

# Investigation of the Role of Traffic Police Function in Reducing Geographical Inequalities in Mortality from Road Traffic Accidents

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## Abstract

**Background and Objectives:** Road traffic accident (RTA) is one of the major public health problems. Inequality in this problem and its trend has not been yet investigated in Iran. A better understanding of different contributing factors to RTA like inequalities can be helpful to reduce the negative influence of road crashes. Hence, this study aimed at examining geographical inequality in mortality from RTAs over the previous decades. **Materials and Methods:** In this cross-sectional study, all people who died from RTAs from March 2006 to February 2015 were selected. The data were taken from Legal Medicine Organization in Iran. The Theil index was used to estimate geographical inequality in mortality from RTA. Data were then analyzed using the Stata software. **Results:** During the 10-year period of this study, 210,582 people in Iran died due to RTA. The mortality rate that caused by RTAs has decreased during the study. We found a larger reduction in a mortality rate in suburban RTAs. In spite of the reduction in RTAs death, geographical inequality increased during the 10-year study. **Conclusions:** The findings of this study indicate that there is a geographical inequality in mortality from RTAs in Iran. This implies that effective interventions in reducing the RTAs should be distributed equally among regions of the country. Further research can be performed to investigate the causes of this inequality.

**Keywords:** Geographical inequality, Iran, mortality, road traffic accident, trends

## INTRODUCTION

With the progression of technology, economy, and quality of life during the time, more and more vehicles appear on the roads. This phenomenon increases the occurrence of a road traffic accident (RTA).<sup>[1]</sup> RTAs are one of the significant health problems<sup>[2,3]</sup> and a leading cause of mortality, disability, and hospitalization, especially in low- and middle-income countries. Furthermore, the cost of treatment and productivity loss in injured people cause a considerable economic burden on the victims, their families and the nation as a whole.<sup>[4-6]</sup> According

to the World Health Organization (WHO) report, every year the lives of almost 1.25 million people are reduced as a result of RTAs,<sup>[7]</sup> and a significant proportion of these deaths occur in South-Western Asia (which Iran is located in this area).<sup>[8]</sup>

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RTAs are the second cause of death, the first leading cause of years of life lost due to premature mortality and the most common cause of injury in Iran.<sup>[9,10]</sup> According to the WHO report in 2015, the mortality rate that is caused by RTAs in Iran is 32 deaths per 100,000 persons but local estimates according to the Legal Medicine Organization (LMO) of Iran is lower and around 25.6 deaths per 100,000 persons.<sup>[9,11,12]</sup> Iran with this mortality rate (32/100,000) is located in the countries that have the highest rate from RTA.<sup>[5,13]</sup>

Although the epidemiology of RTAs and their determining factors have been extensively investigated and debated at the national level, inequality in mortality from RTAs and its trend are not well-explored.<sup>[9-13]</sup> The term of health inequality generically refers to differences in the health of individuals or groups. In other words, any measurable aspect of health that varies across individuals or according to socially relevant groupings can be called a health inequality.<sup>[14]</sup> The geographical inequality in mortality from RTAs has been demonstrated by a few researchers. In one study conducted by Jones *et al.* in Britain indicated that the mortality from RTAs has been distributed unequally among the local authority districts.<sup>[15]</sup> However, these studies were mainly conducted in high-income countries, and the situation in low- and middle-income countries, including Iran needs much more attention.<sup>[2,15,16]</sup> In view of the fact that effective measures to reduce the negative influence of road crashes would require an understanding of different contributing factors such as disparities, which have garnered less attention in the public health arena, this study aimed to:

1. Estimate geographical inequality in mortality from RTAs over the last decade in Iran
2. Examine the role of traffic police function (taking into account the importance of traffic police in reducing the deaths from RTAs) in geographical inequality in mortality from RTAs.

## MATERIALS AND METHODS

### Study population

In this cross-sectional study, the study population included those who died from RTAs in all provinces of Iran between March 2006 and February 2015. We considered all RTA fatalities including deaths of motor vehicle occupants, bike riders (motorized and nonmotorized), and pedestrians which had occurred on public roadways and the time of death was not more than 30 days after the accident.

### Data source

We collected data from the LMO. In Iran, all suspicious deaths should be referred to LMO centers, and the legal process of issuing a death certificate should be done under the direct supervision of this organization. Mortality due to RTAs is one of the definitions of suspicious death, thus this organization has the most complete source for RTAs death data. In this study, physicians who were responsible for the autopsy room in each province collected the data using the standard forms and sent

them monthly to capital legal medicine center in Tehran. These forms were designed based on the study variables. Based on the 10<sup>th</sup> edition of the International Classification of Disease-10, the codes V01-V99 were classified as RTA deaths. Data about police function were extracted from traffic police database.

### Study variables

In this study, geographical characteristics including the province of death occurrence, and place of collision (inside or outside city roads) were received from LMO; Data about traffic police function including the number of issued traffic tickets and also the number of certified drivers were extracted from traffic police. After collecting the data, the process of data cleaning was performed. When we faced with missing or imprecise codes in the database, death registry coordinator tried to correct them by calling and negotiating with a responsible doctor in the providential LMO office.

### Statistical analysis

RTA mortality rates were estimated by dividing the number of RTA deaths in each province during each year by the mid-year population of that province. The population numbers were obtained from the statistical center of Iran. All the rates were directly aged standardized by the World Standard Population (WHO 2000–2015). The rates are presented per 100,000 populations. Police function in each province was calculated by dividing the number of the issued traffic tickets in each province during each year by the number of certified drivers of that province. Police function in each year is presented per 100 population.

### Inequality measures

The Theil index was employed to measure geographical inequality in mortality from RTAs. Theil index is becoming a standard tool for the measurement of inequality in unordered groups (provinces of Iran in this study). The data were analyzed using the Stata software version 14.1 and DASP statistical package version 14.

Theil index is one of the disproportionality measures that developed by Henri Theil in 1967. This measure can be decomposed into between group and within group components in the presence of continues outcome and individual data. Even in the absence of continues and individual data (e.g., mortality and incidence), entropy indices easily can be used to calculate between group disparities. This measure can be written by the following formula:

$$T = \sum_i^j = p_j r_j \ln(r_j)$$

In this equation,  $p_j$  is the share of each province from the population and  $r_j$  is the ratio of the mortality from RTA in each province to the average of mortality that caused by RTAs in the whole country in each year. Measuring between-group inequality in the above manner makes clear that changes in the value of inequality over the time are of the function of two quantities: changing  $p_j$  and  $r_j$ . The differentiation between these two components is important in choosing

interventional and preventive public health policies. If we find that inequality is increasing but that the main reason for the observed change is that the share of each province in the total population has increased, it simply demonstrates that the inequality increase is primarily due to movement into and out of different provinces – not to differentially increasing rates of RTA within provinces of the country. If we find, however, that population shares have remained relatively constant over time, but RTA inequality has increased because RTAs ratios are increasing; this implicates differential source of RTA changes in particular group which may then become the target of public health intervention.

There are different Stata commands for calculating the Theil index including; ientropy, geivars, ainequal, ineqdeco, inequal7, ineqerr and ainequal. The output of all these commands is the same but we reported the results from ientropy command because it reports the confidence interval. This index fluctuates between zero and one. When there is no geographical inequality in mortality from RTA, the Theil index is zero, with increasing the inequality, the value of this index also increases (when all outcomes occur in the province with the lowest population, the Theil index has the highest rate).

We also repeated all the analyses separately for mortality rates of inside and outside city roads.

## RESULTS

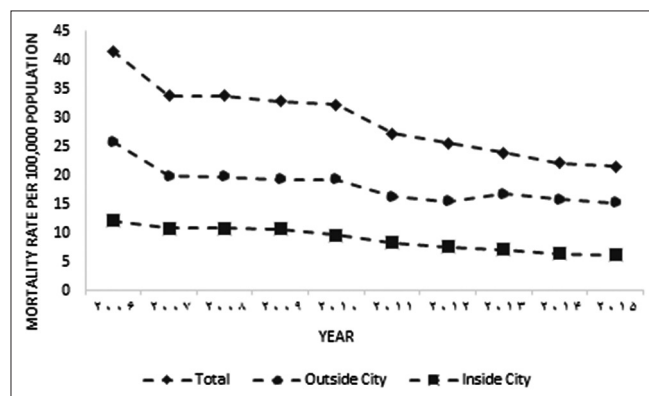
This study showed that during the 10-year period, there was a total of 210 582 RTA deaths. The RTAs mortality rate in our study decreased from 41.50/100,000 in 2006 to 21.50 in 2015. The same decreasing trend was also observed when we analyzed RTAs mortality rates by inside and outside city roads. The mortality rates for RTAs are less for inside city injuries than for outside city injuries. This favorable situation can be observed during the 10-year period of study (mortality rates for outside city injuries were about two times higher than that of inside cities). The total decrease between 2006 and 2015 was 40.70% in outside city injuries, 49.18% for inside city injuries and 48.19% generally. The trends of the road traffic

mortality rates for outside and inside city injuries have been shown in Figure 1.

The inequality in mortality from RTA and its trend based on the Theil index are presented in Table 1 and Figure 2. In 2006, the Theil index demonstrated that RTA mortality rates were unequally distributed among provinces in Iran (Theil index: 0.05; 95% confidence interval [CI]: 0.004, 0.11). In general, the inequality in RTA death rates fluctuated during the study but increased by an average of 20%. According to the Theil index value in Table 1, we found that there was no evidence that the inequality in mortality from outside city RTAs during the time of the study was different from null (most CIs included zero). The results for linear regression analysis indicated that for every additional year in time, total inequality increases by an average of 0.002 ( $P = 0.04$  and coefficient: 0.002). Alterations in the total Theil index during a 10-year period of the study was linear, this linear trend was also observed for the outside city and inside city injuries [Figure 2a-c].

Table 2 shows the percentage of police function and inequality in the distribution of this function among provinces of Iran during the study. In general, police function increased by 154.72% during this time, but the Theil index indicated that the distribution of police resources was not equal across the provincial levels. The regression model was used to analyze how inequality in the distribution of traffic police function was associated with the passing of time. Results showed that this inequality was reduced in the time of the study. The additional result was presented in Table 2.

The results of the linear regression model showed that the mortality rate from RTAs decreased by increasing the police function rate (Equation 1). On the other hand, the results of the quadratic regression model showed that if the distribution of police traffic function was equal, death from RTA more and more decreased (Equation 2).

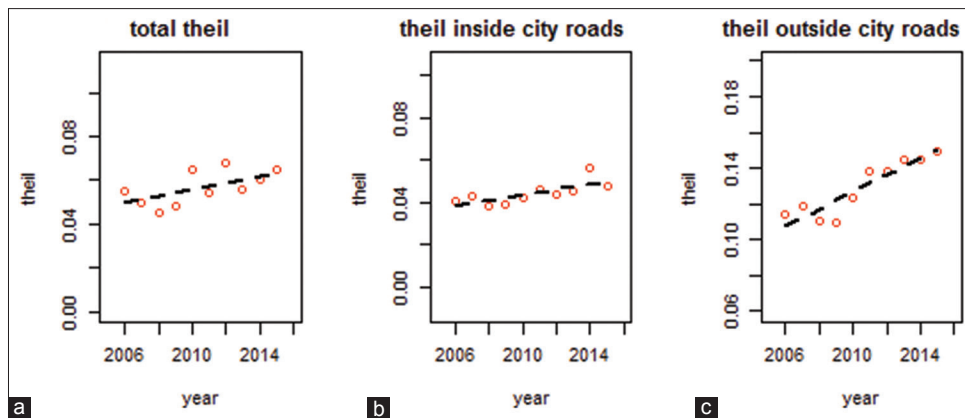


**Figure 1:** Age-adjusted RTA mortality Rates per 100,000 in each outside and inside injuries over the 10-year period from 2006 to 2015 in Iran

**Table 1: Inequality in mortality from road traffic accident based on the Theil index in Iran during 2006-2015**

Years of study	Theil index (95% CI)		
	Total	Inside city roads	Outside city roads
2006	0.05 (0.004-0.11)	0.04 (0.02-0.07)	0.11 (-0.0001-0.22)
2007	0.05 (0.0004-0.10)	0.04 (0.02-0.08)	0.12 (-0.01-0.25)
2008	0.04 (0.002-0.88)	0.04 (0.01-0.06)	0.11 (-0.01-0.23)
2009	0.04 (0.05-0.09)	0.04 (0.01-0.06)	0.11 (-0.02-0.23)
2010	0.06 (0.007-0.12)	0.04 (0.02-0.07)	0.12 (-0.01-0.26)
2011	0.05 (0.006-0.10)	0.05 (0.02-0.07)	0.14 (-0.02-0.3)
2012	0.07 (0.02-0.11)	0.04 (0.02-0.06)	0.14 (-0.01-0.29)
2013	0.06 (0.005-0.11)	0.04 (0.03-0.06)	0.14 (-0.04-0.33)
2014	0.06 (0.005-0.11)	0.06 (0.03-0.08)	0.14 (-0.03-0.32)
2015	0.06 (0.003-0.12)	0.05 (0.02-0.07)	0.15 (-0.04-0.33)
$\beta$ coefficient	0.002	0.002	0.005
$P$	0.04	0.01	0.001

CI: Confidence interval



**Figure 2:** Trends of geographical inequality in mortality from RTAs based on Theil index over the 10 years' period from 2006 to 2015 in Iran: (a) Geographical inequality in total injuries based on Theil index. (b) Geographical inequality in inside city roads injuries based on Theil index. (c) Geographical inequality in outside city road injuries based on Theil index

**Table 2: Relative frequency distribution of police function and inequality in this function in Iran during 2006-2015**

Years of study	Relative frequency of traffic police function	Theil index (95% CI)
2006	88.54	0.08 (0.05-0.11)
2007	129.29	0.051 (0.03-0.07)
2008	167.88	0.038 (0.02-0.06)
2009	164.67	0.034 (0.01-0.05)
2010	188.85	0.042 (0.02-0.06)
2011	219.82	0.07 (0.05-0.11)
2012	160.95	0.036 (0.02-0.05)
2013	186.90	0.055 (0.03-0.08)
2014	204.70	0.059 (0.03-0.08)
2015	225.53	0.092 (0.04-0.14)
$\beta$ coefficient	11.37	Year: -0.02 Year <sup>2</sup> : 0.002
<i>P</i>	0.003	0.02

Equation 1:

$$\text{Mortality from RTAs} = 54.24 - 0.14 \text{ Police function rate}$$

Equation 2:

$$\text{Inequality in mortality from RTAs} = -116.98 + 4.44 \text{ Inequality in police function rate} (\times) - 0.02 \times^2$$

According to the Theil index formula that presented in the method section, change in the value of inequality over time is a function of two quantities:  $p_j$  (Share of population of each province from the total population) and  $r_j$  (the ratio of the mortality from RTA in each province to the average of mortality that caused by RTAs in the whole country). Hence, any increments in this index can be because of increments in one or both of these values. When we examined these two factors in our study [Table 3] demonstrated that the  $p_j$  remained relatively constant over time. Hence, it can be implicated that increase in inequality in RTA mortality is solo because the RTA mortality ratios ( $r_j$ ) are changing among particular provinces, which may then become the target of public health

interventions.<sup>[5]</sup> According to Table 3, the amounts of  $r_j$  in the provinces of East Azerbaijan, Ardabil, Isfahan, Ilam, Booshehr, Fars, and ... were increased.

## DISCUSSION

In this study, we documented that the mortality rate due to RTA decreased from 41.5/100,000 populations in 2006 to 21.5 in 2015, this finding was consistent with previous researches.<sup>[17,18]</sup> This decline was observed for both outside and inside city rates during the study. This reduction in the trend can be justified by the simultaneous collaboration of traffic police and the ministry of health and medical education (MOH and ME). The most important police action in reducing road accidents and its consequences was legislation of wearing of seatbelts and motorcycle helmets mandatory, amplification of traffic rules, and production of mass media training programs (all these interventions began in 2005 in Iran).<sup>[17-20]</sup> The MOH and ME activities were to minimize the postaccident phase by enhancing the emergency medical services in terms of technical, equipmental, and operational; these services included increasing the numbers of ambulances, air ambulance facilities, motorbike emergency services, and emergency medical service stations and reducing the average time to provide emergency services.

According to our results, the mortality rate from RTAs in the outside city is almost twice the inside city. Similar results were seen in prior researches. Many different types of risk factors may contribute to the increased injury mortality rates in outside city roads including lack of safety on outside city roads, especially on rural roads, the high average speed of vehicles travelling on the suburban roads, inappropriate geometric structures on these roads such as the presence of arcs or steep angles on some of the roads, existence of spiral mountain roads, the absence of safeguards on the edge of the roads, lack of parking or earthly shoulders on the roads, and undesirable lighting on these roads.<sup>[5,21-27]</sup>

The result of this study showed that despite remarkable progress in reducing RTAs deaths, geographical inequality in



**Table 3: Values of  $p_j$  and  $r_j$  by the province of collision between 2006 and 2015 in Iran**

Provinces of the country	$p_j$			$r_j$		
	2006	2010	2015	2006	2010	2015
East Azerbaijan	0.05	0.05	0.05	0.80	0.83	0.94
West Azerbaijan	0.04	0.04	0.04	0.78	0.81	0.79
Ardabil	0.02	0.02	0.02	0.70	0.7	0.75
Isfahan	0.06	0.06	0.06	0.98	0.98	1.04
Ilam	0.01	0.01	0.01	0.84	1.01	1.45
Booshehr	0.01	0.01	0.01	1.24	1.18	1.37
Tehran	0.19	0.19	0.19	0.50	0.5	0.44
Charmahale Bakhtiari	0.01	0.01	0.01	1.03	0.86	1.07
Southern Khorasan	0.01	0.01	0.01	0.96	1.31	1.35
Khorasan Razavi	0.08	0.08	0.08	0.99	1.00	0.97
North Khorasan	0.01	0.01	0.01	1.21	1.34	1.41
Khuzestan	0.06	0.06	0.06	0.93	0.88	0.84
Zanjan	0.01	0.01	0.01	1.27	1.28	1.22
Semnan	0.01	0.01	0.01	2.01	2.31	2.10
Sistan and Baluchistan	0.03	0.03	0.03	1.24	1.23	1.33
Fars	0.06	0.06	0.06	1.32	1.31	1.36
Qazvin	0.02	0.02	0.02	1.65	1.28	1.39
Qom	0.01	0.01	0.01	1.26	1.31	1.05
Golestan	0.02	0.02	0.02	1.02	1.14	0.94
Gilan	0.03	0.03	0.03	1.38	1.14	1.22
Lorestan	0.02	0.02	0.02	1.29	1.26	1.16
Mazandaran	0.04	0.04	0.04	1.09	1.11	1.10
Markazi	0.02	0.02	0.02	1.39	1.88	1.65
Hormozgan	0.02	0.02	0.02	1.30	1.2	1.14
Hamedan	0.02	0.02	0.02	1.30	1.26	1.29
Kurdistan	0.02	0.02	0.02	1.10	1.19	1.26
Kerman	0.04	0.04	0.04	1.6	1.12	1.54
Kermanshah	0.03	0.03	0.03	0.92	1.01	1.04
Kohgiluyeh	0.01	0.01	0.01	0.90	0.9	1.14
Yazd	0.01	0.01	0.01	1.22	1.2	1.03

mortality from RTAs increased between 2006 and 2015 in the provinces of the country (inequality increased 20% in the Theil index). This means although effective measures in reducing RTA deaths have increased during the last decade, these programs have not been fairly distributed among the provincial level or the effectiveness of these measures varied between the regions. The results of this study are consistent with two other studies, which have investigated regional inequalities in road traffic death.<sup>[28,29]</sup> According to a study that conducted in England, there is geographical inequality in mortality from RTA; this study demonstrated that fatal injuries have been concentrated in disadvantaged areas.<sup>[15]</sup> Regarding the role of traffic police function in RTA death inequality, the traffic performance has increased by 154.72%, but this factor has been unequally distributed across the regional levels, which can be a factor in increasing the inequality in mortality from RTAs. Therefore, the expansion of factors related to the reduction of fatal accident with an emphasis on the fairly distribution of this resources among the provinces of the country is necessary.

When we examined the components of the Theil index, it was found that was constant in all provinces during the time and amount of changed over time in some provinces [Table 3]. Therefore, intervention for reducing traffic accidents should be concentrated in these provinces.<sup>[30]</sup>

This research extends previous studies in two important ways. First, this is the first study to measure regional inequality in mortality from RTAs by specific indicator of inequality. Second, in this study, the role of traffic police function in the creation of inequality in mortality from RTAs was evaluated for the first time. However, there are some limitations to our analyses. First, in this study, a denominator for the rate calculation was population of the place of residence. People exposed to the risk of RTAs in both residence and nonresidence areas, but there is no information available on the population of nonresidents. Second, we did not measure the death rates of drivers, passengers, and pedestrians separately. This greater level of detail would be desirable to improve our ability to explain the patterns of inequality found. We cannot ignore this hypothesis that inequality in mortality among pedestrians is not the same as for vehicle users. Future studies should try to investigate RTA mortality inequalities separating these groups. Third, in this research, we measured inequality in mortality from RTA among the provinces; while interventional and preventive measures are implemented at smaller levels; therefore, it is recommended that the inequality be measure at these levels. Fourth, in this ecological study, we must be careful about the occurrence aggregation bias in interpretation of the results. This means that when we study in an aggregate level in ecological studies, our conclusion must be in that level not at the individual level because the observed relationship between variables on an aggregate levels does not necessarily represent the association that exists at an individual level. Finally, it should be noted that this study was the first national survey to examine regional inequality in mortality from RTA; although this could be considered as the positive point of this study but the lack of a similar study in the country made it difficult to interpret the results.

### CONCLUSIONS

A decrease in the road traffic mortality rate after 2005 can be attributed to effective interventions by the legislative organization, police, MoRT and MOH and ME and also mass media training. This finding can serve as a basis for health-care professionals and policymakers to implement more preventive measures. The existence and increment of inequality among the province of Iran indicate geographically unequal distribution or the effectiveness of these interventions and can serve as a guide for authorities to distribute effective interventions equally in all geographical area.

Finally, this research was a basic study to examine the existence of inequality and its trend; therefore, our finding suggests that additional work should be investigated regarding the cause of this inequality.

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## Conflicts of interest

There are no conflicts of interest.

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