

Crash Fatality Trends in WHO Eastern Mediterranean Region During 1980 - 2014

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Abstract

WHO-Eastern Mediterranean Region (EMR) covers 627 million inhabitants and 98 million vehicles. This study aims to estimate and analyze the road crash deaths in EMR during the past 35 years by compiling the data for each country within the region. The crash fatalities are mainly adjusted and modelled for underreporting, death definition differences and missing data. The data are gathered from official sites, fact books, international databases, extensive literature, web search, and personal communications. The developed models employed simple deterministic time series by employing curve fitting regression and scattered diagrams. The sum of crash deaths in the region followed continuous increasing trends. The recorded traffic crash deaths increased about two and a half times between 1980 and 2011. The adjusted crash deaths during 2013 and 2014 showed precedence records close to 99,000. The estimated crash death represents just 60% of that reported in EMR Status Report on Road Safety. The crash deaths for the year 2025 are expected to increase by 15% compared with 2014. The fatality rate per vehicles showed continuous descending patterns. Such positive trends might be deceiving in the absence of exposure rate. The fatality rates per population showed highly fluctuated conditions with no regressed model fitting the data well. The current adjusted fatality rates are far above the norms compared with the developed countries. The patterns in various sub-EMR showed clear diversities between them. Such poor safety records require careful reading, a proper interpretation of the results, and extensive research.

Keywords: Crash fatalities; Under-reporting; Death definition; Death rates; Eastern Mediterranean region

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Introduction

The World Health Organization (WHO) Eastern Mediterranean region (EMR) consists of 22 countries. The region holds the highest crash death rates worldwide, as reported by its Regional Director [1]. To investigate such a statement in more elaborate and liberal ways, long-term crash death data need to be searched since such data provide better understanding of past trends, improve perception of the current state, forecast more accurate future predictions, distribute health resources on various health sectors in just manners, and lead to employment of efficient and practical counter plans. However, gathering historical crash fatality and vehicle fleet data for the 22 countries within the region require extensive effort. In fact, compiling such huge data for the region and adjusting them for various corrective factors are by themselves an added scientific effort since the region lacks such data for prolonged period.

The road injury death data for the Eastern Mediterranean countries are carefully refined and corrected for several factors; such as underreporting, gaps in gathered data within a country, countries with very few historical data, calendar year, and 30 days' death definition. Underreporting of traffic crash deaths include those deaths that occurred but have not been reported in official statistics. This is the dominating factor in adjusting the official data.

Many experts acknowledged the presence of under-reporting, for many years, as an important reason for the difficulty in comparing road crash deaths between countries [2]. Accurate adjustments to the reported traffic deaths are extremely difficult, except for few developed countries, due to the lack of proper data, limited researches, intensive time needed to gather the necessary data, and excessive efforts needed to accumulate such data. Though several researchers as Lateef, Janstrup and Samuel et al. utilized

the capture and recapture technique to adjust their countries' official traffic death estimate, yet the method does not consider death cases that are not reported at all. Other indirect methods lack accuracy for the same reason [3-5].

The WHO adjusted the road death for some countries based on modelled data for other countries, due to the lack of data which is acceptable in the absence of any other justifiable method, but still requires further investigations for the accuracy of the technique employed. Studies based on crash fatality and vehicle fleet data for the 22 countries within the EMR considering a long period of time are very scarce, if any, and yet to be searched well. Many reasons explain for such scarcity are explained by Al-Madani [6-8]. However, without such data, any forecasts might be misleading from a statistical approach.

A range of adjusted global traffic crash death, with a low and a high estimate, is a useful option in the absence of the necessary adjustment factors. Jacobs, Aeron-Thomas, Britain and Astrop utilized a range of minimum and maximum factors to estimate the global traffic crash death for a year [9,10]. Such a range is especially useful when a study covers a considerable number of years. In support to the earlier argument, several studies indicated that underreporting varies with time. For example, Salifu and Ackaah found a significant drop in underreporting in Ghana during 2004 compared with 1998 [11,12].

Jacobs and Aeron-Thomas found underreporting percentages of traffic crash deaths to be highly variable between one region and another. However, it is very difficult to have a just estimate for adjustment percentages without extensive research for the dominant countries [7,8].

Objectives and study approach

The road crash deaths during the past three and a half decades in WHO Eastern Mediterranean Region is estimated and analyzed considering the data for 22 countries within the region. The analysis is extended to cover 5 sub-regions within EMR. The study also models the recorded and the adjusted crash deaths to forecast future road crash mortalities. The crash fatalities are adjusted for underreporting, death definition differences and missing data. The models are developed through parametric time series employing curve fitting. Consequently, the models forecast the crash death for the year 2025 utilizing the data for the period from 1998 to 2014. The employed models utilize linear, polynomial, exponential, logarithmic, moving average, and power models. No sophisticated parametric or nonparametric modelling techniques were necessary due to the simplicity of the data sequence, treatment of missing data, and controlling the assumptions. Parametric regression analysis is performed since the functional pattern of the relationship may roughly be distinguished. Those based on nonparametric models, as Neural Networks, require extensive data to structure the forecasting model and the estimates. As a result, they are useful when the shape is complicated, unknown, the relationship of one predictor depends on another(s), and the predictors are either quantitative or binary. Furthermore, smoothing spline estimates add to the uncertainty of the estimate due to added auxiliary assumption as

well [13]. All these lead to the use of the parametric curve fitting regression.

EMR is subcategorized into the following five sectors: Arabian Peninsula covering six Gulf Cooperation Council (GCC) countries and Yemen, North-West Africa covering Morocco, Tunisia, and Libya, North-East Africa covering Egypt, Sudan, Somalia, and Djibouti, North-West Asia covering Jordan, Lebanon, Syria, Iraq, and Palestine, and South-West Asia covering Iran, Pakistan, and Afghanistan.

The study compiles the data from a very large number of sources as official reports, renowned and well-known international databases, personal communications, and research literature [7,8]. The procedure in building-up the database considers the following steps: countries official records takes the priority in the data selection, provided the selected data follows a logical sequence and do not contradict with the scientific rationale or with other more convincing and well-searched sources as dissertations. Wherever possible, the data from other sources are crosschecked with official records. Ambiguous and contradicting records were double-checked utilizing other data sources. Otherwise, they are excluded from the database. The procedure in building up the database, which is the real backbone of the study, is presented in more details by Al-Madani [7].

The adjustments to the road mortalities mainly cover two basic parameters; underreporting of traffic mortalities and number of days within which a death occurs for each country. There is no specific criterion to follow in assigning adjustment values, especially when one realizes that such adjustments vary with time, country, development, employed strategies, and other parameters. However, handling countries with similar characteristics equally, sounds to be a reasonable assumption to be employed in the absence of other searched factors. The study considers earlier literature in assigning the adjustments for each country. Although the studies regarding underreporting of crash fatalities are very limited, yet the estimation of underreporting adjustment factors for the various considered countries are mainly based on the available research, logic, and rationale. The factors for the countries with an unknown percentage of underreporting are either compared with known ones or a factor which has been utilized elsewhere is employed, provided similarities in population, fatality rate, and development of the country are logically considered. Such attempts lead to rough estimates of underreporting percentages in road injury deaths, in the absence of any other literature. Such arguments further support the assignment of a range of traffic fatalities to estimate the actual road traffic deaths when compared with reported records.

Most of the recent studies based their adjustment factors for death definition, in terms of number of days the death has occurred. This is mostly on the recommendation proposed by Europe's Ministers of Transport Conference for the years 1968 and 1995. They set a 30 days' benchmark to consider the traffic crash death without any adjustments. Only half of Eastern Mediterranean countries currently employ such definition [1,2]. Percentage of deaths occurring during the same day of the

accident sums to 77%, as presented by Jacobs et al. [9,10]. A correction factor of 1.3 is proposed to adjust such cases to meet 30 days' definition. This factor is employed by many researchers and institutions, as the WB and the UN, in many of their literature since long back. It should carefully be revised. However, when the deaths occur within 3, 7 and 365 days, the respective adjustment factors employed are 1.15, 1.08, and 0.97. Though these factors are more useful for the high-income countries, they are extended to other countries, due to the absence of other reasonable literature. Since such factors have been proposed long back; they should be applied cautiously. They tend to be lesser now in the developed countries. Therefore, the adjusted records for the recent years tend to be slightly overestimated. Naji and Djebarni used a factor of 1.48 to convert 3 days' death records in Yemen to 30 days [14,15].

A combined factor of both underreporting and death definition, along with any other necessary corrective actions, is utilized to adjust the recorded fatalities for each country. The study sat a procedure to account for various cases, i.e. multiple correction cases, in assigning the factors for each country. When a country considers traffic fatalities for less than 30 days, as death on spot, as in many Indonesian provinces or within 3 days, then the low scenario considers the underreporting adjustment factor alone [16]. The high one considers the sum of both, death definition and the underreporting adjustment factors, jointly. When a country holds a low underreporting factor as 2% to 5%, but the death definition factor is not, then the low scenario employs death definition factor alone. The high one employs the sum of both. More procedural details can be found by Al-Madani.

Adjusting road deaths

Underreporting of crash injuries is not limited to low-income countries alone, high-income ones also have similar problems but on a much lower scale than low-income countries [17,18]. Though Derriks and Mak reported that data regarding an actual number of fatal and serious crashes in most of International Road Traffic and Accident Database (IRTAD) countries are quite accurate [19]. Global Burden of Disease (GBD) reports considered even higher adjustments for such countries. According to Bhalla and Harrison, the difference between the reported deaths and those presented by GBD-2010 were as high as 45% in sum of 25 countries within the Organization for Economic Co-operation and Development (OECD) countries [20]. They have questioned the quality of the data presented by GBD-2010 for European Union countries. Estimates based on GBD-2010 data indicated underreporting of over 100% in many low-income countries [17,18].

Underreporting of up to 70% has been observed in the literature regarding road death in Morocco by Derriks and Mak. Jacobs and Aeron-Thomas assigned 25 to 50% adjustments to correct the road deaths in North-African countries. Egypt police statistics reported 54% fewer fatal records than health authorities during 2011 [21]. Puvanachandra et al. claimed even a higher percentage for Egypt during 2009 [22]. WHO reported the true

number of death in India to be twice that reported to police [20]. The WHO also stated, in another report, that the true number of fatalities due to road crashes to be 1.5 times that officially reported [23]. The same study also presented the actual number of fatalities to be in the range of 47% to 64% of that reported officially during 2005. Unexpectedly, Gururaj claimed as little as 5% difference in fatal road crashes in police reports in Bangalore, India, during 2008 [24]. According to Mohan, Tiwari and Bhalla urban areas in India underestimated the true records by only 10 to 20% during 2015. Dandona, Kumar, Abdul Ameer, Reddy and Dandona estimated even lower rates [25]. Likewise, the researchers presented varying percentages of underreporting in Pakistan in general and Karachi in specific during various years. These ranged between 23% and 123.2% [26]. The underreporting in Karachi, Pakistan, during 1994 and 1998 was about 44%. Bhatti and Salmi concluded that highway police reports in Pakistan cover only 23% of the fatalities, i.e. they report less than quarter of the road deaths, and those in urban police reports cover only 56%. Others estimated around 78% underreporting [3].

Naji (and Naji and Djebarni estimated 48% underreporting of fatal crashes in Yemen during 1993. Junaid and Stephen compared police road crashes data with hospital records for Saudi Arabia during 1988 and found 80% lesser fatalities in police data. Considering UAE, in Al-Ain city, Junaid and Stephen found 60% underreporting of accidents during 1992. No doubts that the records of many of the earlier countries have considerably improved with time, still clear gaps between the official crash deaths and the actual ones exist.

Jacobs and Aeron-Thomas predicted a range of global road deaths for the year 2010 to be between 746,000 and 877,000. This is clearly lesser than the 1.39 million deaths forecasted by the WHO [27] and the WB for the year 2000 [28]. It is also lesser than the 1.22 million deaths estimated by the WHO in 2010 for the year 2008, the 1.27 million for the year 2004, or the 1.17 million for the year 1998 [7,29]. Kopits and Cropper [30,31] estimated the adjusted global crash death to be 633,000 victims for the year 2000. According to WHO Global Status Report for Road Safety (GSRRS), the global annual road injury deaths sums to 1.23 million, as surveyed during 2008. GBD-2010 estimated 1.3 million deaths due to road injury As can clearly be seen, there are clear differences in the global crash death estimates between one source and another.

WHO crash records for Eastern Mediterranean Region (EMR) countries show lots of shortcomings? These include the following: the precision of the fatality sums and the vehicle fleets for several countries as Iran, Afghanistan, Pakistan, Sudan and Yemen, improper consideration or compensation for few others as Somalia, Djibouti, improper or non-continuous long-term data for many others. The adjustment employed to various countries looks ambiguous. The calendar year difference, as for Saudi Arabia, is ignored. The Arabic moon (Hijri) calendar year is lesser than the Gregorian (Lunar) year by 2.8%. Long-term data regarding vehicle fleets in the EMR are still very challenging to gather.

Methods

Data gathering

Official publications, well-known databases, and a huge amount of scientific reports helped in building up the database. The study used many annual statistical and fact books. Extensive web search and personal contacts with the official institutions reinforced the data collection process. All the collected data were supported with proper references, except for few cases. The study sets a procedure in considering missing data within a country, other than underreporting which is handled differently. These are explained by Al-Madani. It is worth noting that the data for the EMR crash related literature holds lots of unconvincing and contradicting forecasts and require careful revision. It also is very essential to revise the underreporting and the 30 days' death adjustment factors for the region.

Results

Past and current status of crash death frequencies and rates in the EMR

The sum of road crash deaths for the 22 Eastern Mediterranean countries showed a firm increasing trend during the period from 1980 to 2001 (**Figure 1**). Then it fluctuated up and down but with a clear increasing tendency towards 2014. Such a fluctuation trend during the past 13 years requires further analysis and research. The recorded traffic crash death increased by about two and a half times during the period between 1980 and 2001, i.e. from 26,525 deaths to 63,413. Subsequently, the increase in road deaths was insignificant. However, the recorded road deaths increased to 67,664 by 2014. The trends for the adjusted road death, both low and high scenarios, followed the earlier pattern very closely. One may note that the recorded road deaths in the EMR required an adjustment of 45 to 49% to correct the reported death records for underreporting, death definition, and calendar year difference.

Though the earlier trends look as if the pattern is approaching a threshold peak (**Figure 1**), it is very difficult to support such argument in the time being, since such fluctuations may continue for some years to come. They might even increase once again because of the clear diversity in the road death trends between the various EMR countries, as will be elaborated later.

It is worth mentioning that the recorded road injury deaths for the whole EMR during 2014 represented over 10% of the global base road death, as per WHO worldwide base estimate for the year 2008 (WHO, 2010). The WHO prediction for base road death, adjusted for 30 days' definition, exceeded 660,000 deaths.

The road death estimates for the EMR, as considered in this study, jump to 88,953 and 98,372 fatalities, when the death records are adjusted for the low and the high scenarios, respectively (**Figure 1 and Table 1**). The latter represents around 11% of the adjusted global road deaths as estimated by Al-Madani.

The EMR Status Report on Road Safety by WHO in 2010 indicated a total of 146,000 adjusted deaths for the region during 2004. According to the data collected here (**Figure 1**), the adjusted road fatalities, based on high adjustment scenario, indicates 88,834 deaths for the same year. This is just 60% of that reported by EMR. The report did not explain the bases for the adjustments made. However, it is worth mentioning that EMR office based its estimate on the data obtained through WHO in the 2010 report. The report was based on data obtained through a survey conducted during 2008 for 178 countries. Several multi-sectoral ministries and nongovernmental representatives in each country responded to questionnaires developed for the survey. Two countries in the EMR region did not respond to the survey. Another two countries did not consider health representatives in the survey. Worldwide, only 75 countries, out of 178 considered ones, filled out 85% of the questionnaires sent to the WHO representatives. The data adjustments for 94 countries were estimated ones. The report did not present any details regarding the underreporting death adjustment factors in exception

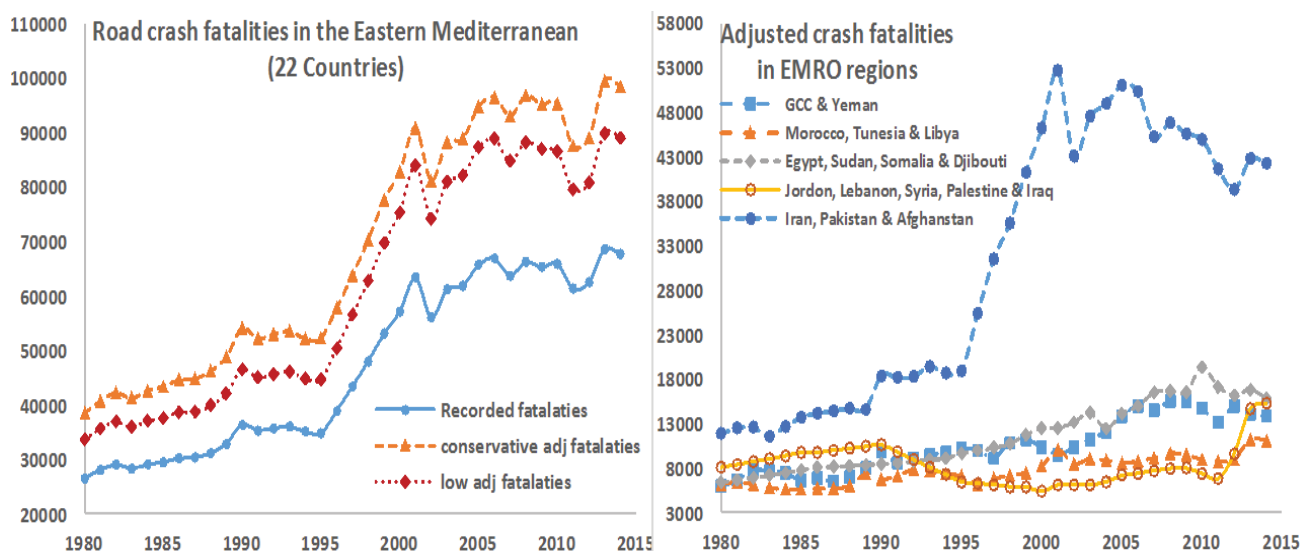


Figure 1 Adjusted crash fatality trends in various EMRO Regions during 1980-2014.

Table 1 Reported crash fatalities, adjusted fatalities, population, and vehicle fleet in Eastern Mediterranean sub-regions in 2014.

EMRO regions	Covered Countries	Crash Death (1980)			Crash Death (2014)			% difference (1980-2014)		
		Recorded (Base)	High Adjustment	Low Adjustment	Recorded (Base)	High Adjustment	Low Adjustment	Recorded (Base)	High Adjustment	Low Adjustment
Arabian Peninsula	7	4,238	5,934	5,250	12,303	13,849	13,849	190	133	164
N&N-W Africa	3	5,070	6,204	6,061	8,852	11,116	10,785	75	79	78
N&N-E Africa	4	3,565	6,420	4,456	8,865	15,868	11,081	149	147	149
N-W Asia	5	6,058	8,097	7,430	11,136	15,274	13,632	84	89	83
S-E Asia	3	7,595	11,849	10,498	26,509	42,266	39,607	249	257	277
EMRO	22	26,525	38,504	33,695	67,664	98,372	88,953	155	155	164
Worldwide (Al-Madani)	215	432,893	575,491	505,436	637,667	905,276	791,752	47	57	57

of results extracted from modelled data. While the reported fatalities by WHO are mostly gathered from official records and considered to be an added scientific effort, the factors utilized for the adjustments require careful handling since they are mostly judgmental estimates of a group of safety representatives in each country. However, one may point out that WHO base estimate, without employing any adjustments except 30 days' death adjustment, showed lesser global road deaths than that estimated in this study. The reasons behind overestimated global road deaths by WHO calls for careful attention and research. The procedure followed by WHO in assigning underreporting death factors requires careful application. Most of the EMR countries lack proper scientific estimates for the underreporting of road death. However, several attempts are made by various researchers in Pakistan to check on police records using capture and recapture method.

The death records discussed earlier for the region is highly alarming, since crash deaths are over-presented in the region when vehicle fleet is considered. The region hosts just 5.5% of the global vehicle sums, while the road fatalities in the region are responsible for about 11% of the worlds' road deaths. Population wise the region covers around 9.5% of the world's population. The problem may further escalate when exposure rates are considered. However, such parameters require further analysis to support the earlier argument.

Though the death rate per vehicle alone, does not effectively represent the road users' exposure to crash death, it helps the experts to assist the safety situation more efficiently in the absence of other relevant data. The death rate per inhabitants further supports the experts to compare the death rates with those for the developed countries.

The trend for the adjusted road death per 10,000 vehicles in the EMR countries, as observed from **Figure 2 and Table 2**, indicates a sharp decrease in the death rates, except during the period between 1988 and 1999. The rates dropped from 36.5 during 1980 to 10.0 during 2014. While the frequency of adjusted road death increased from 38,504 during 1980 to 98,372 during 2014 (**Table 1**), the vehicle fleet increased from 10.6 million to 98.4 million during the same period (**Table 2**). In other words, while the vehicle fleet increased in the region by over nine times during the past three and a half decades, the corresponding crash fatalities increased by two and a half times. This may explain the

descending trend of the crash death rates per vehicles, though the frequencies are in the increasing mode.

The case for the road death per million people is quite different than that per 10,000 vehicles (**Figure 2**). Three distinct trends can be observed during the studied period. The first is a steady state with slight fluctuation pattern between 1980 and 1994. The second is a sharp jump in road death rate per million population between 1995 and 2001. The third is a fluctuated pattern with a slight dropping tendency during the subsequent period. The road death per million inhabitants increased from 132 during 1980 to 157 during 2014, with a peak death rate of 184 occurring during 2001. It is worth noting that both rates of 157 fatalities per million population and 10 fatalities per 10,000 vehicles, for the year 2014, are far greater than those for the high-income countries. The average rates for 44 European countries for the year 2014 are 69.5 fatalities per million population and 1.2 per 10,000 vehicles.

Reported and adjusted crash death in the Eastern Mediterranean sub-regions

The road crash deaths in various Eastern Mediterranean sub-regions show increasing patterns during the period between 1980 and 2014, as can generally be observed from **Figure 1**. The trends closely follow that for the sum of 52 Asian countries but on a much lower scale (Al-Madani, 2018). While Asia accounts for 377 thousand reported traffic fatalities and 543 thousand adjusted ones during 2014 (Al-Madani, 2018, 2015); those in the whole Eastern Mediterranean region accounts for only 68 thousand and 98 thousand deaths, respectively. However, one may clearly note, from the upper curve in **Figure 1**, the presence of significant jump in the road death in the South-West Asian countries within EMR, i.e. those involving Iran, Pakistan, and Afghanistan, between 1995 and 2001. In fact, the road death in this sub-region tripled during the earlier six years from 11,949 to 36,369. Similarly, the adjusted deaths increased from 18,894 to 52,647 deaths. Such an increase is most probably due to the sudden jump in the adjusted road deaths in Iran from under 3,000 during 1995 to over 8,000 during 1996, then to over 13,000 during 1997, and then to around 29,000 during 2001. However, the trend during the past decade in this sub-region tends to drop.

The trend in the North-West Asia region within EMR, i.e. those involving Jordan, Lebanon, Syria, Palestine, and Iraq, did not

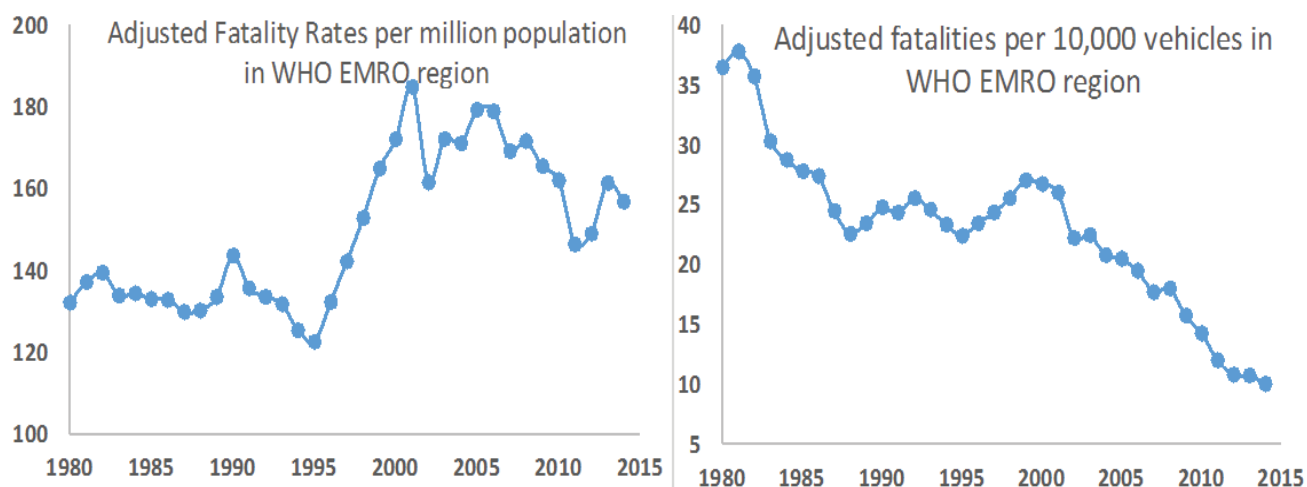


Figure 2 Trend of adjusted crash fatality rates in sum of 22 EMRO countries during 1980-2014.

Table 2 Vehicle fleets and adjusted road death rates in various Eastern Mediterranean sub-regions during 1980- 2014.

Years	Arabian Peninsula		North, North-West Africa		North, North-East Africa		North-West Asia		South-East Asia		Eastern Mediterranean	
Countries	GCC and Yemen		Morocco, Tunisia and Libya		Egypt, Sudan, Somalia and Djibouti		Jordan, Lebanon, Syria, Palestine and Iraq		Iran, Pakistan and Afghanistan		22 Countries	
Parameters	Vehicles (000)	Death/10,000 vehicles	Vehicles (000)	Death/10,000 vehicles	Vehicles (000)	Death/10,000 vehicles	Vehicles (000)	Death/10,000 vehicles	Vehicles (000)	Death/10,000 vehicles	Vehicles (000)	Death/10,000 vehicles
1980	3,204	18.5	1,585	39.1	1,225	52.4	1,238	65.4	3,306	35.8	10,559	36.5
1990	7,044	13.9	2,436	27.8	2,171	39.0	2,522	42.2	7,710	23.9	21,883	24.7
2000	9,794	10.6	3,876	21.3	3,327	37.6	4,518	11.9	9,472	48.8	30,985	26.7
2010	15,553	9.5	6,288	14.2	7,281	26.5	8,421	8.8	29,472	15.2	67,016	14.2
2014	20,442	6.8	7,874	14.1	13,758	11.5	14,341	10.7	41,942	10.1	98,357	10.0

show any drastic changes with the years except during the last three years of the studied period. The latter is probably due to the rapid increase in Iraq's road death records. Nevertheless, one may say that the first decade showed an increasing trend in the region's adjusted crash deaths. The deaths increased from 6,058 during 1980 to 7,899 during 1990. The second decade showed a decreasing pattern since the road deaths dropped to 4,056 by the year 2000. The latter is the lowest record for this sub-region during the past 35 years. The third decade showed again an increasing trend. The road deaths increased to 5,867 by 2009. The increasing pattern continued subsequently. Likewise, the road death in the North-West African region, involving Morocco, Tunisia, and Libya, did not show any sudden changes during the whole period, but the increasing trend in the road death cannot be missed. The adjusted road deaths increased between 1980 and 2014 from 6,204 to 11,116; an increase of about 79% for 35 years.

The crash death in the sum of seven countries within the Arabian Peninsula showed a continuous increasing trend during the period between 1980 and 2009. The subsequent five years showed fluctuated death records as if the road death record is approaching its peak threshold during this era. However, such an argument cannot yet be confirmed. But, one may surely say that

the increase in the road traffic fatalities, during the latter few years, has clearly flattened. In fact, the road death during 2013 and 2014 clearly dropped. Nevertheless, the fluctuated pattern may probably continue for the coming few years before it settles. This argument is also true for the North-West Asia and North and North-East Africa regions within Eastern Mediterranean region. Several reasons explain such dropping or controlled tendency. These reasons may include, among several others, the following: extensive traffic safety initiatives conducted by various countries during the past years, global awareness towards traffic casualties as a major public health problem, the WHO initiatives towards traffic safety issues, and the challenges made to improve the traffic safety records in many countries. The UN activities as UN General Assembly Resolution 57/309 in 2003 and General Assembly Resolution 64/255 in 2010 also had positive influences on traffic safety [32,33]. Furthermore, the technological advances in vehicle manufacturing, IT advances in the roadway system, and the extensive social media coverage of road crashes also had positive effects on traffic safety. The latter are true for the high and middle-income countries and many low-income ones, as well.

In contrast to all the Eastern Mediterranean sub-regions, traffic fatalities in 27 EU countries, inclusive of UK which is not anymore

part of EU showed a clear descending pattern during the period between 1980 and 2014 [34]. The pattern is obvious since most of the EU countries enforced comprehensive Traffic Safety Strategies to reduce crash casualties long back. Many EMR's countries transferred traffic safety strategies from such countries, after being improved to suit their traffic safety needs. However, it is worth noting that such dropping trends are becoming more challenging with time. In fact, the recent death records in the UK and Sweden showed a marginal increase during 2015 and 2016.

Past and current crash fatality rates

Crash fatalities with respect to the vehicle fleet: From **Figure 2**, the right-side figure, presents the trend of fatality rate per 10,000 vehicles with the time in the EMR. In general, the descending pattern through the years cannot be missed, except for few years between 1996 and 2001. Though such a trend is very healthy, one needs to be cautious since the pattern might lead to a deceiving conclusion in the absence of proper exposure rate. The rates are substantially high compared with the developed countries. Furthermore, the vehicle ownership rate in the region is clearly below that in the high-income countries. The region hosts 157 vehicles for every thousand inhabitants. That for the average of 44 European countries is 596. The latter is over three and a half times that for the average of 22 EMR countries. The current rate of 10 adjusted crash fatalities per 10,000 vehicles (**Table 2 and Figure 3**) in the region, as well as the reported 6.9 fatalities per 10,000 vehicles, is far above that for the EU countries, Japan, or the USA. The corresponding rates for the earlier countries are close to one or lesser. Such great gaps between the EMR and the developed countries show the necessity of effective counter plans to control such rates to meet an acceptable figure. The intended plans should be implementable on real grounds and with proper financial support. It is worth mentioning that the EMR Status Report on Road Safety (WHO, 2010a) did not cover crash death rates with respect to the vehicles. Therefore, no comparison was possible here.

Various sub-EMR, in exception of South-West Asia, followed similar descending patterns as that for EMR but at different scales (**Figure 3**). The pattern in the South-West region followed a very fluctuated manner. This is partly due to the drastic changes in Iran's records during the period between 1995 and 2001. Currently, the highest rate is observed in the North-West African countries, where over eleven people are killed in road-related crashes per 10,000 registered vehicles. The lowest is in the Arabian Peninsula, where six people are killed for every 10,000 registered vehicles. The latter is six times that for the developed countries. The highest drop in the fatality rate during the past 35 years can be observed in the North-West Asia region. The dropped from 65.4 deaths per 10,000 vehicles to 10.7. The latter is lesser than one-sixth of the former.

Crash fatalities with respect to the population: During the past 35 years, the fatality rates per million inhabitants for the EMR passed through three distinct patterns (**Figure 2, left figure**). The period between 1980 and 1994 presented a quite steady state trend, followed by a sharp increase in the fatality rates during

the period from 1995 to 2001, subsequently the trend followed a fluctuated pattern with no clear trend. The latter fluctuated pattern tends to descend with the time. In fact, such a pattern is quite contradicting with the data presented in the EMR Status Report on Road Safety by WHO, the report indicated a death rate of 264 per million inhabitants during 2002 compared with 322 during 2008. These are far greater than those presented here. The highest adjusted rate observed in this study approached 185 deaths per million inhabitants during the year 2001 (**Figure 3, top**). The rate during 2011 showed to be the lowest during the past 35 years. Currently, the rate is 157 fatalities per million inhabitants. Though such rates look conservatively fine since it isn't substantially different than the rates for some of the developed countries, it might mislead the readers because of the clear gap in the motorization rates between the EMR and the developed countries. However, the latterly mentioned rate is far lesser than the rate stated in the EMR Status Report on Road Safety. The report, as mentioned earlier, shows a modelled rate of 322 fatalities per million inhabitants for the year 2008 compared with 171 adjusted fatalities per million inhabitants estimated here for the same year. The latter is about half of the former. It is worth noting that the annual population growth rate in the EMR is in the range between 2.1 and 2.9. The population increase between 1980 and 2014 is 115%.

The patterns in various sub-EMR showed clear diversities between them in terms of fatalities per million inhabitants (**Figure 3, top**). While the highest rates are observed in the Arabian Peninsula region, the lowest exist in the North-Eastern Africa region, i.e. Sum of Egypt, Sudan, Somalia, and Djibouti. The trend in the North-Eastern Africa region, showed a steady increasing pattern during the studied period, with two outlying records during 2004 and 2010. The adjusted road crashes during 1980 showed 92 deaths per million inhabitants. That during 2014 approached 119. This is still over twice that for UK and Sweden (Al-Madani, 2015 & 2013). The adjusted fatality rates in the Arabian Peninsula showed clear fluctuations with the years. These ranged between 185 and 339 deaths per million inhabitants. However, the death rates dropped from 197 during 1980 to 166 during 2014. Likewise, the North-West African regions, i.e. Morocco, Tunisia, and Libya, showed fluctuated trends that ranged between 154 and 230 deaths per inhabitants. The rate during 1980 showed 216 corrected crash deaths per million inhabitants. The death rates during 2014 showed to be very close to that of 1980, i.e. 219 deaths per million population. The crash death pattern in North-West region of Asia, i.e. Jordan, Lebanon, Syria, Palestine, and Iraq, passed through four distinct trends. The first decade, 1980 to 1990, followed a steady trend with adjusted death rate close to 270 per million inhabitants. The rate dropped drastically during the subsequent decade to lesser than 102 deaths per million inhabitants. Then fluctuated between 110 and 127 until 2010. The last three years of the studied period showed a sudden jump in the rates to approach 209 deaths per million inhabitants. This is probably due to the sudden increase in the observed death records in Iraq during the earlier period. The trend in the EMR's South-East Asia sub-region, i.e. Iran, Pakistan, and Afghanistan, followed an opposite pattern to that of North-West Asia sub-

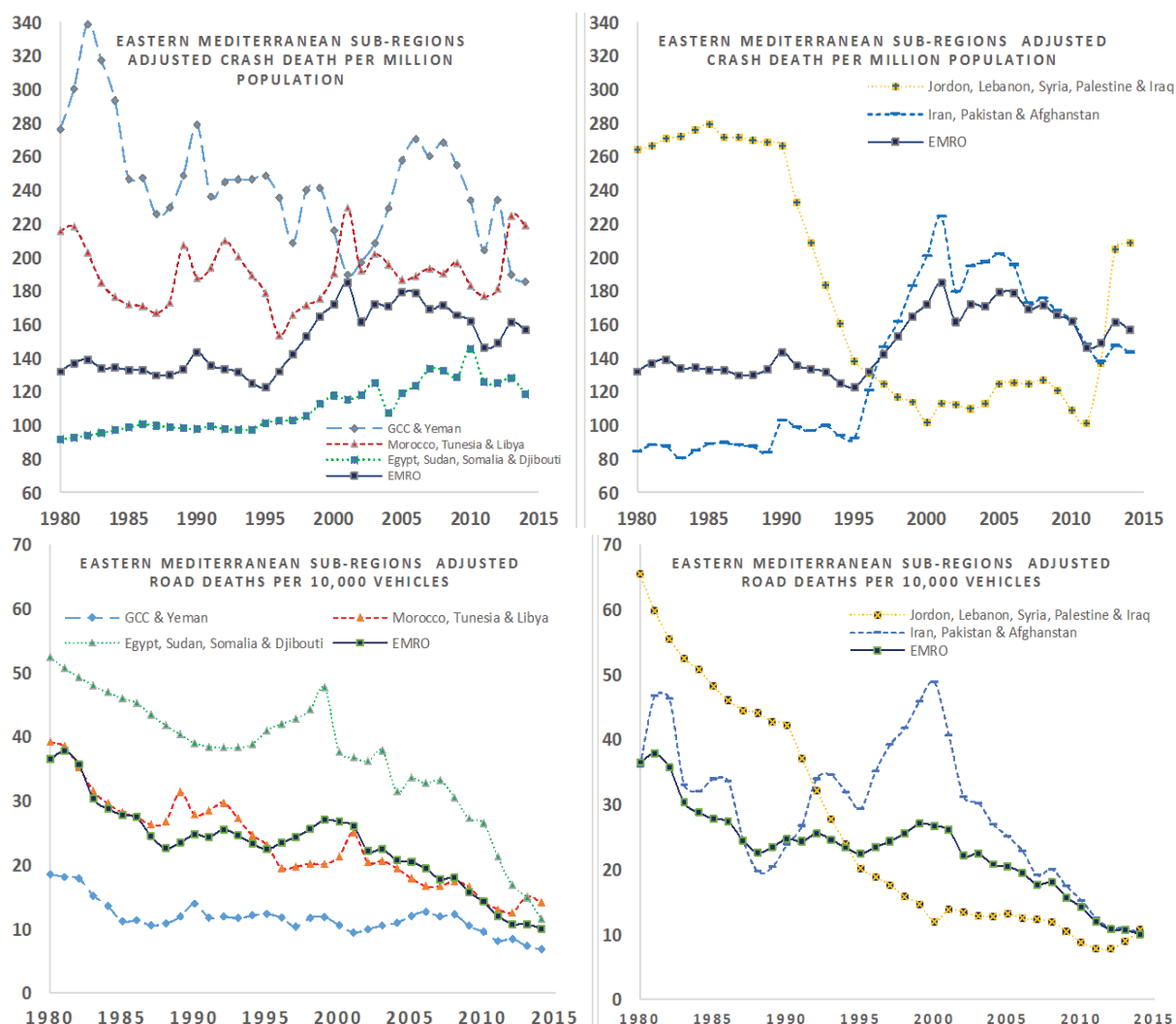


Figure 3 Adjusted crash fatality rates per population and vehicles in the Eastern Mediterranean regions during 1980-2014.

region (**Figure 3, bottom right**). The adjusted crash death rate during 1980 to 1989 stayed between 80 and 89 deaths per million inhabitants. Then it increased during the following six years but stayed between 92 and 103 deaths per million inhabitants. Then it increased drastically during the following six years to reach 224 deaths per million inhabitants. Such drastic increase is probably, as mentioned earlier, due to the sharp increase in the death records in Iran during this period. Then it fairly curved down to reach 143 deaths per million inhabitants during 2014.

Future traffic crash fatality trends in the EMR

Both the reported and the adjusted crash fatalities in the EMR showed lots of fluctuations during the past 17 years. However, the ascending tendencies of the fluctuated patterns cannot be missed (**Figure 4, top**). Several factors lead to such scattering pattern, as the diversity in the crash fatality trends between one country and another, as mentioned earlier, sudden changes in the fatalities in the official records of several countries, and the accuracy of the data from the mother source of each country. Though a polynomial model fits the data better than any other

models, the linear model looks more probable considering the fluctuated pattern of the data, in general, and the increasing pattern of motorization rate. Consequently, the estimated reported and adjusted crash deaths for the year 2025 approaches 78,500 and 113,000, respectively. These indicate over 15% increase, compared with 2014 records. Such an increase is in contrast with the trends in the developed countries. Such an increase in the crash death during the 11 years between 2014 and 2025 is reasonably comparable with over 10% increase during the past decade.

The modelled data for both recorded and adjusted fatality rates per 10,000 vehicles for the whole region indicate fairly dropping trends. The current 6.9 recorded fatalities per 10,000 vehicles and 10 adjusted fatalities are expected to descend exponentially by 2025 to 3.6 and 5.1, respectively (**Figure 4, right**). Though such drops are substantial, yet they are far above the current norms of high-income countries. Furthermore, the various tested models for Europe show the reported and the adjusted deaths records to asymptote towards very low death rate by the year 2025.

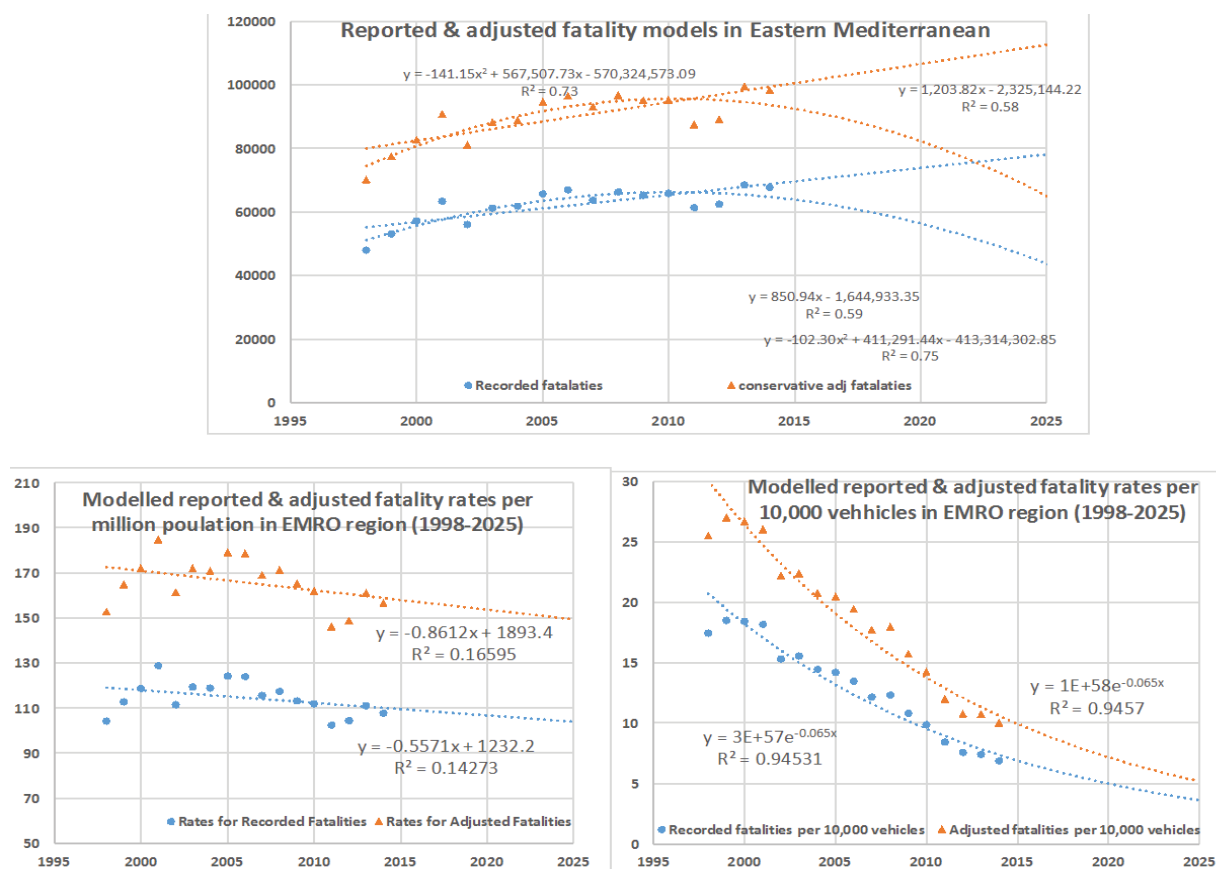


Figure 4 Modelling reported and adjusted crash deaths and death rates in Eastern Mediterranean region during 1998-2025.

The future trend for the fatality rate per million inhabitants is not as clear as those discussed earlier since no significant tested models fitted the fluctuated data well. Nevertheless, a weak linear model shows slight descending tendency (**Figure 4, left**). The recorded and adjusted fatality rates are expected to drop to 103 and 149 fatalities per million inhabitants by the year 2025; i.e. a 2% drop. Once again, these are far greater than the current average rates for EU countries. Most of the European countries started successful long-term national road safety plans long back. For example, UK set a target during 1987 to reduce road casualties by one-third by the year 2000. As a result, the road death has fallen by 39% as reported by the Department of the Environmental, Transport and the Regions [35]. In fact, there are great opportunities to transfer such experience to many EMR countries, after refinement to improve for culture, social, and economic differences. In fact, some have already benefitted from their Traffic safety plans.

Discussion

While the crash death rates per vehicles in the EMR descend with the time, the death rates per population tend to plateau, and the death frequencies increase. Such findings look ambiguous and contradicting. However, such ambiguity can partially be explained by the faster growth of vehicle fleets in the region compared with increase in both the population and the investments on the infrastructure. While, the vehicle fleet multiplied over 9 times

during the past three and a half decades (**Table 2**), the population only doubled. In fact, the vehicle ownership rate in the region is consistently increasing, i.e., from as little as 36 vehicles per 1000 population during the year 1980, to 157 during 2014. It is expected to double in less than a decade-time. This means that the region will be attracting large number of vehicles that are beyond the capabilities of its roadway networks due to the slower development of the infrastructure. This may also explain the continuous decrease in the fatality rates per vehicles and the increase in the fatality frequencies.

It is also worth mentioning that there are apprehensible differences in the follow-up with the technological advances in the fields of enforcement, emergency services, civil defense, and roadway system, between various EMR countries. Such differences add to the difficulties in interpreting the results. Differences in driving behavior, citation rules, crash data management and quality also add to the interpretation difficulties of the results. Nevertheless, the increasing crash death patterns and the fluctuated death rates per population in the region indicate highly alarming state.

Though clear diversities in the fatality rates and frequencies exist between various sub-EMR, their general patterns followed similar trends, in exception of the North-West Asia sub-region. As a result, the overall average for the EMR is fitted well in the middle between the curves of the various sub-regions. Therefore, one may say that the earlier ambiguity might not be due to the

diversity in the fatality rates between various sub-EMR. However, these require further investigation to answer various ambiguous results.

An issue that may also influence the crash involvement in the region is negligence of the decision makers in keeping the transportation safety plans among the priority list. In fact, lots of issues force traffic safety plans to be pushed back to the tail end of the priority list in most of the EMR's countries. These include, among others, the poor interest of the politician in traffic safety, the poor finance of safety research, the absence of implementable long-term plans, the weak coordination between the stakeholders, the inadequate evaluation system, and the improper development of public transport system. There is no doubt that all these require extensive research to further expedite the details, to better allocate the available resources.

Conclusion

The crash fatalities in the EMR is consistently increasing. Though the past decade showed fluctuated death pattern, the trend is still on the increasing run. The adjusted fatalities predicted for the WHO-EMR approached 98,400 during 2014. A record which is expected to increase by over 15% towards the year 2025. Though the earlier record is adjusted for underreporting, death definition, missing data, and correction for calendar year, the estimated record represents only 60% of that reported in the Status Report on Road Safety by the EMR's office.

The fatality rate per 10,000 vehicles in the EMR showed a descending pattern. Such optimistic trend needs to be cautiously considered since it might be deceiving in the absence of proper

exposure rate. The current adjusted rate is 9 fatalities per 10,000 vehicles. The modelled data indicated an exponential descends to 5.1 by 2025. This is far above the current norms for the high-income countries. The fatality rates per million inhabitants showed fluctuated trend with no model fitting the data well. The current rate is far above that for the high-income countries. Various EMR sub-regions though showed clear diversities between them, the fluctuation in the trends of the death frequencies and rates for most of them followed closely similar patterns but at different scales. These findings indicate ambiguous situation since the crash death rates per vehicles present descending trends with time, the death rates per inhabitant indicate plateauing shapes, and the death frequencies indicate increasing patterns. This is partially explained by the faster growth in the vehicle fleet compared with the increase in the population and the growth of the roadway infrastructure.

The findings indicate very alarming death records and rates and require careful reading, proper interpretation of the results and further extensive research. Factors contributing in such poor records include lack of effective measurable long-term traffic safety plans, inconsistent handling of traffic safety strategies, insufficient involvement of Non-Governmental Organization in traffic safety problem, poor coordination between various stakeholders, and poor involvement of research-based solutions, non-forgiving infrastructure, and inefficient development of human behavior. It is very essential to revise the underreporting and the 30 days' death adjustment factors in the region. The EMR crash related database require careful revision since their literature holds lots of unconvincing and contradicting forecasts.

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