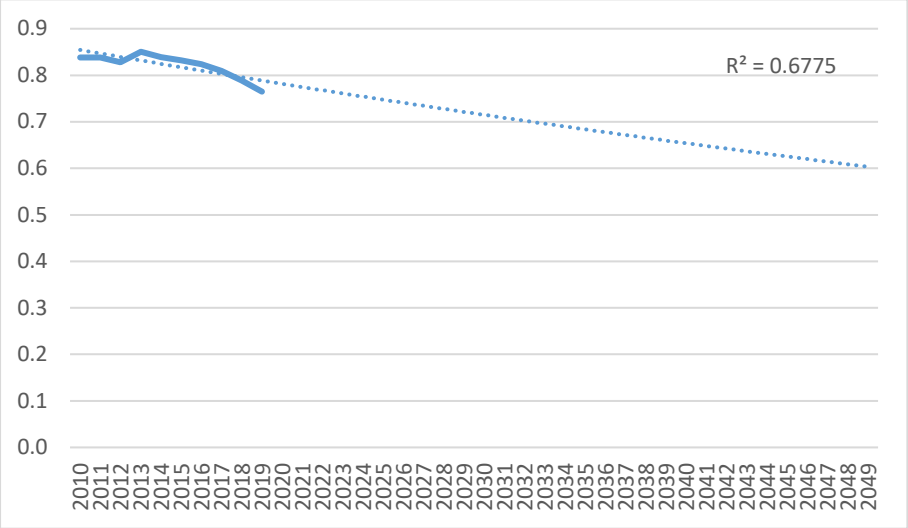

Figure 66: 10 to 14 year-old female other fatality rate per 100,000

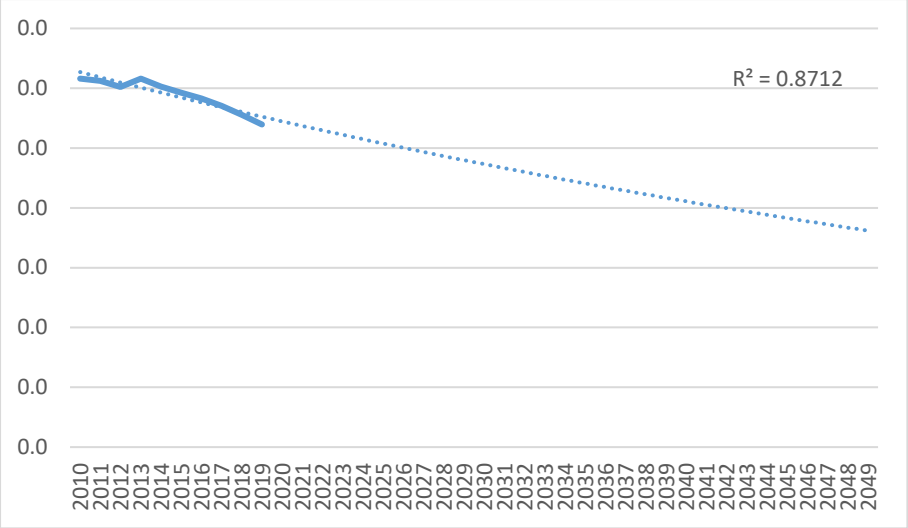

Figure 67: Serious and permanent injury male pedestrians 10 to 14 years old per 100,000

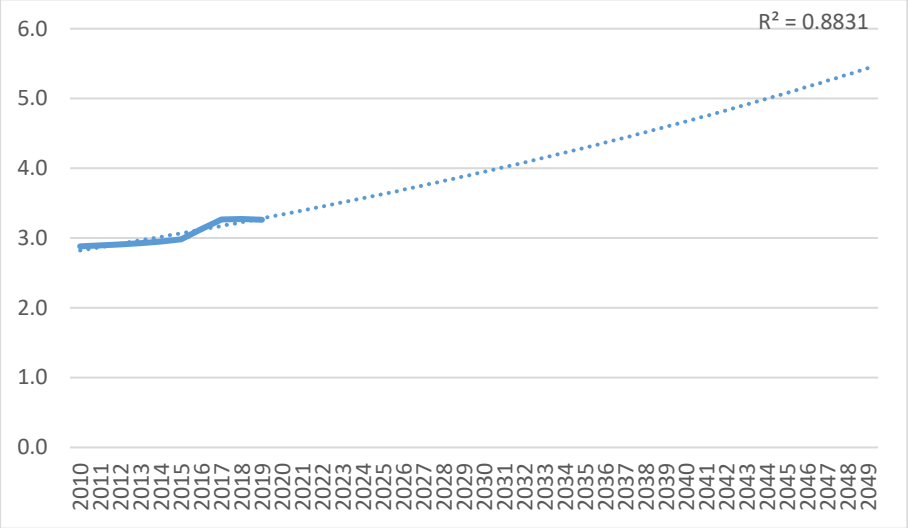

Figure 68: Serious and permanent disability male cyclists 10 to 14 years old per 100,000

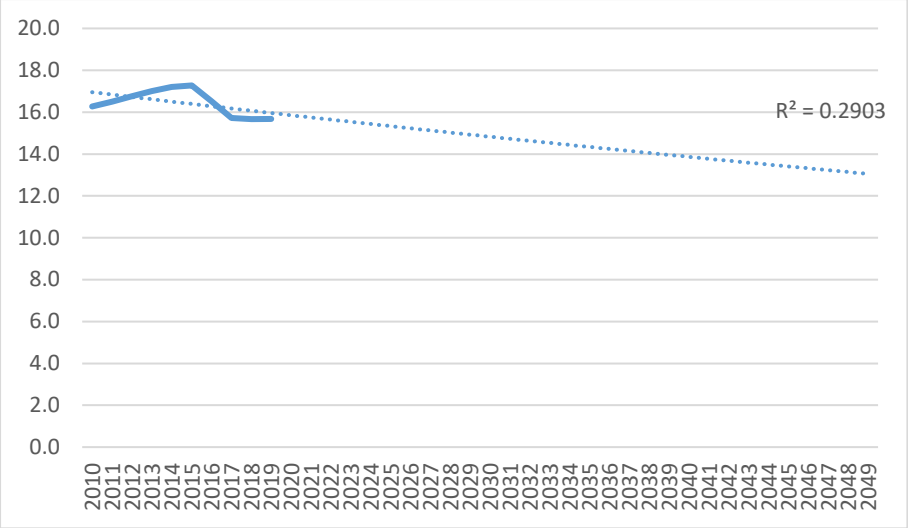

Figure 69: Serious and permanent disability motor cyclists male 10 to 14 years old per 100,000

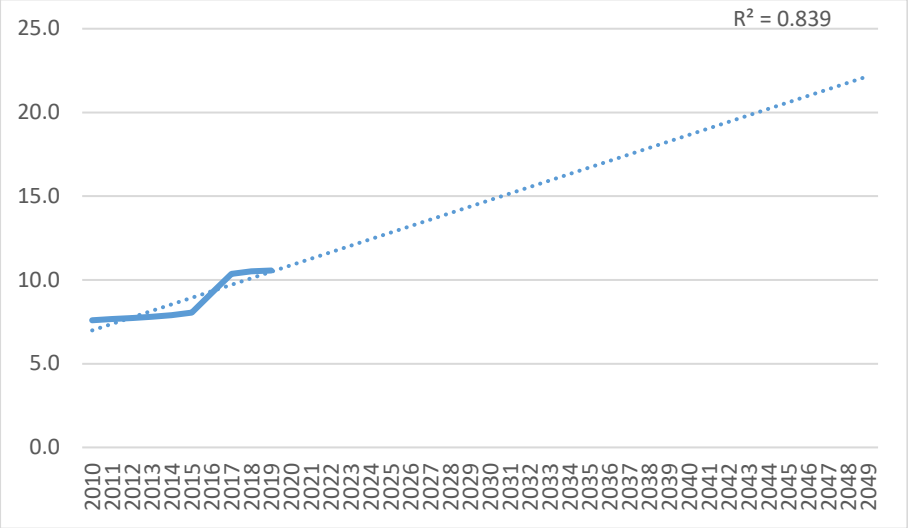

Figure 70: Serious and permanent disability motor vehicles males 10 to 14 years old per 100,000

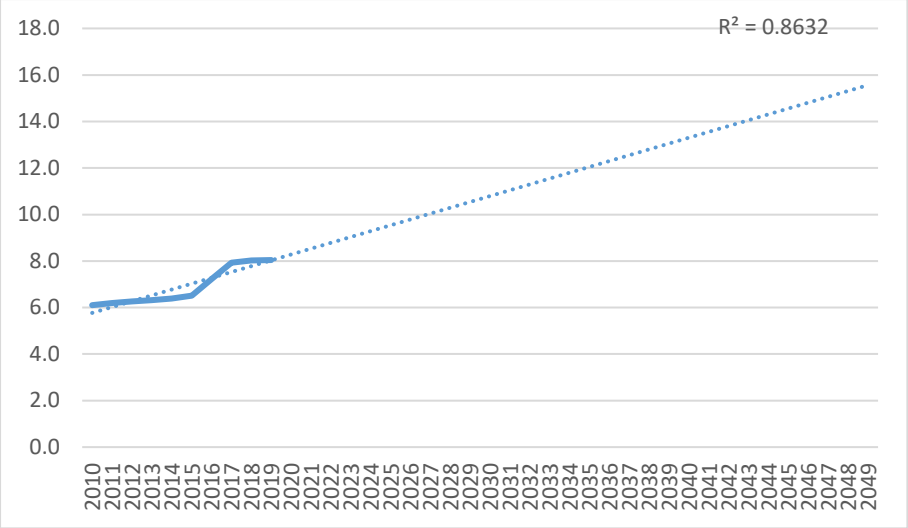

Figure 71: Serious and permanent disability other, males 10 to 14 years old per 100,000

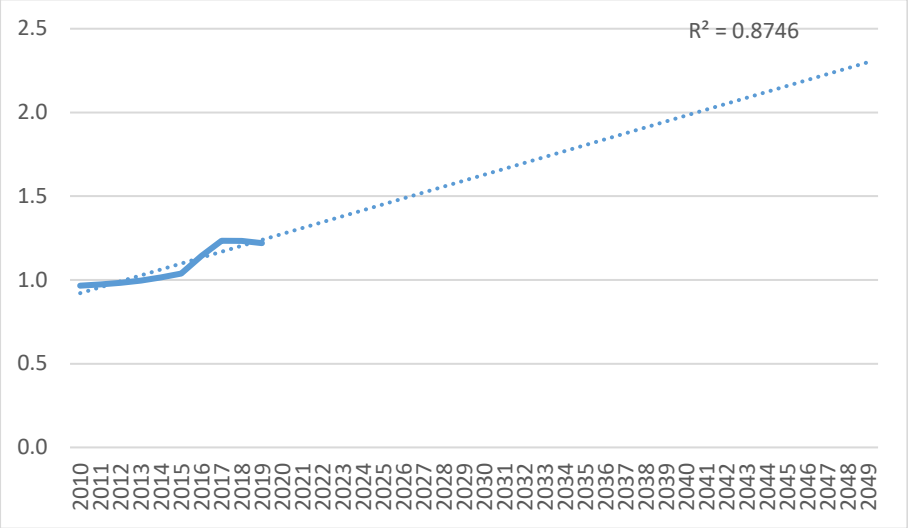

Figure 72: 10 to 14 year-old female pedestrian serious injury rate per 100,000

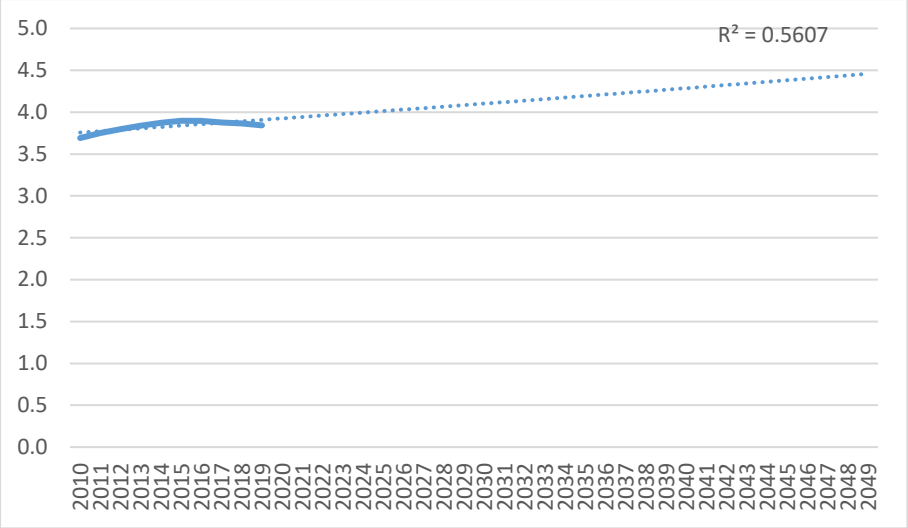

Figure 73: 10 to 14 year-old female cyclists serious injury rate per 100,000

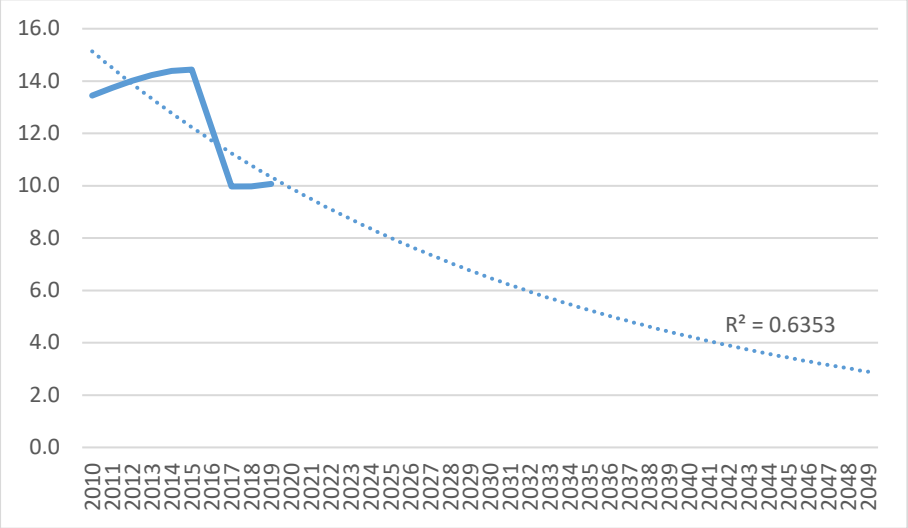

Figure 74: 10 to 14 year-old female motor cyclists serious injury rate per 100,000

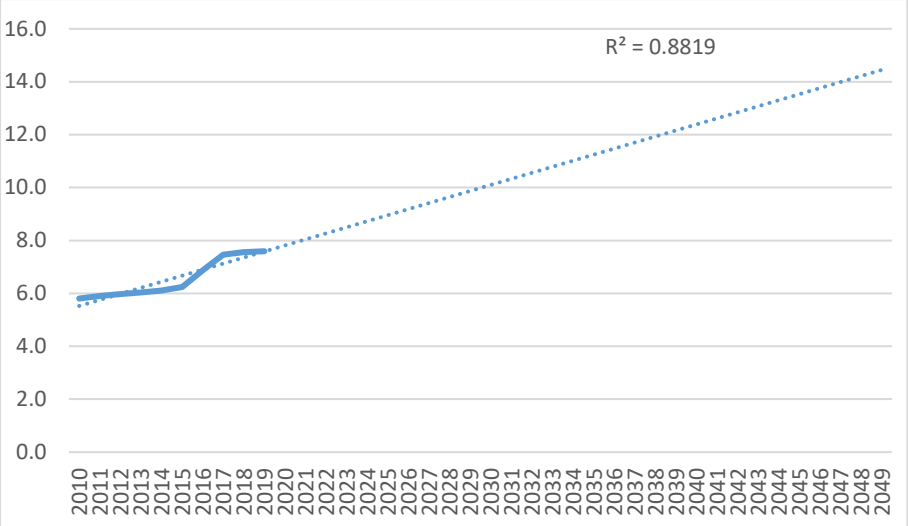

Figure 75: 10 to 14 year-old female motor vehicles serious injury rate per 100,000

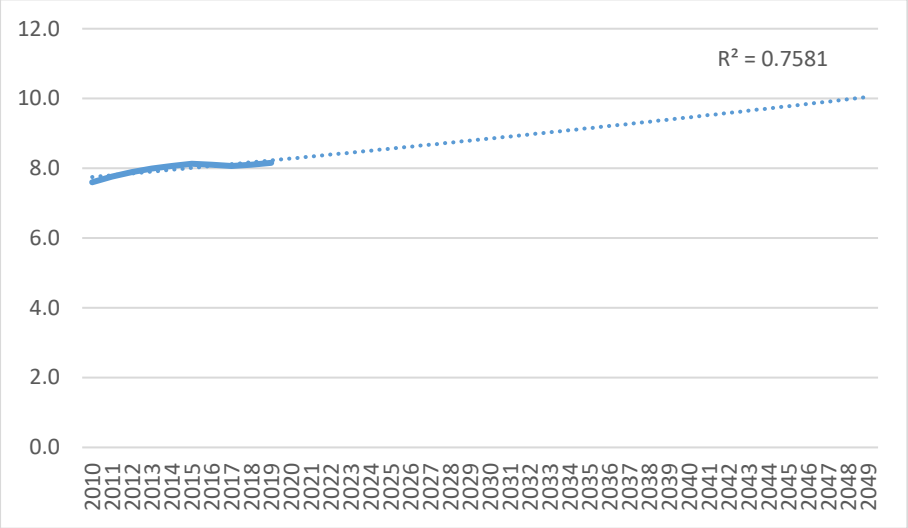

Figure 76: 10 to 14 female other serious injury rate per 100,000

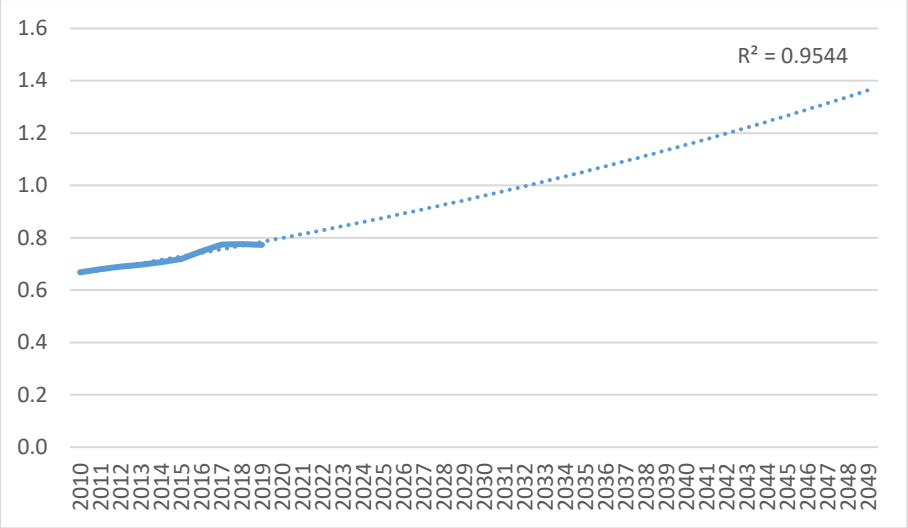

Figure 77: 15 to 19 year-old male pedestrian fatality rate per 100,000

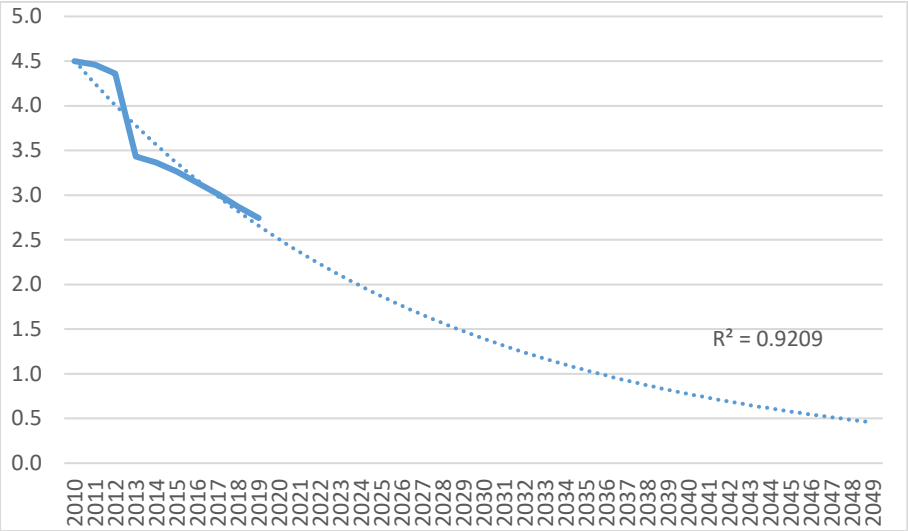

Figure 78: 15 to 19 year-old male cyclists fatality rate per 100,000

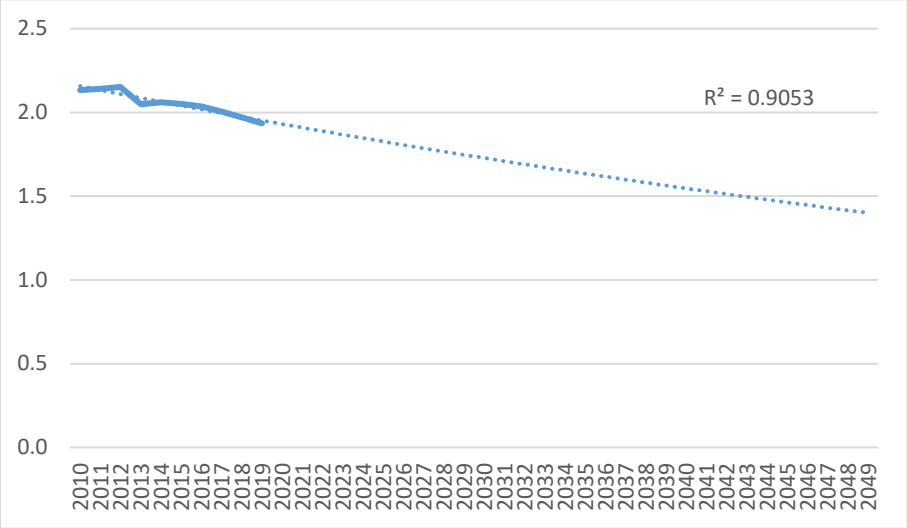

Figure 79: 15 to 19 year-old male motor cyclists fatality rate per 100,000

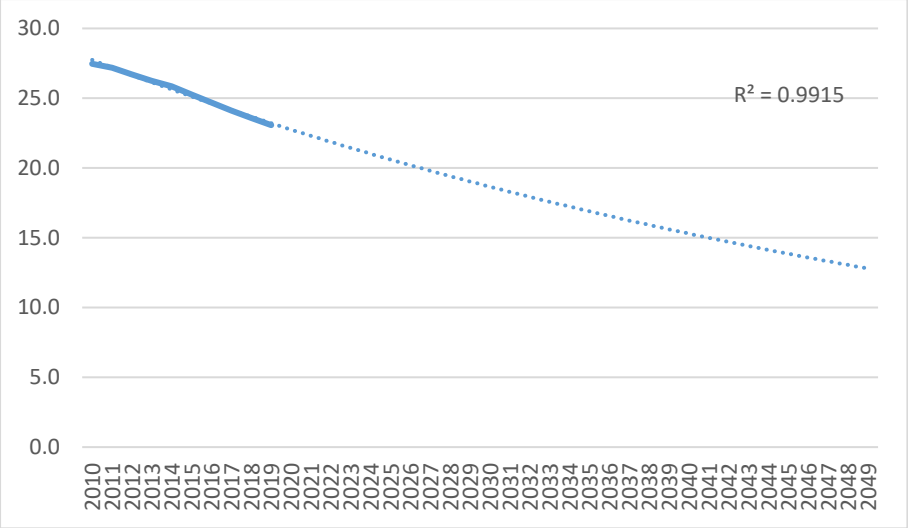

Figure 80: 15 to 19 year-old male motor vehicles fatality rate per 100,000

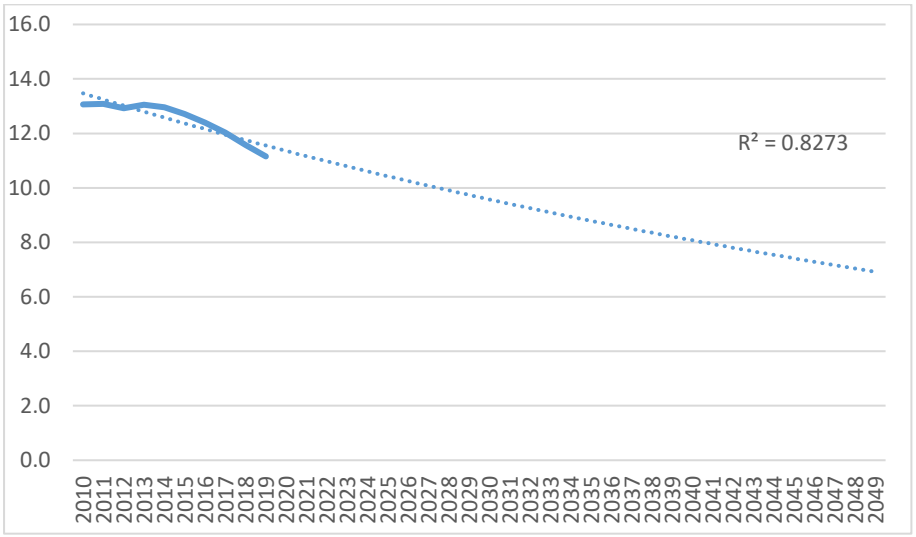

Figure 81: 15 to 19 year-old male other fatality rate per 100,000

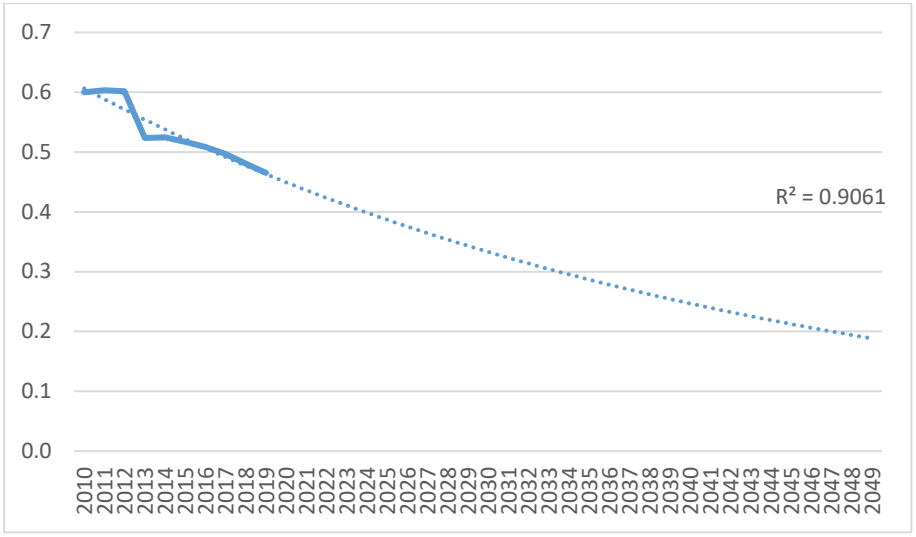

Figure 82: 15 to 19 year-old female pedestrian fatality rate per 100,000

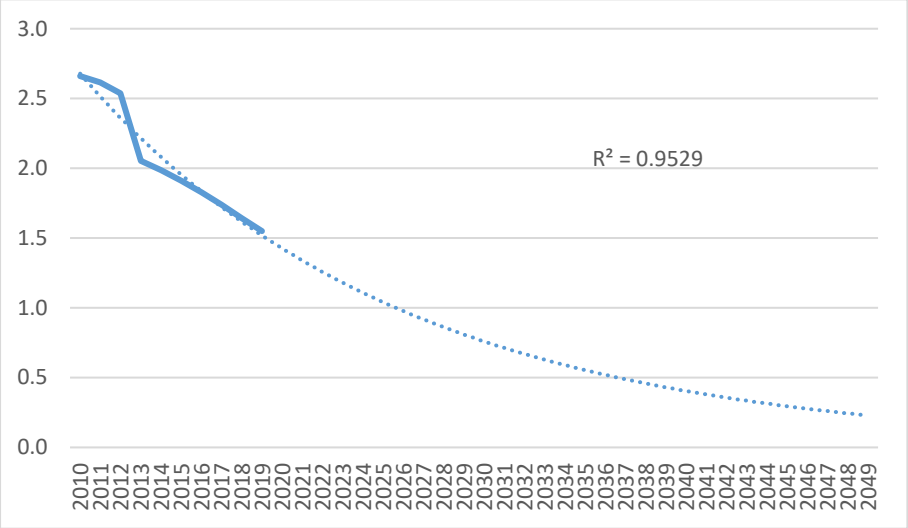

Figure 83: 15 to 19 year-old female cyclists fatality rate per 100,000

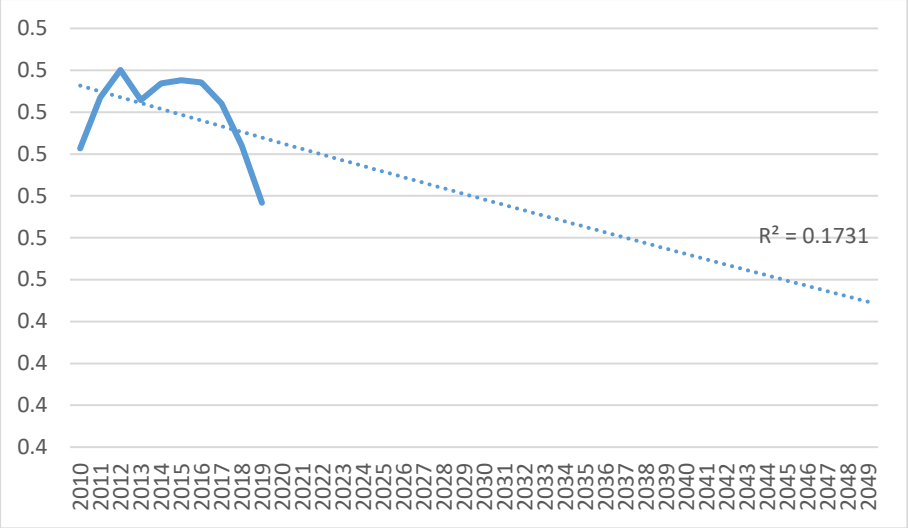

Figure 84: 15 to 19 year-old female motor cyclists fatality rate per 100,000

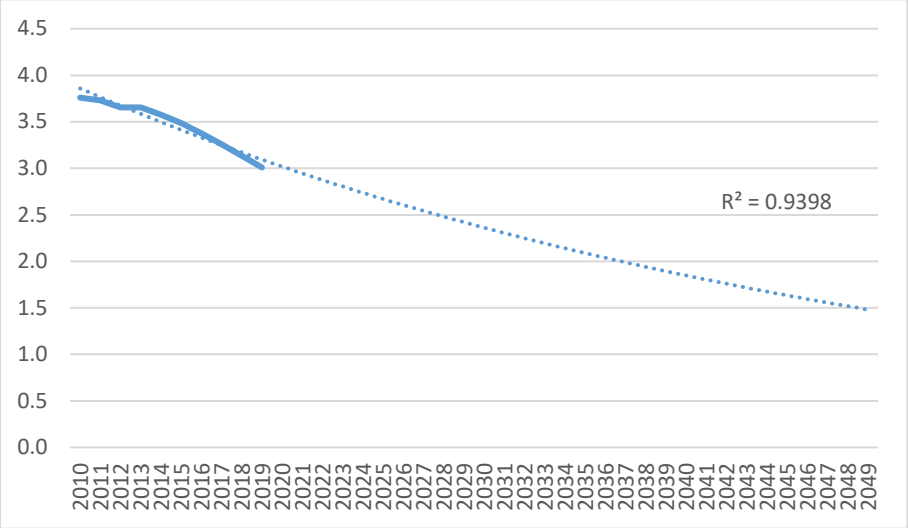

Figure 85: 15 to 19 year-old female motor vehicles fatality rate per 100,000

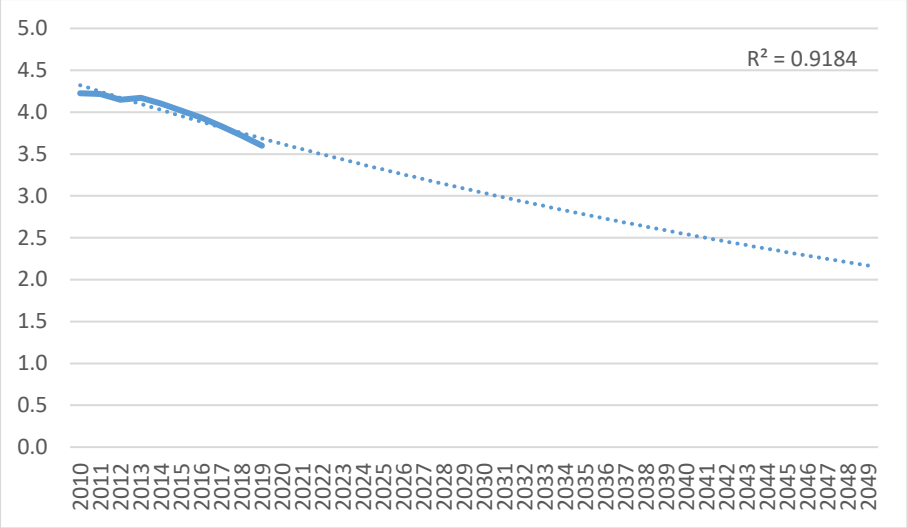

Figure 86: 15 to 19 year-old female other fatality rate per 100,000

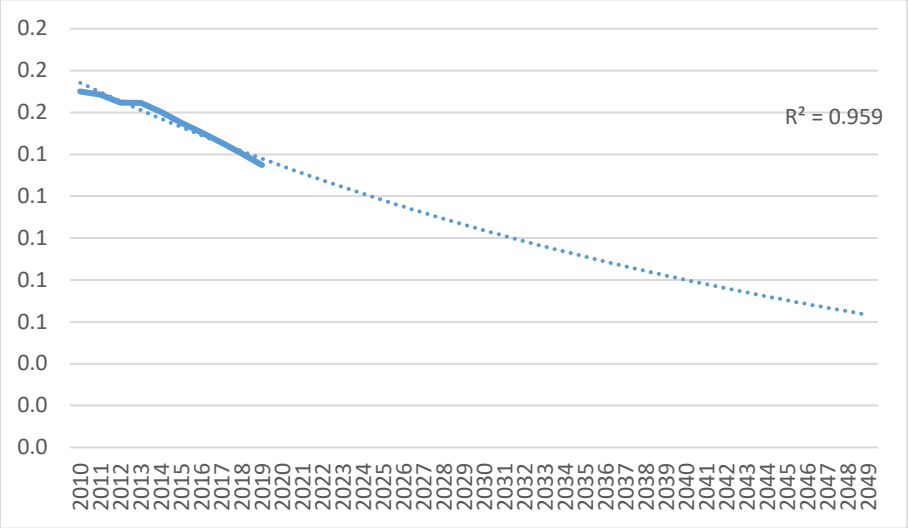

Figure 87: 15 to 19 year-old male pedestrian serious injury rate per 100,000

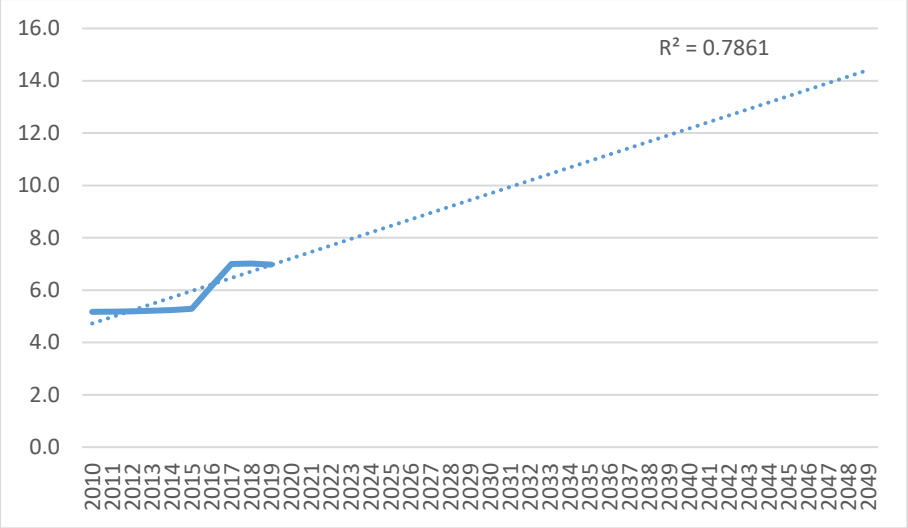

Figure 88: 15 to 19 year-old male cyclists serious injury rate per 100,000

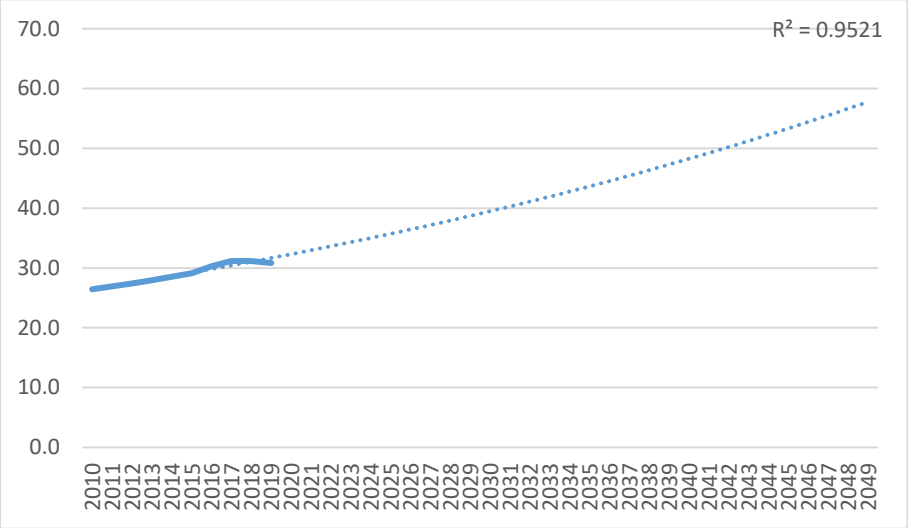

Figure 89: 15 to 19 year-old male motor cyclists serious injury rate per 100,000

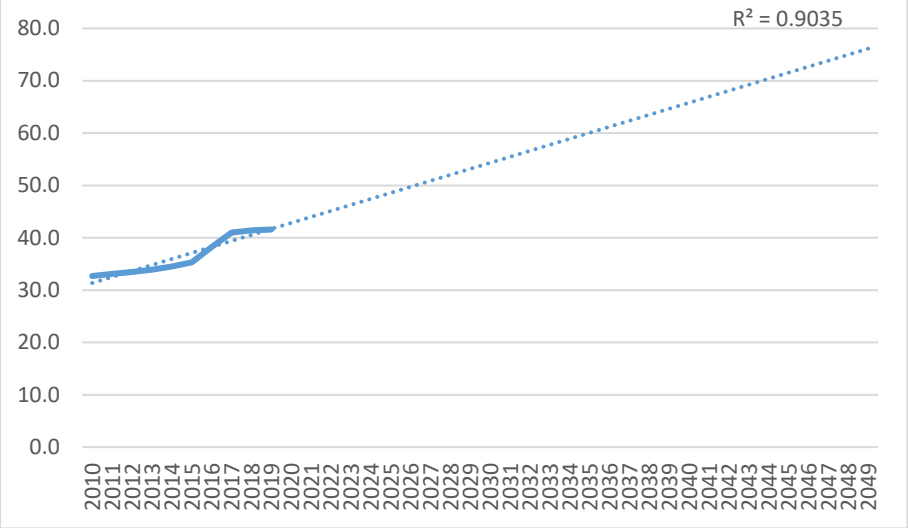

Figure 90: 15 to 19 year-old male motor vehicles serious injury rate per 100,000

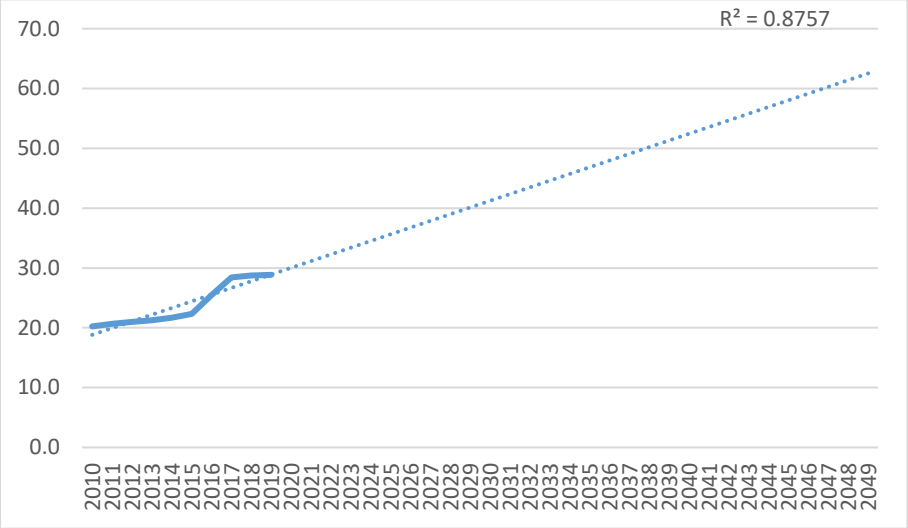

Figure 91: 15 to 19 year-old male other serious injury rate per 100,000

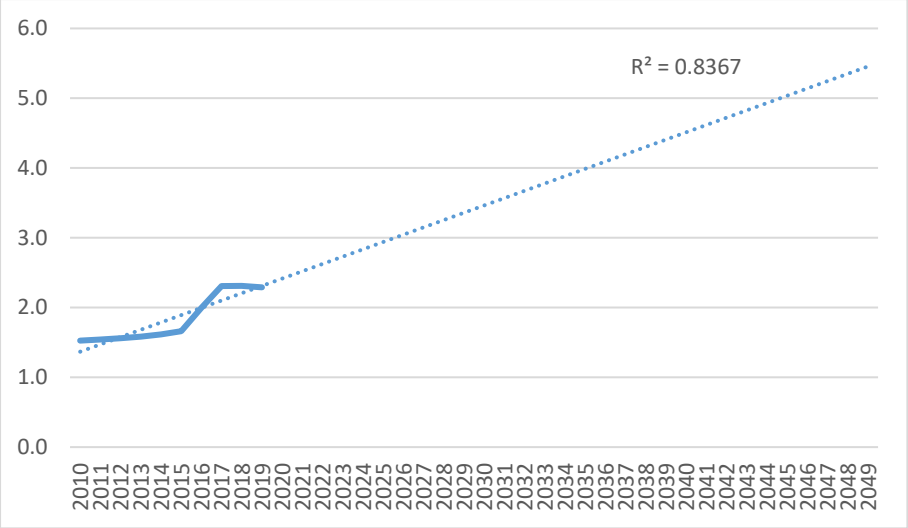

Figure 92: 15 to 19 year-old female pedestrian serious injury rate per 100,000

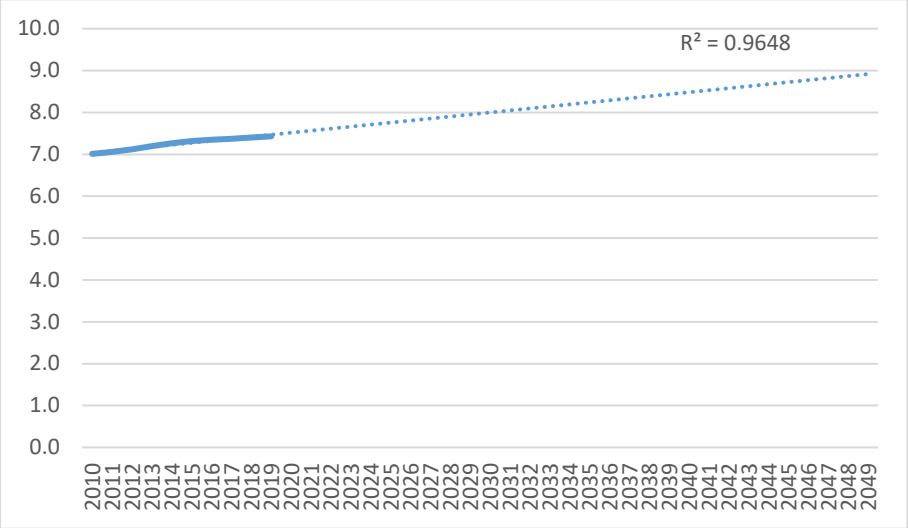

Figure 93: 15 to 19 year-old female cyclists serious injury rate per 100,000

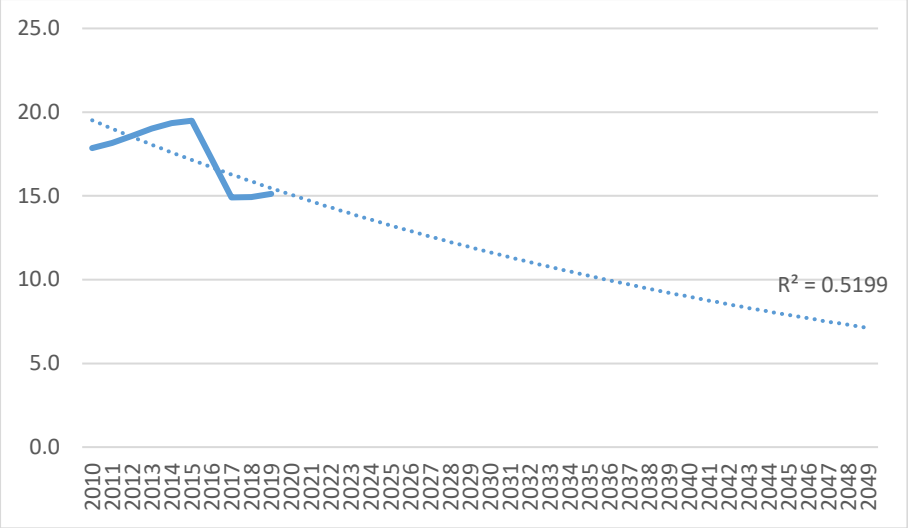

Figure 94: 15 to 19 year-old female motor cyclists serious injury rate per 100,000

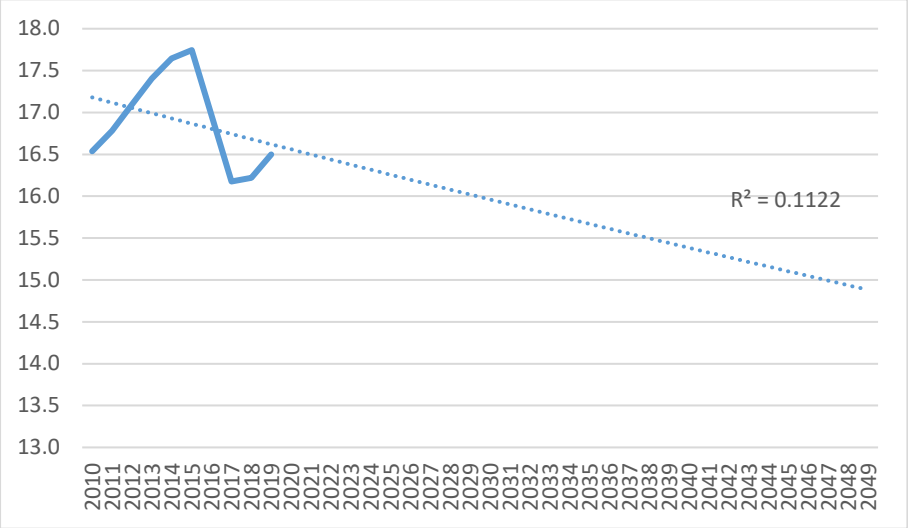

Figure 95: 15 to 19 year-old female motor vehicles serious injury rate per 100,000

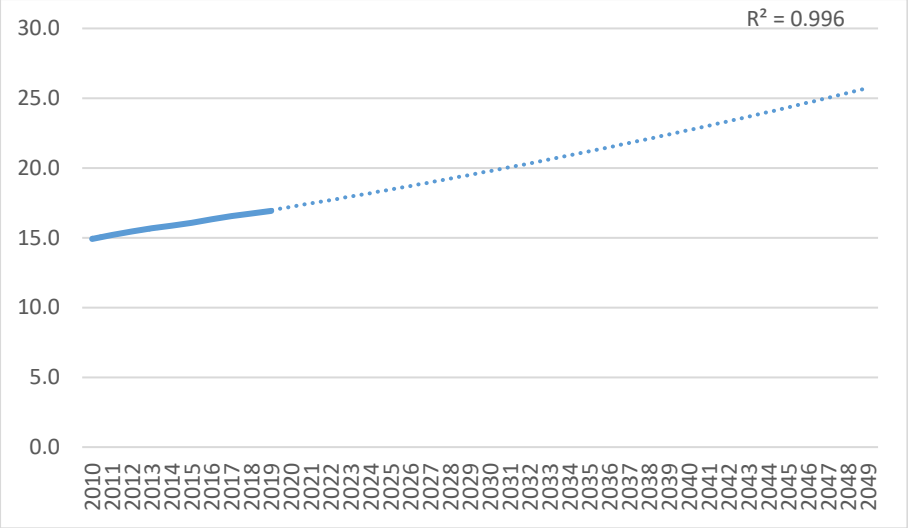

Figure 96: 15 to 19 year-old female other serious injury rate per 100,000

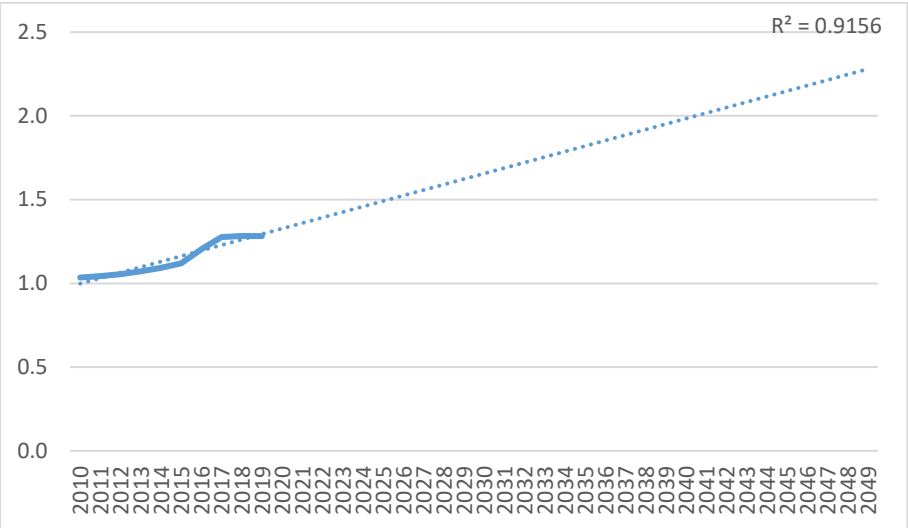

Figure 97: 20 to 24 year-old male pedestrian fatality rate per 100,000

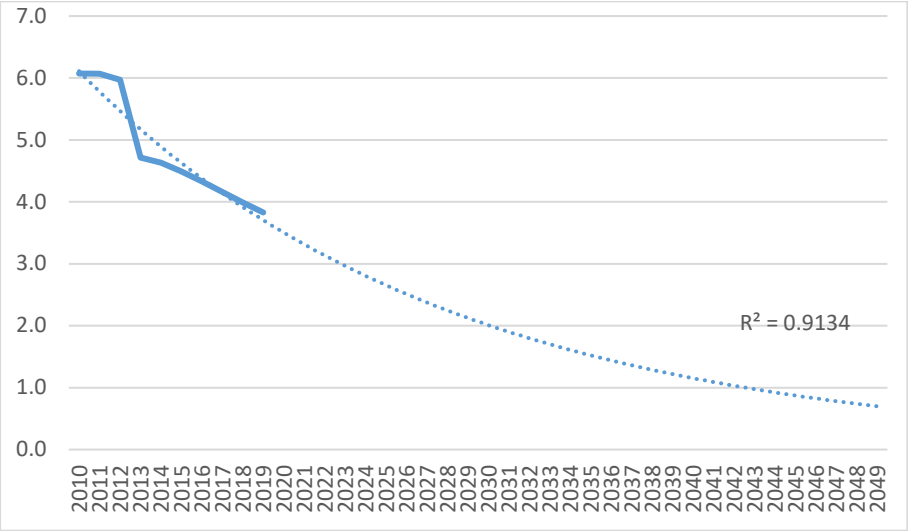

Figure 98: 20 to 24 year-old male cyclists fatality rate per 100,000

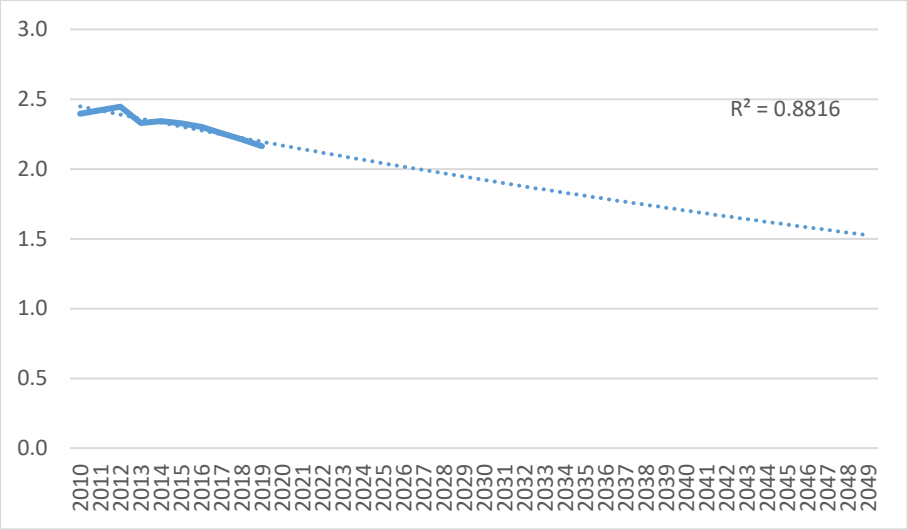

Figure 99: 20 to 24 year-old male motor cyclists fatality rate per 100,000

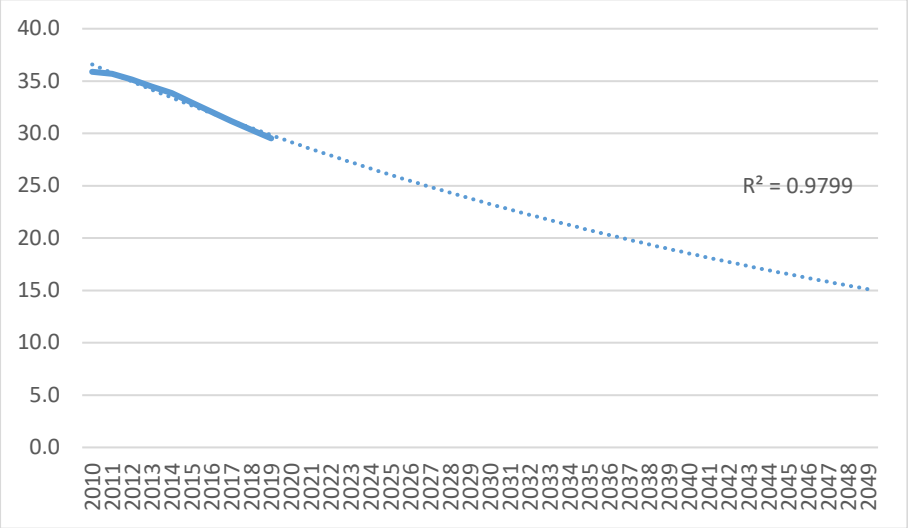

Figure 100: 20 to 24 year-old male motor vehicles fatality rate per 100,000

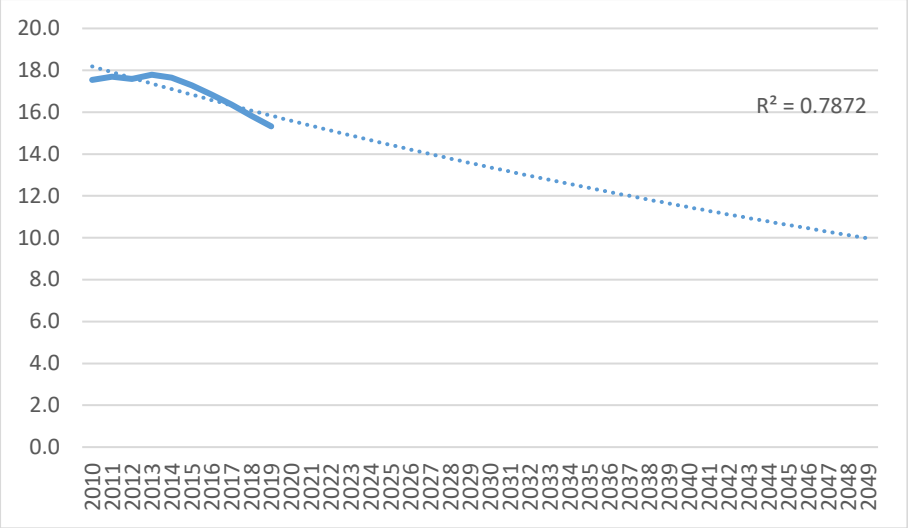

Figure 101: 20 to 24 year-old male other fatality rate per 100,000

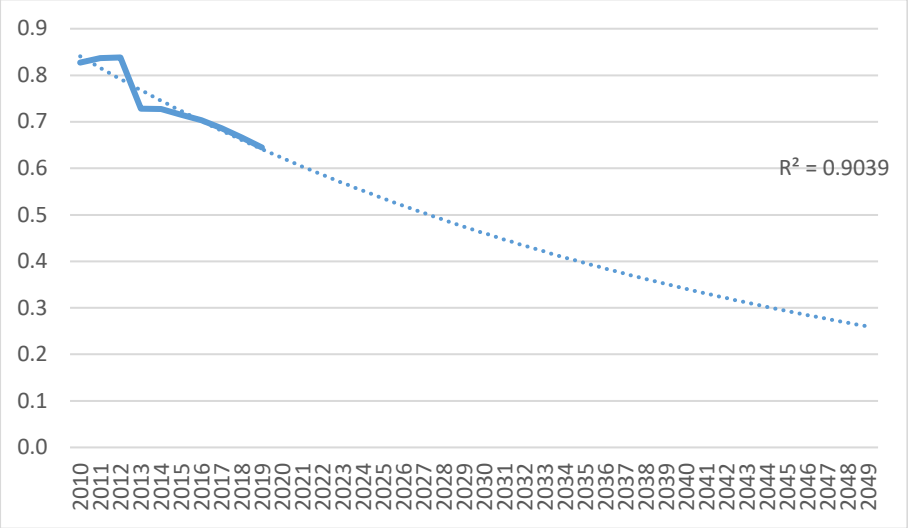

Figure 102: 20 to 24 year-old female pedestrian fatality rate per 100,000

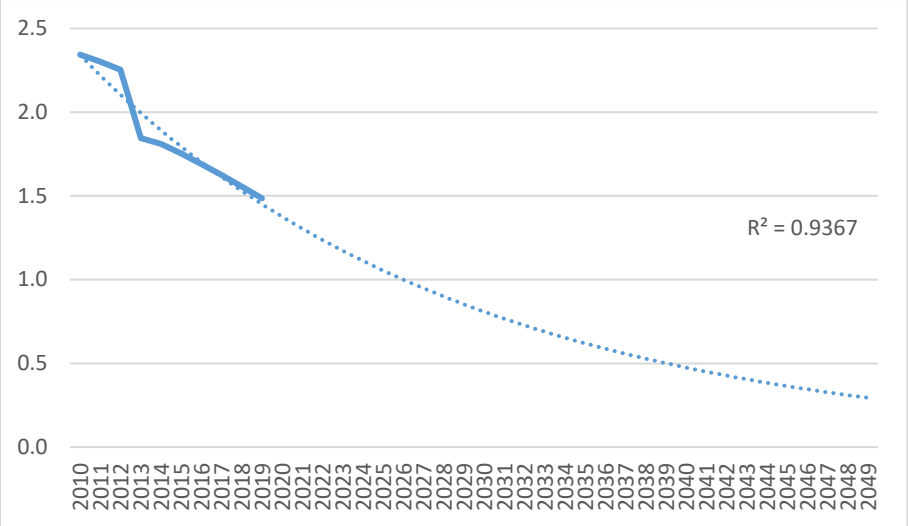

Figure 103: 20 to 24 year-old female cyclists fatality rate per 100,000

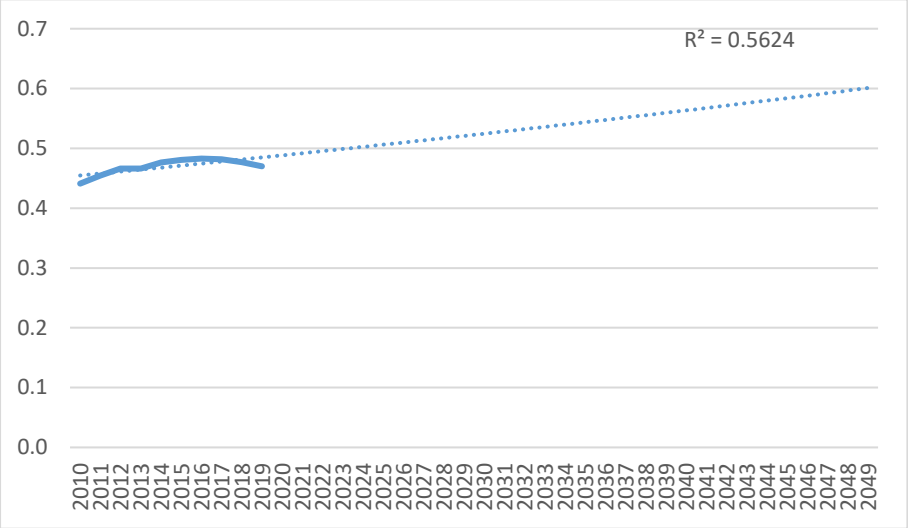

Figure 104: 20 to 24 year-old female motor cyclists fatality rate per 100,000

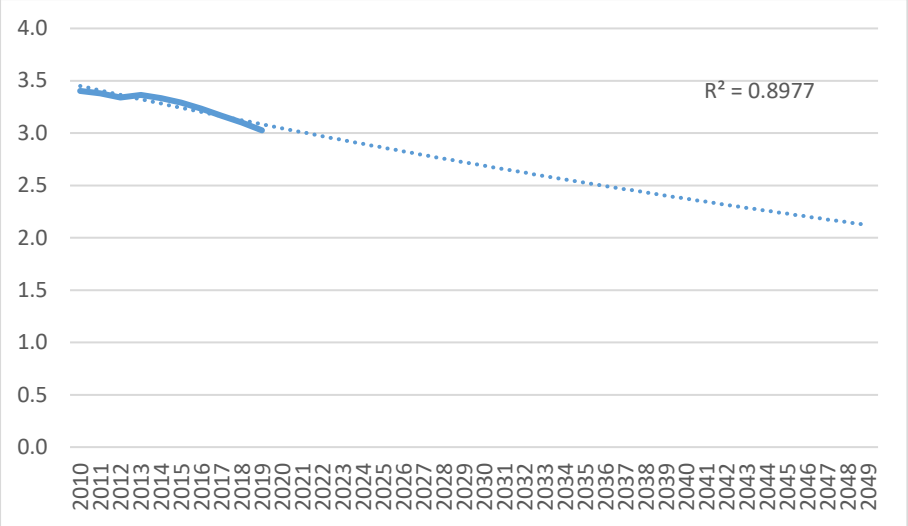

Figure 105: 20 to 24 year-old female motor vehicles fatality rate per 100,000

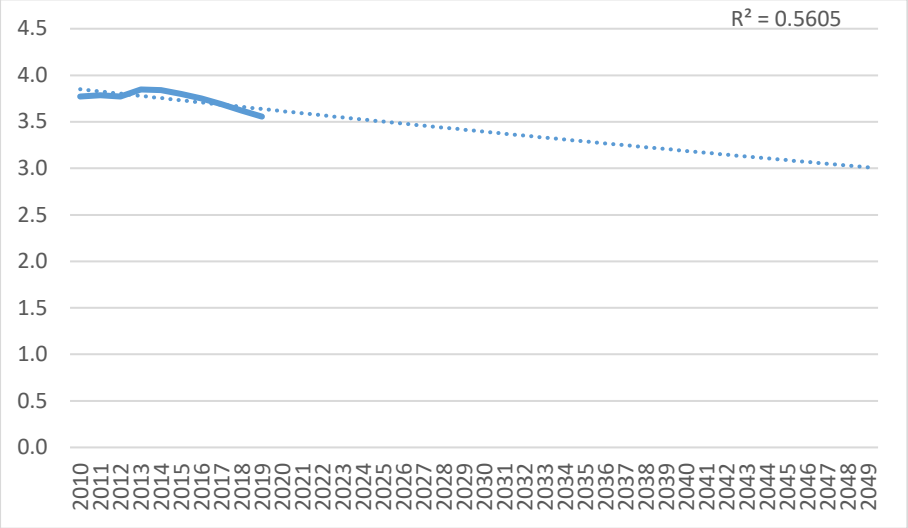

Figure 106: 20 to 24 year-old female other fatality rate per 100,000

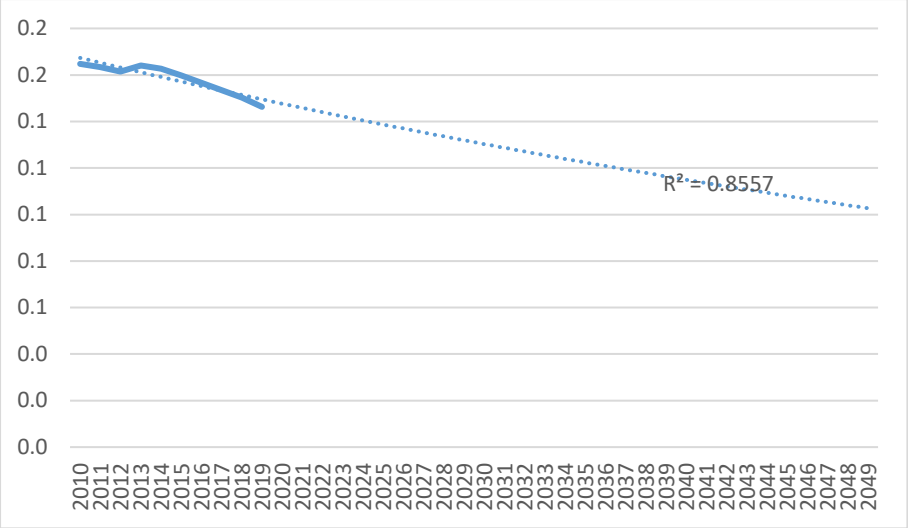

Figure 107: 20 to 24 year-old male pedestrian serious injury rate per 100,000

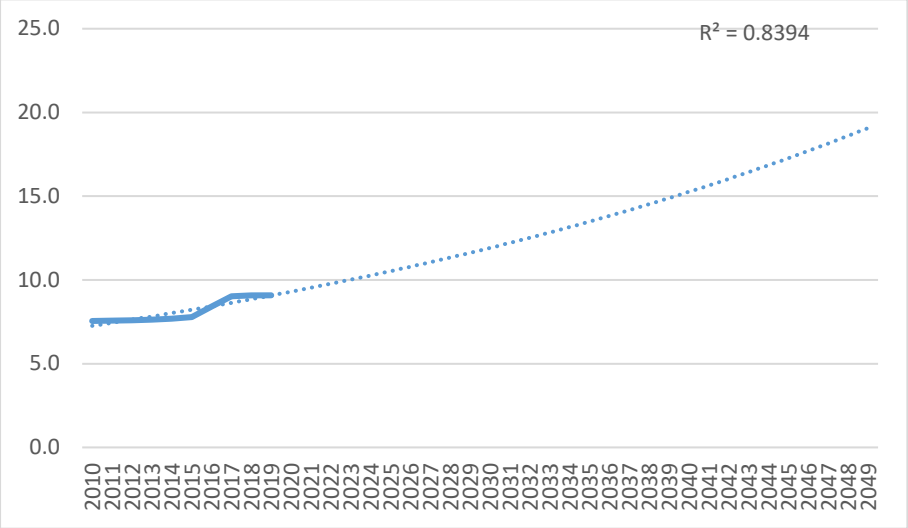

Figure 108: 20 to 24 year-old male cyclists serious injury rate per 100,000

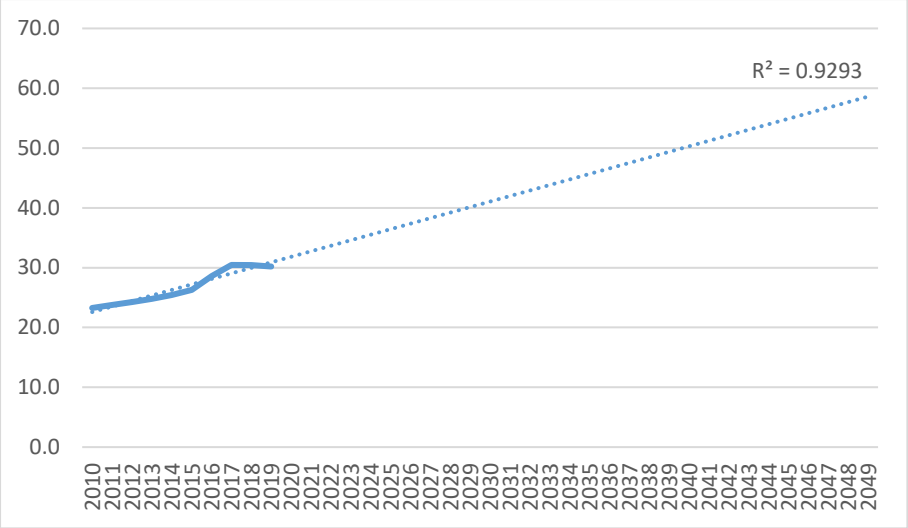

Figure 109: 20 to 24 year-old male motor cyclists serious injury rate per 100,000

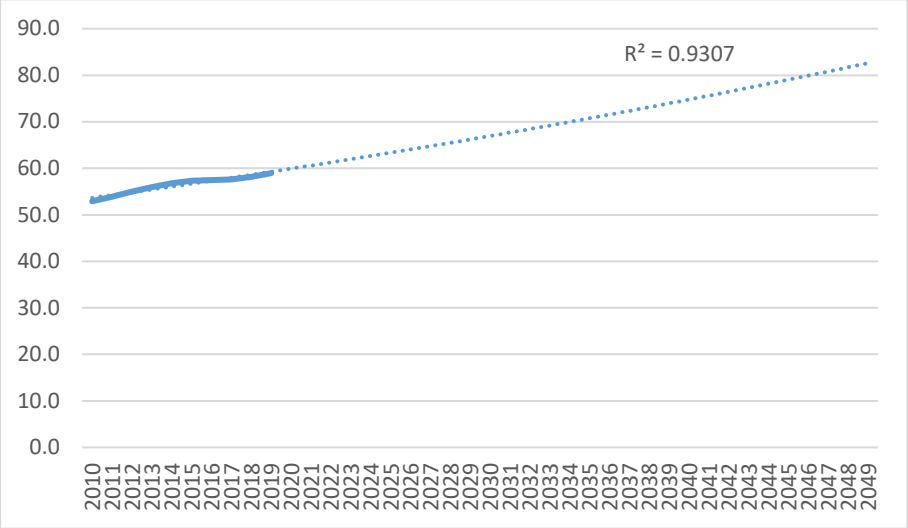

Figure 110: 20 to 24 year-old male motor vehicles serious injury rate per 100,000

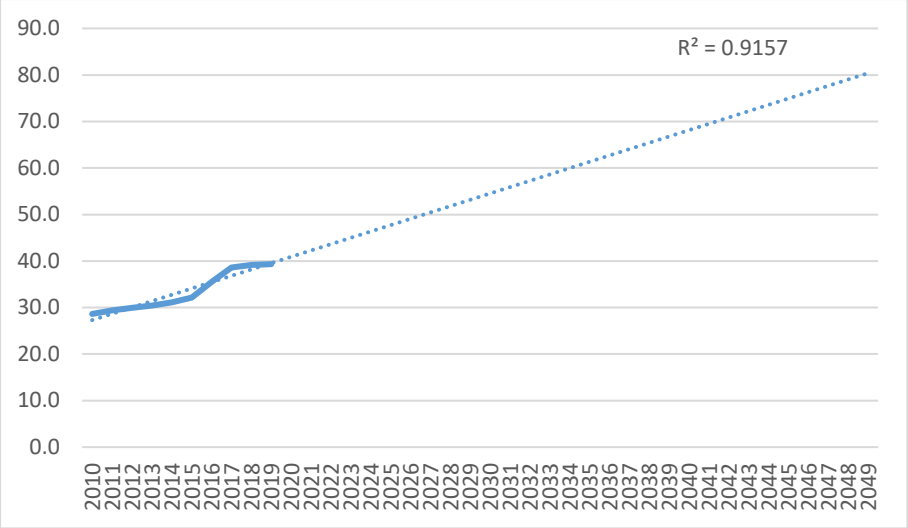

Figure 111: 20 to 24 year-old male other serious injury rate per 100,000

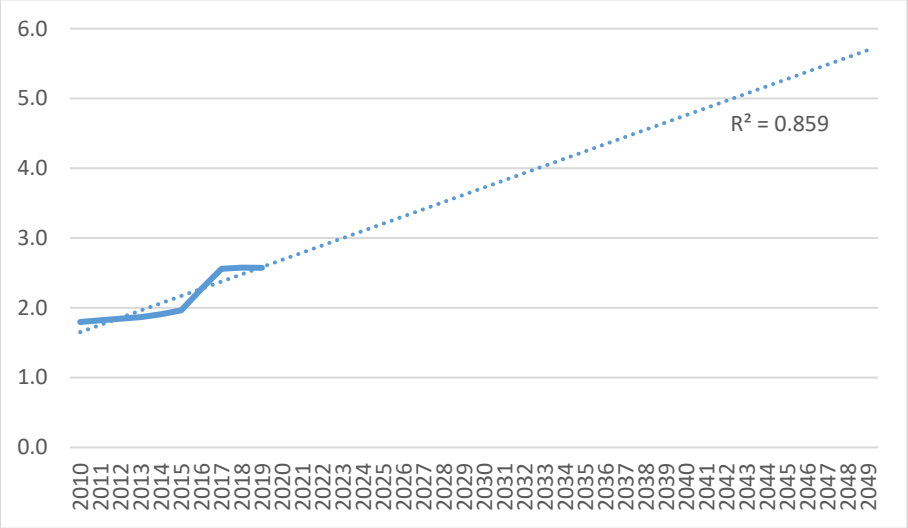

Figure 112: 20 to 24 year-old female pedestrian serious injury rate per 100,000

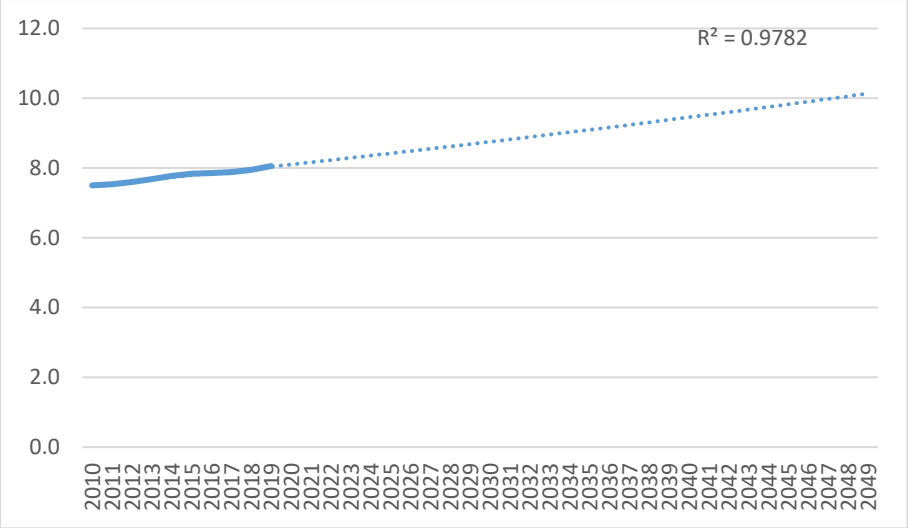

Figure 113: 20 to 24 year-old female cyclists serious injury rate per 100,000

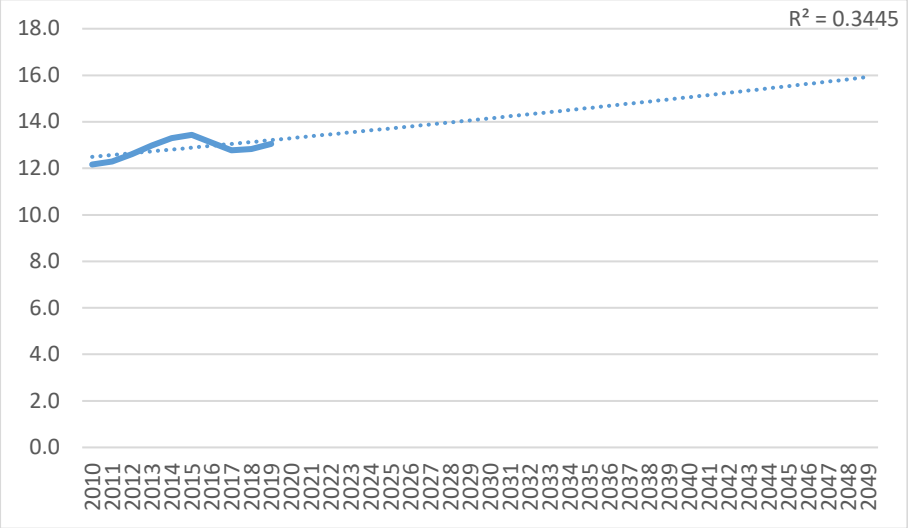

Figure 114: 20 to 24 year-old female motor cyclists serious injury rate per 100,000

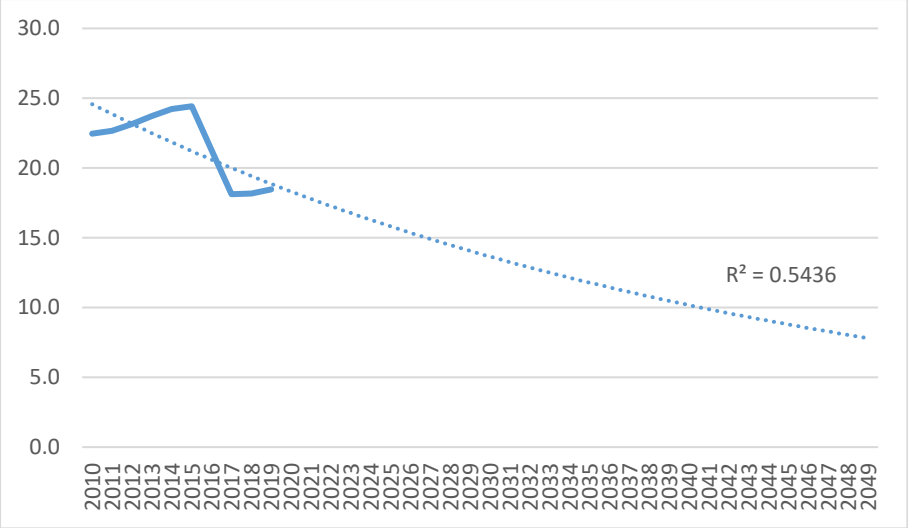

Figure 115: 20 to 24 year-old female motor vehicles serious injury rate per 100,000

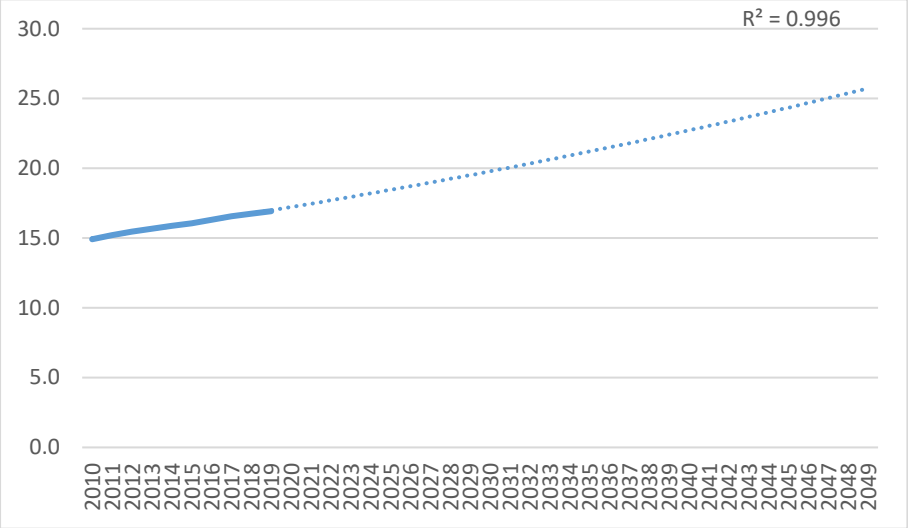

Figure 116: 20 to 24 year-old female other serious injury rate per 100,000