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Araştırma / Research

TRENDS IN ROAD TRAFFIC CRASHES IN TURKEY, 1980-2016

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ABSTRACT

The objective of this article is to examine the trends of traffic crashes, deaths and injuries in Turkey from 1980 to 2016. A time-series methodology were used to analyze crash trends per 1000 people, 1000 driver, 1000 vehicle and a million vehicle-kilometer traveled (VKT). Furthermore, the association between economic development of Turkey and traffic crashes were explored. The effectiveness of highway investments and traffic enforcement on traffic crashes, deaths and injuries were also discussed. Results shows that even though a dramatic increase is has observed in income, vehicle ownership and VKT in Turkey, road traffic deaths has decreased by 17% in the last 26 years. However, crashes and injuries has continued to increase, and death rates are still higher than rates in the European Union (EU) countries.

Keywords: Traffic crashes, crash rate, nationwide safety analysis, Turkey.

TÜRKİYE'DEKİ KARAYOLU TRAFİK KAZALARINDAKİ EĞİLİMLER, 1980-2016

ÖZ

Bu çalışmanın amacı Türkiye'de 1980 ile 2016 yılları arasındaki trafik kazası, ölüm ve yaralanma oranlarını incelemektir. Zaman serisi analizi kullanılarak 1000 kişi, 1000 sürücü, 1000 taşıt ve milyon taşıt-kilometre başına düşen kaza eğilimleri analiz edilmiştir. Ayrıca, çalışma süresince Türkiye'de gerçekleşen ekonomik gelişme ile trafik kazaları arasında ilişki araştırılmıştır. Karayolu yatırımlarının ve trafikteki yaptırımların kazalar, ölümler ve yaralanmalar üzerindeki etkisi de tartışılmıştır. Çalışmanın sonuçları Türkiye'de gelir düzeyinde, taşıt sahipliğinde ve taşıt-km'de yaşanan hızlı artışa rağmen, trafik kazalarındaki ölümlerin son 26 yılda %17 oranında azaldığını göstermiştir. Öte yandan, trafik kazalarının ve yaralanmaların sayısı artmaya devam etmektedir ve ölüm oranları halen Avrupa Birliği ülkelerinin üzerindedir.

Anahtar Kelimeler: Trafik kazaları, kaza oranı, ulusal güvenlik analizi, Türkiye

1. INTRODUCTION

Traffic crashes are regarded as a health problem in many countries [1]. Annual worldwide figures show that traffic crashes are responsible for 1.2 million deaths and almost 50 million of injuries [2]. It is the ninth leading cause of deaths, and predicted to become the seventh leading cause of deaths by 2030. World Health Organization reports that 90% of the traffic deaths occur in low and middle-income countries, even though these countries have approximately 54% of the world's vehicles [3]. The association between traffic crashes and economic development has been investigated by several researchers [4-9]. It is well known that economic development leads to increased number of motor vehicles and mobility, and affects road safety performance of a country [10]. The literature on the relationship between economic development and traffic safety is extensive, and therefore a brief summary will be presented in this study.

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Several studies in the literature suggest that, in a developing country, traffic deaths tend to increase initially with increasing use of motor vehicles, and then starts to decrease after a country reaches a certain level of development [5-8]. For example, Van Beck et al. [7] studied the traffic death rates of 21 industrialized countries from 1962 to 1990, founded that economic development leaded to an increasing number of traffic deaths until 1970s, but then the relationship became negative. Kopits and Cropper [5] used panel data of 88 countries from 1963 to 1966, and concluded that the association between prosperity and traffic safety turns from positive to negative when GDP (Gross Domestic Product) per capita reaches $8,600. In a similar study, Bishai et al. [8] used traffic safety data from 41 countries for the period 1992-1996, suggested that beyond an inflection point of $1,500–$8,600 GDP per capita, the economic development no longer leads to additional traffic deaths, although number of crashes and injuries continue to increase. From different perspective, Yannis et al. [10] studied the effect of GDP changes on traffic deaths for the period 1975-2011 from 27 European countries. The results revealed that annual increase of GDP per capita leads to an annual increase of death rates, whereas annual decrease of GDP per capita leads to an annual decrease of death rates. Previous studies showed that maximum death rates in various countries over time occurs within the range of 100-300 vehicles per 1000 people [11,12]. Studies focusing on the association between vehicle ownership and prosperity suggested that the higher GDP per capita leads to higher vehicle ownership rate increases in each country. On the other hand, road deaths per vehicle tend to decreases over the time as GDP increases [6,7,13].

Turkey, experiencing a growing traffic safety problem, was one of the 10 countries studied in Road Safety in 10 Countries (RS10) program. RS10 started in 2009, and aimed to reduce deaths and serious injuries on roads in low and middle-income countries. Specific goals of Turkey in RS10 included to increase rate of seat-belt wearing, control speed and enhance enforcement of regulations on speed and seat-belt use [14]. Gupta et al. [15] reported that RS10 program significantly increased seat-belt use in pilot cities, whereas limited improvements has been obtained to reduce speeding behavior. The primary goal of this article is to present nationwide time series analysis of the road traffic crashes for the period 1980-2016 in Turkey. Specifically, crash, death and injury rates per 1000 people, 1000 driver, 1000 vehicle and a million vehicle-km traveled (VKT) are provided. Furthermore, factors that could explain the variation in calculated rates were compared with the previous studies. The correlation between prosperity and death rates were discussed in relation with highway network density, VKT and traffic enforcements. The structure of paper is as follows: national crash figures and crash trends are discussed in Section 2. In section 3, cross analysis of economic and crash data is presented, while in Section 4 the paper is concluded through discussion and further recommendations.

2. BACKGROUND

2.1. National Figures

Table 1 presents population, income and motorization indicators during the study period. The population of Turkey increased by 78% (from 44.7 million to 79.5 million) from 1980 to 2016 [16]. As a result of the economic development, the number of drivers increased by 984% (from 2.6 million to 28.2 million), and the number of registered vehicles increased by 1141% (from 1.7 million to 21.1 million) [17]. The number of vehicles per 1,000 people increased from 38 to 252. VKT, which is a measure of vehicle use, increased by 682% (see Table 1) [18]. During this period, national transportation policy has focused on the investments for the highways, and significant improvements have been made in the road infrastructure. Nevertheless, as a result of highway-oriented growth in transportation, the total number of traffic crashes increased from 36,914 to 1.18 million, and became one of the most important problems that was waiting for a solution for the national transportation policy [19,20].

Table 1. Population, income, motorization indicators in Turkey, 1980-2016 [16-18,21]

Year	Population (million)	GNI per capita	Driver (million)	Motor vehicle (million)	VKT (million)
1980	44.7	1,512	2.6	1.7	15,343
1981	45.9	1,517	2.8	1.8	15,957
1982	47.0	1,342	2.9	1.9	16,595
1983	48.2	1,250	3.0	2.0	17,260
1984	49.4	1,183	3.2	2.2	17,949
1985	50.7	1,296	3.5	2.4	18,667
1986	51.8	1,426	3.8	2.7	20,849
1987	52.9	1,608	4.5	3.0	23,016
1988	54.1	1,634	4.9	3.3	24,553
1989	55.3	1,897	5.5	3.7	26,613
1990	56.5	2,624	6.2	3.8	27,041
1991	57.2	2,577	6.8	4.1	26,056
1992	57.9	2,691	7.5	4.6	28,514
1993	58.6	3,025	8.2	5.3	30,807
1994	59.4	2,145	8.8	5.6	31,251
1995	60.1	2,765	9.4	5.9	34,833
1996	60.9	2,931	10.2	6.3	41,015
1997	61.7	3,029	11.3	6.9	46,384
1998	62.5	4,367	12.0	7.4	49,947
1999	63.4	3,983	12.9	7.8	49,866
2000	64.3	4,185	13.9	8.3	56,151
2001	65.2	2,996	14.5	8.5	52,631
2002	66.0	3,543	15.0	8.7	51,664
2003	66.8	4,585	15.5	8.9	52,349
2004	67.6	5,905	16.2	10.2	57,767
2005	68.4	7,249	17.0	11.1	61,129
2006	69.3	7,887	17.6	12.2	64,577
2007	70.6	9,485	18.4	13.0	69,609
2008	71.5	10,581	19.4	13.8	69,771
2009	72.6	8,779	20.5	14.3	72,432
2010	73.7	10,382	21.5	15.1	80,124
2011	74.7	11,045	22.8	16.1	85,495
2012	75.6	11,469	23.8	17.0	93,989
2013	76.7	12,287	24.8	17.9	99,431
2014	77.7	11,918	26.0	18.8	102,988
2015	78.7	10,792	27.5	20.0	113,274
2016	79.5	10,675	28.2	21.1	119,671

2.2. Traffic Crash Trends

Fatal and/or injury traffic crashes are reported and kept according to the areas of responsibility by the traffic police and gendarmerie units in Turkey. Summary statistics of these crashes are published annually by Turkish Statistical Institute (TurkStat) and Turkish General Directorate of Security (TGDS). These aggregate statistics provides temporal (i.e., hourly, daily and monthly), spatial (i.e, provincial and regional) distribution of the crashes, as well as types of vehicles involved, gender and age distribution of the crash victims. However, disaggregate level crash data are not published. Property damage only (PDO) crashes are reported by involved drivers and the related data stored in the traffic insurance center database. For PDO crashes, only the annual number of crashes is published by TurkStat and GDS. Turkey has started to implement the internationally recommended post-crash 30-day observation period in 2015. Therefore, deaths due to traffic crashes within the 30-day period following the crash have started to be shown in the statistics. In 2016, 47.8% (3,493 deaths) of the deaths occurred at the crash site and 52.2% (3,807 deaths) of the deaths occurred during post-crash period.

Hence, since 2015, the number of deaths appears to be about twice larger than that of previous years. In this study, only deaths occurred at the crash site were considered in order to present historical trends of the crashes. Post-crash statistics published only for 2015 and 2016 were not considered in the analyses.

Table 2 presents number of crashes, deaths, injuries as well as highway investment budgets, length of divided highways and monetary value of traffic tickets per driver in the study period. It is seen that the number of traffic deaths has decreased by 17% from 1980 to 2016. If the Table 2 is examined in detail, it can be observed that the number of deaths increased between 1980 and 1987, then fluctuated until 1998, and later started to decrease. Starting from 1995, Turkey has begun to allocate significant budgets to highway investments by attaching importance to traffic safety (see Table 2). As a result of these investments, deaths decreased by 43% after 1998. However, number of traffic crashes and injuries continued to increase. These values indicate that the developed strategies have been effective on national highway safety, however, their effects has remained within certain limits.

Crash, death and injury rates per 1000 people, 1000 driver, 1000 registered vehicle and million VKT are provided in Figure 1 to 3 (see also Table 3). It is seen that crash rates steadily increased except for some years and peaked in 2011 or 2012. After that, a downtrend seems to have started. However, it appears that in 2016 the level of crash rates significantly higher than 1980 levels (see Figure 1). Death rates increased rapidly until 1986 or 1987, and then, declined continuously until 2016. It is seen that deaths rates are significantly lower in 2016 as compared to 1980 values (see Figure 2). Injuries per 1000 people steadily increased between 1980 and 2016. Injuries per 1000 driver and injuries per 1000 motor vehicle rapidly peaked, and then, showed downward trend until 2003, and slightly increased in the following years. Injuries per a million VKT steadily increased until 1993, and afterwards, it had a slight decline and remained almost constant. It is seen that the injury rates per 1000 driver and 1000 vehicle in 2016 were almost the same as the 1980 values. On the other hand, in 2016, injury rates per 1000 people and a million VKT were significantly higher than the 1980 values (see Figure 3).

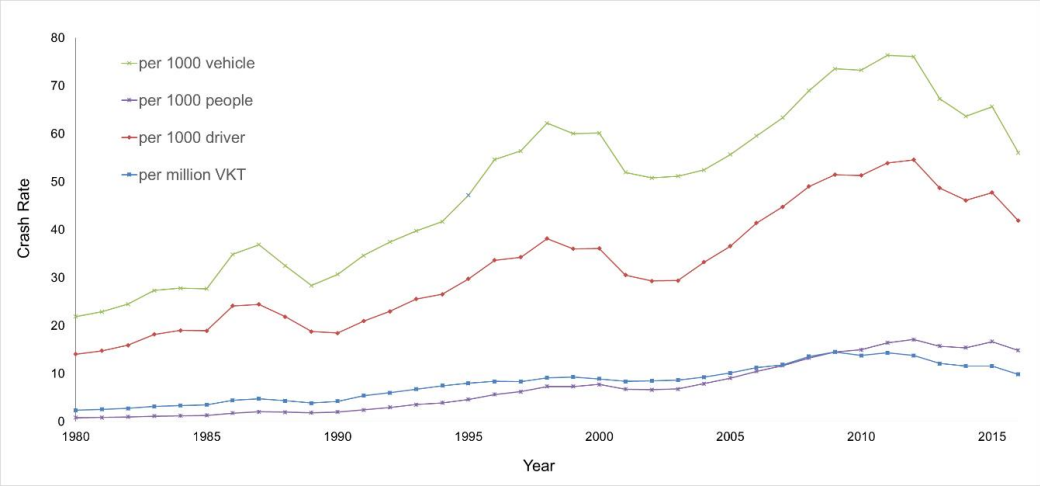

Figure 1. Crash rates, 1980-2016 [16-20]

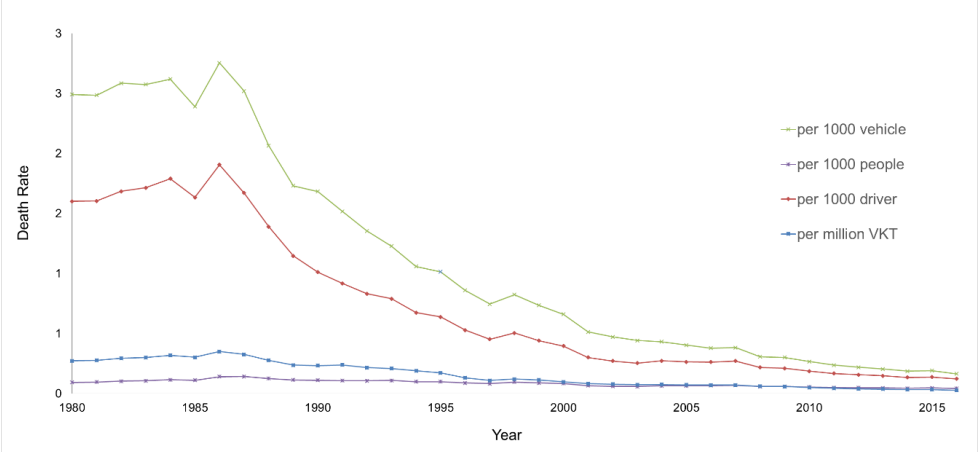

Figure 2. Death rates, 1980-2016 [16-20]

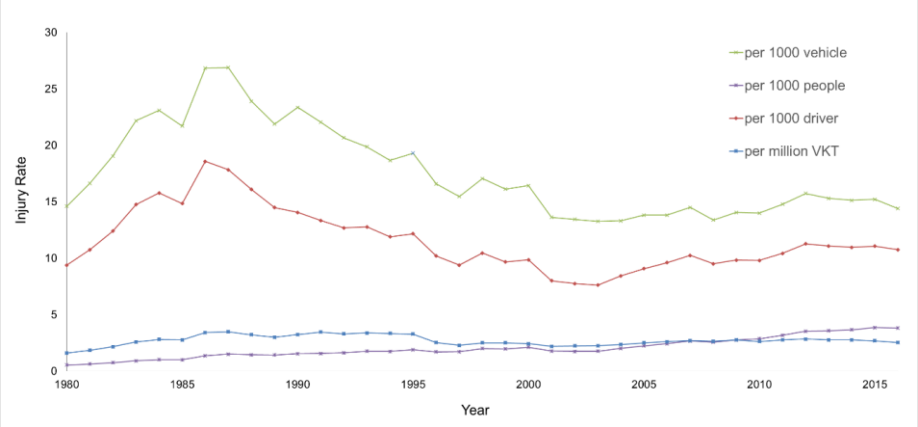

Figure 3. Injury rates, 1980-2016 [16-20]

Table 2. Traffic safety indicators in Turkey, 1980-2016 [19-20,22-24]

Year	Crashes	Deaths[a]	Injuries	Highway investment (Million USD)	Divided highway length (Km)	Annual ticket per driver (USD)
1980	36,914	4,199	24,608	343	NA	NA[b]
1981	40,953	4,441	29,744	0	NA	NA
1982	46,249	4,884	35,976	0	NA	NA
1983	55,208	5,201	44,769	0	NA	NA
1984	60,840	5,731	50,521	0	1,437	NA
1985	65,831	5,680	51,586	0	1,675	NA
1986	92,625	7,315	71,264	0	1,705	NA
1987	110,207	7,530	80,321	0	1,657	NA
1988	107,651	6,846	79,174	0	1,824	NA
1989	103,758	6,332	80,013	0	1,944	NA
1990	115,295	6,317	87,668	414	2,151	NA
1991	142,145	6,231	90,520	0	2,313	NA
1992	171,741	6,214	94,820	0	2,759	NA
1993	208,823	6,457	104,330	0	3,196	NA
1994	233,803	5,942	104,717	0	3,502	NA
1995	279,663	6,004	114,319	204	3,659	NA
1996	344,643	5,428	104,599	352	3,966	NA
1997	387,533	5,125	106,246	487	4,222	NA
1998	458,661	6,083	125,793	497	4,798	NA
1999	465,915	5,713	125,158	445	5,035	11.3
2000	500,664	5,510	136,751	569	5,537	13.5
2001	442,960	4,386	116,203	807	5,821	7.9
2002	439,777	4,093	116,412	1,119	6,040	8.8
2003	455,637	3,946	118,214	1,119	7,200	15.5
2004	537,352	4,427	136,437	1,586	8,972	21.3
2005	620,789	4,505	154,086	2,059	10,178	21.6
2006	728,755	4,633	169,080	2,754	11,685	24.4
2007	825,561	5,007	189,057	3,236	12,973	35.7
2008	950,120	4,236	184,468	4,048	14,458	34.8
2009	1,053,346	4,324	201,380	4,642	16,494	34.3
2010	1,106,201	4,045	211,496	6,260	18,863	34.1
2011	1,228,928	3,835	238,074	6,581	20,273	34.3
2012	1,296,634	3,750	268,079	5,221	21,193	36.3
2013	1,207,354	3,685	274,829	5,776	21,962	50.7
2014	1,199,010	3,524	285,059	5,323	22,460	51.9
2015	1,313,359	3,831	304,421	6,364	22,036	37.8
2016	1,182,491	3,493	303,812	5,004	23,831	39.0

Note: [a] Deaths at the crash site; [b] NA: Not available

Table 3. Crash, death and injury rates in Turkey, 1980-2016 [16-20]

Year	Crashes per				Deaths per				Injuries per			
	1000 people	1000 driver	1000 vehicle	Million VKT	1000 people	1000 driver	1000 vehicle	Million VKT	1000 people	1000 driver	1000 vehicle	Million VKT
1980	0.83	14.09	21.92	2.41	0.09	1.60	2.49	0.27	0.55	9.39	14.61	1.60
1981	0.89	14.81	22.93	2.57	0.10	1.61	2.49	0.28	0.65	10.76	16.66	1.86
1982	0.98	15.96	24.50	2.79	0.10	1.69	2.59	0.29	0.77	12.42	19.06	2.17
1983	1.15	18.21	27.35	3.20	0.11	1.72	2.58	0.30	0.93	14.77	22.18	2.59
1984	1.23	19.02	27.83	3.39	0.12	1.79	2.62	0.32	1.02	15.80	23.11	2.81
1985	1.30	18.95	27.72	3.53	0.11	1.63	2.39	0.30	1.02	14.85	21.72	2.76
1986	1.79	24.15	34.90	4.44	0.14	1.91	2.76	0.35	1.38	18.58	26.85	3.42
1987	2.08	24.48	36.89	4.79	0.14	1.67	2.52	0.33	1.52	17.84	26.89	3.49
1988	1.99	21.88	32.49	4.38	0.13	1.39	2.07	0.28	1.46	16.10	23.90	3.22
1989	1.88	18.80	28.39	3.90	0.11	1.15	1.73	0.24	1.45	14.50	21.89	3.01
1990	2.04	18.49	30.74	4.26	0.11	1.01	1.68	0.23	1.55	14.06	23.37	3.24
1991	2.49	20.97	34.65	5.46	0.11	0.92	1.52	0.24	1.58	13.35	22.07	3.47
1992	2.97	23.00	37.46	6.02	0.11	0.83	1.36	0.22	1.64	12.70	20.68	3.33
1993	3.56	25.58	39.77	6.78	0.11	0.79	1.23	0.21	1.78	12.78	19.87	3.39
1994	3.94	26.58	41.70	7.48	0.10	0.68	1.06	0.19	1.76	11.91	18.68	3.35
1995	4.65	29.79	47.22	8.03	0.10	0.64	1.01	0.17	1.90	12.18	19.30	3.28
1996	5.66	33.65	54.66	8.40	0.09	0.53	0.86	0.13	1.72	10.21	16.59	2.55
1997	6.28	34.30	56.46	8.35	0.08	0.45	0.75	0.11	1.72	9.40	15.48	2.29
1998	7.34	38.16	62.22	9.18	0.10	0.51	0.83	0.12	2.01	10.47	17.06	2.52
1999	7.35	36.03	60.05	9.34	0.09	0.44	0.74	0.11	1.98	9.68	16.13	2.51
2000	7.79	36.12	60.17	8.92	0.09	0.40	0.66	0.10	2.13	9.87	16.44	2.44
2001	6.80	30.57	51.98	8.42	0.07	0.30	0.51	0.08	1.78	8.02	13.64	2.21
2002	6.66	29.33	50.81	8.51	0.06	0.27	0.47	0.08	1.76	7.76	13.45	2.25
2003	6.82	29.42	51.17	8.70	0.06	0.25	0.44	0.08	1.77	7.63	13.28	2.26
2004	7.95	33.27	52.49	9.30	0.07	0.27	0.43	0.08	2.02	8.45	13.33	2.36
2005	9.07	36.61	55.70	10.16	0.07	0.27	0.40	0.07	2.25	9.09	13.82	2.52
2006	10.52	41.44	59.60	11.29	0.07	0.26	0.38	0.07	2.44	9.61	13.83	2.62
2007	11.70	44.81	63.39	11.86	0.07	0.27	0.38	0.07	2.68	10.26	14.52	2.72
2008	13.29	49.03	69.02	13.62	0.06	0.22	0.31	0.06	2.58	9.52	13.40	2.64
2009	14.52	51.48	73.57	14.54	0.06	0.21	0.30	0.06	2.78	9.84	14.07	2.78
2010	15.00	51.34	73.28	13.81	0.05	0.19	0.27	0.05	2.87	9.81	14.01	2.64
2011	16.45	53.90	76.38	14.37	0.05	0.17	0.24	0.04	3.19	10.44	14.80	2.78
2012	17.15	54.57	76.12	13.80	0.05	0.16	0.22	0.04	3.54	11.28	15.74	2.85
2013	15.75	48.73	67.30	12.14	0.05	0.15	0.21	0.04	3.58	11.09	15.32	2.76
2014	15.43	46.16	63.68	11.64	0.05	0.14	0.19	0.03	3.67	10.98	15.14	2.77
2015	16.68	47.78	65.69	11.59	0.05	0.14	0.19	0.03	3.87	11.07	15.23	2.69
2016	14.87	41.90	56.07	9.88	0.04	0.12	0.17	0.03	3.82	10.76	14.41	2.54

3. A CROSS ANALYSIS OF ECONOMIC AND CRASH DATA

Figure 4 presents the association between GNI (Gross National Income) per capita and death per capita. Figure 5 presents the variation in deaths per capita, deaths per vehicle, GNI per capita, and the number of vehicles per capita, based on 1980 values. GNI per capita, which was $1,512 at the beginning of the study in 1980, increased to $10,675 in 2016, resulted that Turkey moved out of the low-income countries category and entered into the category of middle-income countries (see Table 1). In the literature, the relationship between economic prosperity and the number of deaths per capita has been revealed by many studies. Past studies have shown that the number of deaths per capita increases with economic development in low-income countries and decreases with economic development in high-income countries. As mentioned earlier, deaths per capita peaked in 1987 with a 50% increase after 1980, and then declined almost linearly. When GNI per capita is examined, it is seen that the GNI per capita fell until 1984, then continuously increased until 2016, except for the recession periods in

the economy (see Figure 4 and 5). In 1987, the GNI per capita was $1,608, which was the year with the highest number of deaths per capita in the study period, and it is within the $1,500-$8,600 interval stated in the similar literature studies [5,8]. Unlike the literature, in the period of 1980-1987 in which deaths per capita increased, GNI per capita did not rise, however, it seriously decreased between 1980 and 1984 (22%), after that, increased to a little above the 1980 level. Furthermore, it is revealed that when the death rate peaked in 1987, the number of vehicles per capita different from the findings in the literature. While it is showed that the death rate peaks in the interval of 100-350 vehicles per 1000 people in the literature [11,12], it peaked despite the lower rate of vehicle ownership in Turkey (56 vehicles per 1000 people). Similar to the studies in the literature, deaths per capita and deaths per vehicle significantly decreased after 1987 as parallel to the economic development (see Figure 4). If Figure 5 is examined, it can be seen that the number of vehicles per capita is regularly increasing, while the number of deaths per vehicle showed slight fluctuations in the 1980-1987 period and then decreased more rapidly than the increase in the number of vehicles per capita. Studies in the literature emphasize that an opposite trend should be expected for developing countries. Kopits and Cropper [5] stated that the number of vehicles per capita increases faster than the death per vehicle fall in developing countries, resulting in increasing death rates. Given the fact that Turkey is a still developing country, and accordingly, the vehicle ownership and VKT are increasing, the number of traffic deaths had expected to continue to increase. However, unlike the findings in the literature, the number of deaths started to decrease after 1998.

It is seen that vehicle ownership increased as a result of the increase in the income, which led to an increase in VKT. The increase in VKT has led to an increase in the number of crashes (see Table 1 and 2). As can be seen in Table 1 and 2, almost all the indicators showed significant changes after 2002, especially GNI per capita, vehicle ownership, VKT and crash numbers showed a rapid increase. This rapid increase can be explained by the recovery experienced after the economic crisis in 2001. In addition, because of the economic development, government has started to allocate substantial amount of budget to increase length and quality of the highway network. Particularly after 2002, priority was given to investments in divided multilane highways, and the intercity highway network were started to be converted into divided highways. As a result of this policy, the proportion of the divided intercity highways were increased to 76.6% in 2016, which was only 12.3% in 2002. This might be one of the reasons behind the decreasing trend of the traffic deaths, even though vehicle ownership and VKT rapidly increased after 2002, since divided highways prevents head-on collisions. Efforts have been continuing for converting the entire 31,106 km intercity highway network into a divided network. In addition, the role of traffic enforcements has been increased in road safety policy and penalties became deterrent in Turkey. Over the last decade, speed cameras has been installed to monitor compliance with speed limits. As a result of these inspections, the annual monetary amount of traffic tickets per driver reached to $39, which was $11.3 in 1999 (see Table 2). Since July 1, 2017, average speed control systems have been also started to use on motorways. However, despite the decreasing trends of the traffic deaths, the number of crashes and injuries continue to increase.

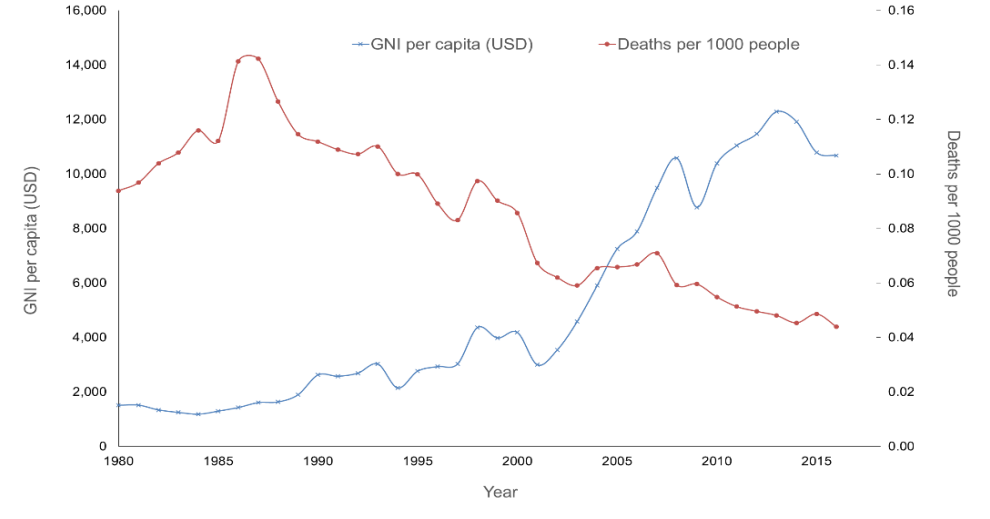

Figure 4. The association between GNI per capita and death per 1000 people**,** 1980-2016

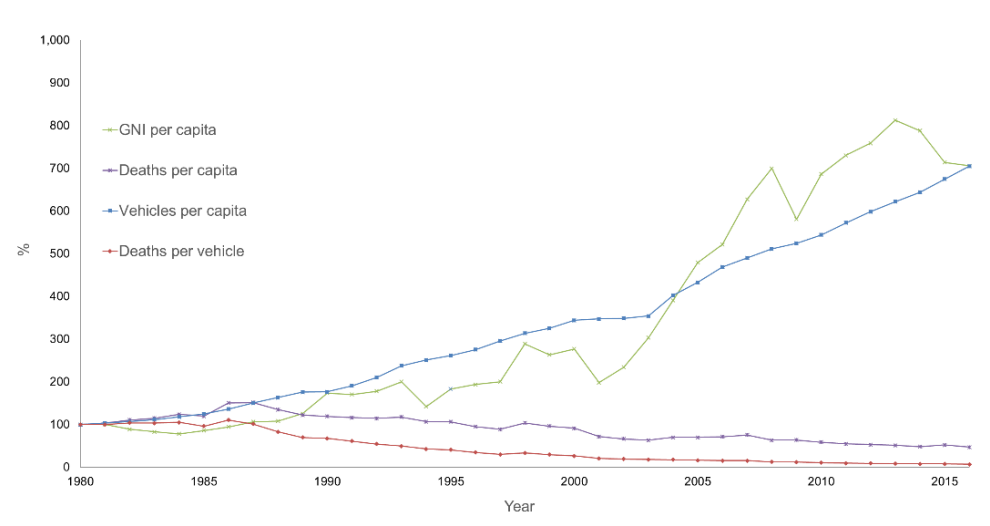

Figure 5. GNI per capita, deaths per capita, vehicles per capita, death per vehicle (1980 base)

4. CONCLUSIONS

It is natural that an increase in income of a country leads to the increasing rates of vehicle ownership and traffic deaths in the first stage. The economic development is also an opportunity for the governments to make the sufficient investments. If these highway investments are implemented and stricter enforcements are applied, the number of crashes, deaths and injuries could be reduced. In Turkey, the budget allocated to highway investments increased every year after 1995, and the length of the divided highways increased accordingly. Traffic enforcements were tightened. Pilot studies have been also undertaken to improve traffic culture in selected regions. As a result, the number of deaths and death rates have significantly decreased. However, death rates are still higher than rates in the European Union countries. Including post-crash period, 0.09 deaths occurred per 1000 people in 2016, which is around 0.05 for European Union-28 countries [25]. Furthermore, despite the decreasing trends of the deaths, the number of crashes and injuries are increasing. These findings support Bishai's [8] argument that the decline in the death rates in developed countries can be explained by lower injury severity and better care facilities after a crash. Various factors may influence the severity of crashes. Among all, increasing length of the divided highways might be one of the main reasons behind this figure, since divided highways prevent head-on collisions. Advances in automotive technology may have been also effective in reducing crash severity. A detailed analysis should be conducted to understand the effects of these factors on crash, death and injury rates in Turkey. In addition, traffic safety profile of a country may show geographic variations. Income, motorization and traffic density performances of industrial regions are expected to be better than those of undeveloped regions. Further research focusing on the role of regional disparities in accident occurrence, and geographic variations of accident rates should be carried out. Therefore, effectiveness of regional transport policies in fatality reduction can also be evaluated.

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