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ANALYSIS OF THE PEDESTRIAN ACCIDENTS IN TURKEY

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ABSTRACT:
This study summarizes the methods and findings of a study on pedestrian safety in Turkey. The analyses were conducted for individual provinces as well as for the country as a whole for the years from 2013 to 2015 using data maintained by the Turkish Statistical Institute. An examination of the national level results indicated that despite the equal distribution of women and men in national population, men constitute the 70% of the fatality in pedestrian accidents and 57% of the injuries. It was found that 65+ age group had the highest rate of accident involvement and fatality rates per million population. The lowest accident involvement rates were observed in the 25-64 age group, while the lowest fatality rates were observed in the 15-24 age group. Province level analysis provided a comparative analysis of pedestrian safety records across the 81 provinces. The comparisons were performed in relative terms. In this case study, pedestrian accident involvements and fatalities per million registered vehicle and population were used as the measures of exposure. Clustering analysis were performed to reveal some patterns based on geographic location of the provinces. The results showed that accident involvement and fatality rates per million population were not significantly clustered. Fatality rates per million registered vehicles were significantly clustered 90% confidence level and pedestrian accident involvement rates per million registered vehicles were significantly clustered 95% confidence level.

Keywords: *Pedestrian Accidents, Pedestrian Safety, Clustering Analysis*

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1. INTRODUCTION

Pedestrians, the most vulnerable road users, should have a level of importance in traffic. Road traffic regulations primarily aim to achieve fast and uninterrupted traffic streams. This importance is ignored most of the time. According to the World Health Organization (WHO), approximately 275,000 pedestrians die annually in traffic accidents. This number corresponds to 22% of all fatalities caused by accidents (WHO, 2015). Previous studies have shown that pedestrian safety is an important problem, not only in developing countries, but also in developed countries (Zhu et al., 2013). Pedestrians constitute 26% of the accident fatalities in China, 16% in Germany, 47% in Honduras, 30% in Mexico, 39% in Romania, 23% in United Kingdom and 14% in the US (WHO, 2016).

In 2015, 1,810 pedestrians died and 34,720 pedestrians were injured in traffic accidents. Therefore, pedestrians constituted 24% of the fatalities by accident in Turkey (TurkStat, 2016a). Like many other countries, there is no data available to show the pedestrian mobility in traffic in Turkey. The pedestrian fatalities per billion vehicle-km should be calculated to make a reliable comparison between countries. However, as most of the pedestrian fatalities occur in urban roads, which do not publish vehicle-km values, the pedestrian fatality per billion vehicle-km may not be calculated in a reliable manner.

Therefore, the fatality rates of pedestrians in accidents is calculated using alternative measures. In 2015, 23 pedestrians for every million citizens died in traffic accidents in Turkey (TurkStat, 2016a; TurkStat, 2016b). The average rate of European Union (EU) countries is 11, however there are significant variations among countries. For example, while in the Netherlands, this rate is 3, in Germany it is 7, in Belgium 9, in Hungary 15, in Poland 29, in Latvia 35 and in Lithuania it is 37 (EC, 2016). It is 17 in the US (NHTSA, 2016). When the total number of pedestrians involved in traffic accidents are considered, 464 pedestrians per million population were involved in an accident in Turkey (TurkStat, 2016a; TurkStat, 2016b). In the US, 215 pedestrians per million population were involved in traffic accidents (NHTSA, 2016). For EU countries, the number of pedestrians involved in traffic accidents is not published.

When the literature is reviewed, studies regarding pedestrian safety in Turkey are limited. In the existing studies, the descriptive statistical analysis of pedestrian accidents were made (e.g. accident locations, date and time of the accidents, road type and environmental characteristics and driver errors) (Ozkan, 2002; Hoskal, 2006). In a recent study, pedestrian accidents occurred around bus stops in selected corridors of Ankara were examined and the factors effective in these accidents were investigated (Yuksekol, 2012). Additionally, there are studies, which review design problems of pedestrian facilities in the cities and the effects of such cases on the traffic safety (Kaplan et al., 2015; Caputcu et al., 2016).

There are no studies available in Turkey that analyses pedestrian safety by gender or age groups. Another research gap in pedestrian safety is the province level comparisons of the pedestrian safety. To fill these gaps in the literature, the first stage of this study examines pedestrian accident involvement and fatality rates that are calculated based on gender and age at the national level. In the second stage of the study, pedestrian accident involvement and fatality rates were calculated at the provincial level by using different measures of exposure. Then, clustering analyses were applied to investigate whether these rates are correlated to geographically or not.

2. METHODOLOGY

In Turkey, pedestrian accidents are being reported and kept by traffic police and gendarmerie departments based on the area of responsibility. The aggregate statistics of these accidents are published by the Turkish Statistical Institute (TurkStat). The statistics published by TurkStat, prior to 2013, only included the accidents that were the responsibility of police. The statistics after 2013 include the pedestrian accidents from police and gendarme areas. Additionally, Turkey has started to implement the recommended post-accident 30-day observation period at the international level since 2015. Therefore, while only the fatalities occurring at the accident locations were recorded prior to 2015, after 2015 any fatalities that occurred within 30 days of the accident were accepted as accidental fatalities and were represented that way in the statistics. According to statistics from 2015, 1,810 pedestrians died in traffic accidents, and 612 of these deaths (33.8%) occurred at the accident locations and 1,198 (66.2%) occurred within 30 days following the accident (TurkStat, 2016a). These figures explicitly reveal the significance of using data from 2015 on-ward in studies to be conducted on pedestrian fatalities in Turkey.

National level pedestrian accident statistics include the distribution of fatalities and injuries by gender, age and the type of accident location (urban or rural). Provincial level statistics include only the number of fatalities and injuries. There is no information about the number of pedestrian accidents at the national level nor at provincial level.

In this study, pedestrian involvement (fatality or injury) and the fatality rates in the accidents were calculated both at the national and provincial levels. While calculating the fatality rates, since 2016 data were not published yet, data from 2015, when the 30-day rule was initiated, were used. While calculating the accident involvement rates using data from 2013, when the police and gendarmerie data started to be published together, and afterwards were used.

Once the aggregate statistics regarding pedestrian accidents were provided in the analyses at the national level. The distribution of the pedestrians involved in an accident by gender was presented. Then, the number of pedestrian fatalities and the number of pedestrians involved in accidents per million population were analysed based on gender and age. In the discussion part of the study, the results of these analysis were compared with the results of the previous studies in the literature. In the analysis at provincial level, the number of pedestrians involved in an accident and the number of pedestrian fatalities per million population and per million registered vehicles were calculated.

For the convenience of expression, the following abbreviations shall be used:

- FMP, for pedestrian fatality per million population;
- FMV, for pedestrian fatality per million registered vehicles;
- PIMP, for the number of pedestrians involved in an accident per million population;
- PIMV, for the number of pedestrians involved in an accident per million registered vehicles.

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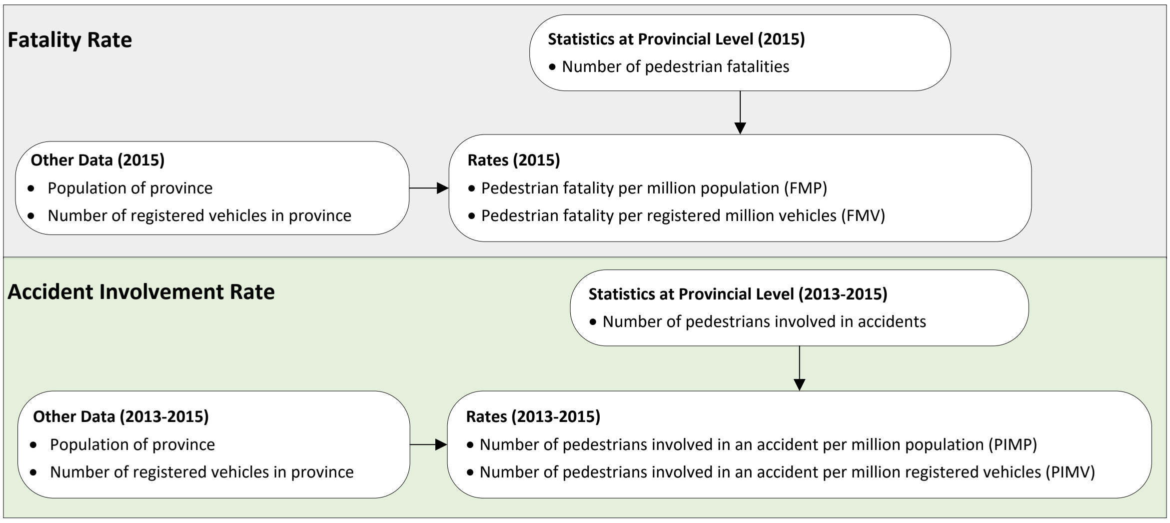

Figure 1. Methodology used in the calculation of accident rates at provincial level.

Methodology used in the calculation of accident rates at the provincial level is summarized in Figure 1. PIAMP and PIAMV rates were calculated using the following formulations.

$$PIMP_{\mathrm{i}} = \frac{1}{3}\sum_{j=2013}^{2015} 10^6 \left(\frac{Fatality_{ij} + Injury_{ij}}{Population_{ij}}\right) \quad (1)$$

$$PIMV_{\mathrm{i}} = \frac{1}{3}\sum_{j=2013}^{2015} 10^6 \left(\frac{Fatality_{ij} + Injury_{ij}}{Vehicle_{ij}}\right) \quad (2)$$

where, i refers to the index used for provinces; j refers to the index used for years; the words ‘Fatality’ refers to pedestrian fatalities; ‘Injury’ refers to the pedestrian injuries; ‘Population’ refers to the population of province; ‘Vehicle’ refers to the number of registered vehicles in province.

These rates were presented by using thematic maps in the Geographical Information Systems (GIS) environment. Then clustering analysis was performed to investigate whether these rates show any spatial correlation or not. During clustering analysis, Global Moran's I method was used. Moran's I value varies between -1 and 1. Positive Moran's I value indicates the clustering of similar values whereas negative Moran's I value indicates the clustering of dissimilar values. 0 indicates that there is no clustering. The following formulation was used in the calculation of Moran's I value (Moran, 1950).

$$I = \frac{N\sum_{i=1}^{N}\sum_{j=1}^{N} W_{ij}\,(X_i - \bar{X})(X_j - \bar{X})}{(\sum_{i=1}^{N}\sum_{j=1}^{N} W_{ij})(\sum_{i=1}^{N}(X_i - \bar{X})^2)}, \quad (3)$$

where, $\bar{X}$ refers to the mean of the variable; X_i refers to the value of the variable at a point; X_j refers to the value of the variable at another point; W_{ij} refers to the spatial weight between the relative locations of i and j points. The Z-score value, which indicates whether Moran's I was statistically significant or not, is calculated by the following formulation.

$$Z = \frac{I - E(I)}{\sqrt{V(I)}}, \quad (4)$$

where the E(I) value refers to the expected value of the I, which is equal to -1/(N-1). V(I) shows the variance of the I value. Moran's I analysis indicates a clustering approach but does not provide information regarding whether low or high values are clustered. If a clustering case is determined, it may be necessary to check General G statistics to understand the clustering of low or high values. If General G values are above the expected value of G, statistics suggest that the high values are clustered. If General G values are lower than the expected value of G instead, then the lower values are clustered. The General G statistic, its expected value and the Z-score were calculated using the following formulations (Erdogan, 2009).

$$G = \frac{\sum_{i=1}^{N}\sum_{j=1}^{N} W_{ij}\,(X_i X_j)}{\sum_{i=1}^{N}\sum_{j=1}^{N} X_i\, X_j} \quad (5)$$

$$E(G) = \frac{\sum_{i=1}^{N}\sum_{j=1}^{N} W_{ij}}{N(N-1)} \quad (6)$$

$$Z = \frac{G - E(G)}{\sqrt{V(G)}} \quad (7)$$

3. FINDINGS

3.1 Findings at the National Level

In 2015, 1,810 pedestrians died and 34,720 pedestrians were injured in traffic accidents in Turkey. These values constitute 24% of all fatalities and 11.4% of the injuries in traffic accidents. According to TurkStat, while 95.2% of pedestrians (34,790 pedestrians) were involved in accidents in urban areas, only 4.8% (1,740 pedestrians) were involved in accidents in rural areas. While only 4.1% (1,426) of the pedestrians involved in accidents in urban areas died, this ratio increased to 22.1% (384 pedestrians) in rural areas (TurkStat, 2016a).

The 2015 *FMP* value in Turkey was calculated as 23 and the *FMV* value was calculated as 91 (TurkStat 2016a; TurkStat 2016b). The rate of pedestrian involvement in traffic accidents, between 2013-2015, are given in Table 1. As shown in Table 1, *PIMP* and *PIMV* values have only showed minor changes between the years.

The *PIMP* values by gender and age are provided in Table 2. The key points of this table are summarized below.

- The 65+ age group has a significant lead on the highest *PIMP* value both in women and men. The 25-64 age group has the lowest *PIMP* value.
- 0-14 and 65+ age groups have significantly higher *PIMP* values in men than in women.
- The 15-24 and 25-64 age groups have *PIMP* values that are comparatively close between women and men.
- As men are significantly more involved in pedestrian accidents than women (see Table 3), the *PIMP* values in the whole population show the same trend in men.

In Table 3, the distribution of fatalities and injuries due to pedestrian accidents by gender is provided. Fatalities in 2015 are approximately three times more than the previous year. 68.5% of these fatalities in women (409 fatalities) and 65.0% in men (789 fatalities) occurred during the post-accident period. This emphasizes the importance of the improvement made in 2015 regarding the new data collection process. Men constitute 70% of the fatalities and 57% of the injuries. These values are high despite the equal distribution of women and men in the national population. The results also show that the number of pedestrians involved in accidents is increasing.

The *FMP* values in 2015 are grouped by gender and age in Figure 2 (TurkStat 2016a; TurkStat 2016b). In all age groups, the *FMP* value for men are higher than those for women. This difference becomes more apparent in the 65+ age group. The 65+ age group has the highest *FMP* value by far, for both women and men. The second group with the highest *FMP* value is the 25-64 age group. The 15-24 age group had the lowest *FMP* value.

Table 1. PIMP and PIMV values between 2013-2015.

Years	Population	Registered Vehicle	PIMP	PIMV
2013	76,667,864	17,939,447	435	1859
2014	77,695,904	18,828,721	457	1886
2015	78,741,053	19,994,472	464	1827

Table 2. PIMP by gender and age (TurkStat 2016a; TurkStat 2016b).

Years	Age	Woman	Man	Population
2013	0-14	400.2	620.4	513.3
	15-24	415.6	423.5	419.6
	25-64	314.7	371.6	343.3
	65+	536.2	1209.6	829.0
2014	0-14	413.5	654.0	537.0
	15-24	482.6	431.9	456.6
	25-64	325.7	380.1	353.1
	65+	594.2	1258.0	883.6
2015	0-14	428.5	680.7	558.0
	15-24	449.9	444.3	447.0
	25-64	342.7	371.9	357.4
	65+	603.3	1252.4	887.4

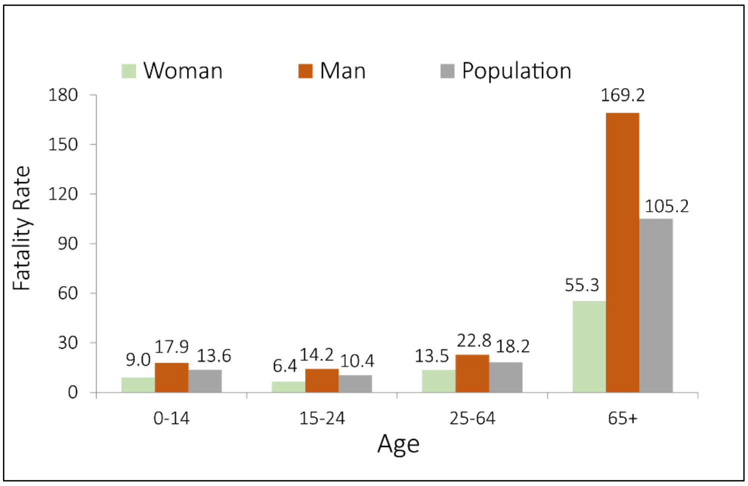

Figure 2. FMP by gender and age in 2015 (TurkStat 2016a; TurkStat 2016b).

Table 3. Distribution of fatalities and injuries in pedestrian accidents by gender (TurkStat 2016a).

Years	Fatality			Injury			Involved in Accident		
	Woman	Man	Population	Woman	Man	Population	Woman	Man	Population
2013	183 (28.0%)	470 (72.0%)	653 (100.0%)	13,984 (42.8%)	18,718 (57.2%)	32,702 (100.0%)	14,167 (42.5%)	19,188 (57.5%)	33,355 (100.0%)
2014	172 (28.8%)	425 (71.2%)	597 (100.0%)	15,159 (43.4%)	19,755 (56.6%)	34,914 (100.0%)	15,331 (43.2%)	20,180 (56.8%)	35,511 (100.0%)
2015*	597 (33.0%)	1,213 (67.0%)	1810 (100.0%)	15,262 (44.0%)	19,458 (56.0%)	34,720 (100.0%)	15,859 (43.4%)	20,671 (56.6%)	36,530 (100.0%)

* In Turkey, post-accident 30-day observation period was initiated in 2015.

3.2 Findings at the Provincial Level

In the analysis at provincial level, the *FMP* and *FMV* values were calculated using 2015 data, and *PIMP* and *PIMV* values were calculated using the data between 2013 and 2015. In the statistical analysis, at the provincial level, a very high correlation was found between pedestrian fatalities and both population and the number of registered vehicles (for both, *r*=0.97). Likewise, a very high correlation was found between the number of pedestrians involved in accidents and both population and the number of registered vehicles (*r=0.92* and *r=0.94*, respectively).

In 2015, the highest pedestrian fatalities occurred in Istanbul (176 fatality 14.5%), Ankara (94 fatality 7.7%) and in Izmir (64 fatality, 5.3%) which are the most crowded provinces. On the other hand, nobody died in pedestrian accidents in Tunceli; only 1 person died in Batman, Nevşehir, Hakkari, Karaman, Gümüşhane, Ardahan and Bayburt; and that 2 people died in Siirt, Bilecik, Sinop, Iğdır, Bartın, Artvin and Kilis. At this point, it is necessary to pay attention to the fact that the rates calculated by using small fatality numbers may substantially change based on small changes in fatality numbers. The fatality rates of provinces, where only one fatality occurred, would increase by three times if 2 more fatalities occur. This may be prevented by increasing the number of data years and using more representative average values for each province. Since it is necessary to use data from 2015 onward, in a study to be conducted in Turkey on pedestrian fatality rates and as 2016 data were not published, only the 2015 data might be used in this study.

In 2015, the mean *FMP* value at the province level was 15.2. The standard deviation of this value is 7.3. In Figure 3, the *FMP* values are shown on a thematic map. While preparing this map, five groups were selected as the region at least one standard deviation below the mean value (*FMP*<7.9), the regions below one standard deviation of the mean value (7.9<*FMP*<15.2), the regions above one standard deviation of the mean value (15.2<*FMP*<22.5), the regions above two standard deviations of the mean value (22.5<*FMP*<29.8), and the regions at least two standard deviations above the mean value (*FMP*>29.8). The reason for selecting such a grouping refers to the acceptance that the values within the range of one standard deviation below and above the mean value is part of the acceptable variability in the data. The values below and above this range are considered for relatively low and high values. The results of Moran's I analysis showed that *FMP* values were not significantly clustered at a 95% confidence level (*I:-0.09; Z-score:-0.83 and p-value:0.41*). As seen in Figure 3, provinces with high and/or low *FMP* value were randomly distributed. The *FMP* value is at least two standard deviations above the mean value in Bolu (38.8), Uşak (34.6), Şırnak (31.6), Çankırı (31.4), Bingöl (30.1). The provinces with the lowest FMP value have been Tunceli (0), Batman (1.8), Nevşehir (3.5), Hakkari (3.7), Ordu (4.1), Karaman (4.2), Diyarbakır (4.4), Siirt (6.4), Gümüşhane (7.1), Isparta (7.2) and Aksaray (7.8).

The mean *FMV* value at the province level was calculated as 81.7 (standard deviation: 84.2). The high coefficient of variation (*cv=1.03*) indicates that there is too much variability between the provinces. In Figure 4, *FMV* values are shown on the thematic map. While creating this map, ranges of one standard deviation to the right and left of the mean value were selected like in Figure 3. The results of Moran's I analysis showed that *FMV* values were not significantly clustered at 95% confidence level (*I:0.14; Z-score:1.94 and p-value:0,051*). On the other hand, there was a clustering at 90% confidence level (*p-value:0,051<0.10*). Because of this trend, red and maroon colours indicate that provinces with high *FMV* values were accumulated to the east of the map (see Figure 4). In the Bingöl (537.3) and Şırnak (485.8) provinces, *FMV* values are significantly higher than other cities (*FMV* in Van, which has third highest value, is 248.9). When the provinces with *FMV* values below the mean value are considered, they were all seen to be within a standard deviation range. When Figure 3 and 4 analysed together, it is found that that Bingöl and Şırnak are the provinces with the highest values in both measure of exposures. In 2015, 8 pedestrians in Bingöl and 15 pedestrians in Şırnak died in traffic accidents.

When the pedestrian accident statistics between 2013 and 2015 are reviewed, 30% of the pedestrians were involved in accidents in Istanbul (3458 pedestrians, 11.6%), Ankara (2778 pedestrians, 9.3%) and in Izmir (2180 pedestrians, 7.4%). Provinces where the pedestrians least involved in accidents had been Tunceli (18), Ardahan (26), Bayburt (32) and Iğdır (40). During this period, *PIMP* mean value at province level was found as 399 (standard deviation:140). The results of Moran's I analysis showed that *PIMP* values of the cities were not significantly clustered at a 95% confidence level and that they were randomly distributed (*I:0.04; Z-score:0.62 and p-value:0.53*) (see Figure 5). In Kilis (987.1) and Elazığ (721.7), *PIAMP* values are significantly higher than other cities. On the other hand, in Muş (173), Batman (184), Kars (189), Hakkari (199), Bitlis (200), Tunceli (205), Iğdır (211), Diyarbakır (230), Şanlıurfa (233), İstanbul (240) and Edirne (248), *PIMP* values are at least one standard deviation below the national average. It is remarkable that Istanbul, where the pedestrians are involved in traffic accidents the most, is listed in this group.

Between 2013 and 2015, the mean *PIMV* value at province level was found as 2293 (standard deviation: 1687). Like in *FMV* values, it is seen here as well that there is too much variability between the provinces (*cv:0.74*). *PIMV* values were highest in Siirt (10685), Bingöl (8805), Ağrı (6311), Şırnak (6289), Hakkari (5934), Van (5871) and Elazığ (4188). According to the results of Moran's I analysis, *PIMV* values were observed to cluster significantly at the 95% confidence level (*I:-0.09; Z-score:-0.83 and p-value:0.41*). General G statistic, which determines the type of this clustering showed that the cities with high *PIMV* values clustered (*G:10-6>E(G):0*). This trend is clearly seen in Figure 6. Local Moran's I analysis results indicating the clustering regions (see Figure 7). According to results of Local Moran's I clustering of high-high values were identified.

After investigation of the spatial correlations, statistical correlations between pedestrian accident rates (i.e. FMP, FMV, PIMP and PIMV) and provincial level indicators (i.e. income per capita, urbanization and literacy ratio) were examined. Results indicated that all of the correlations were weak, except the moderate negative correlations between provincial level literacy ratios and both FMV and PIMV values (*r=-0.48* and *r=-0.57*, respectively).

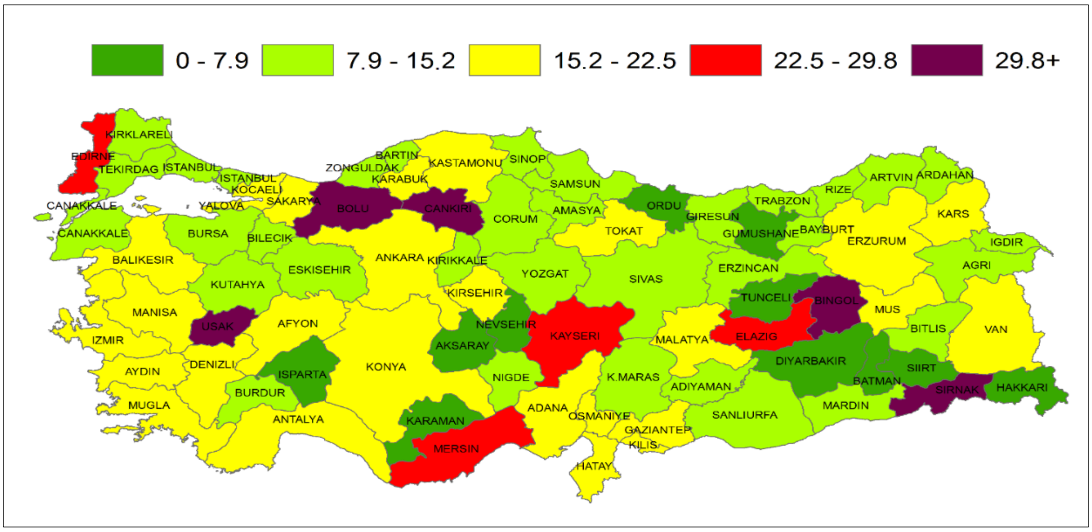

Figure 3. FMP values in 2015.

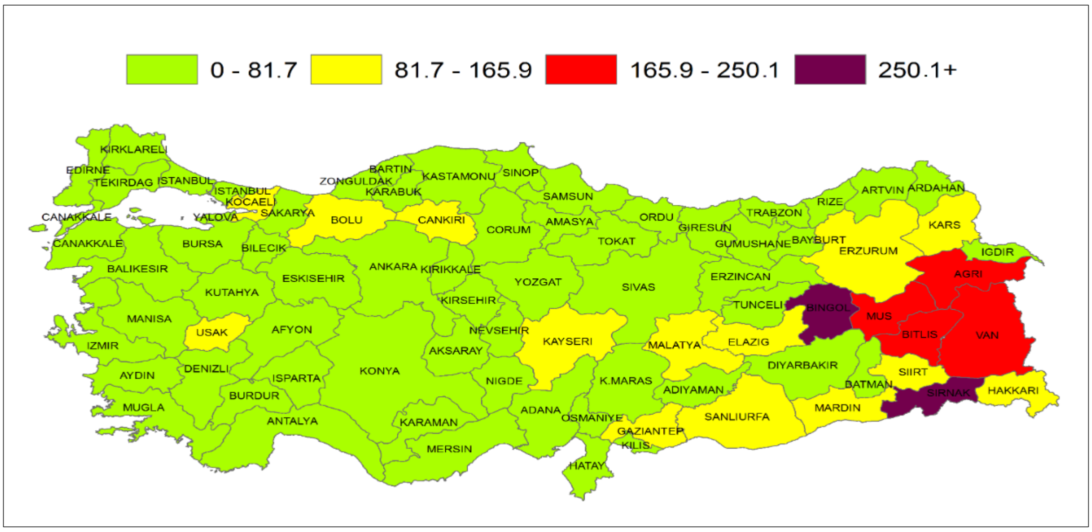

Figure 4. FMV values in 2015.

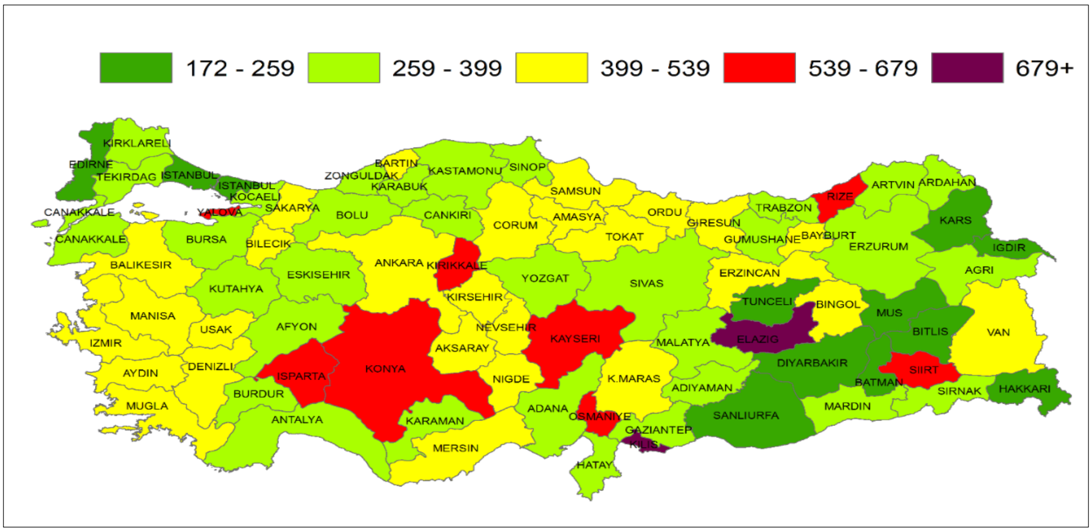

Figure 5. Average PIMP values between 2013 and 2015.

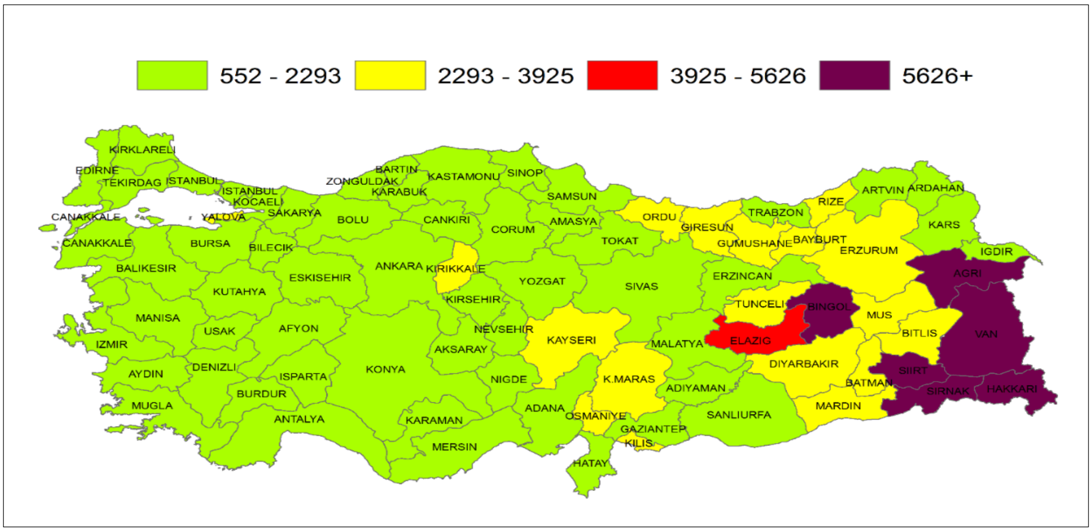

Figure 6. Average PIMV values between 2013 and 2015.

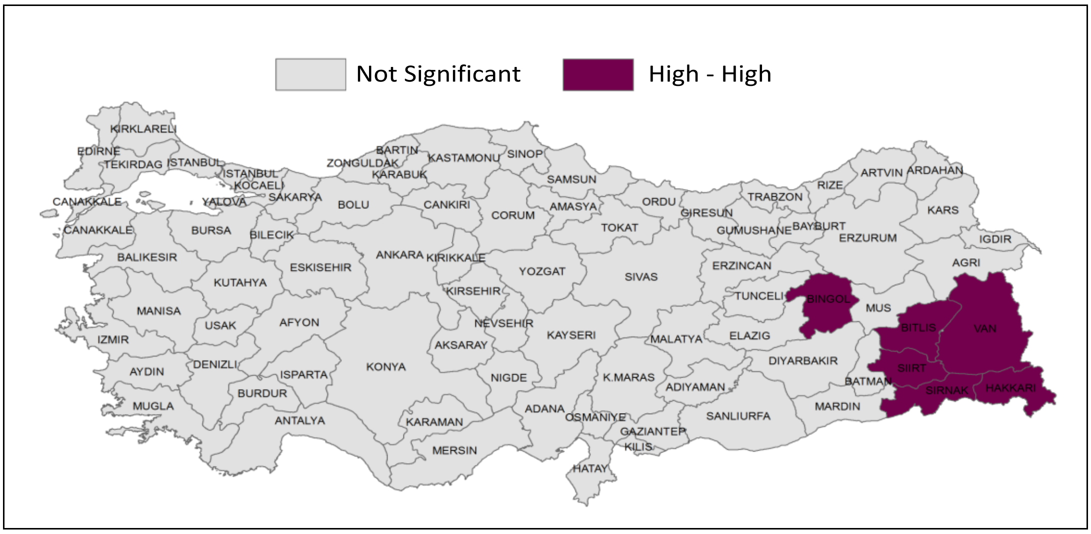

Figure 7. General G statistic for PIMV values.

4. DISCUSSION AND CONLUSION

Walking is one of the primary modes of transportation; therefore, it is necessary to provide safer pedestrian environments to encourage people to walk more frequently (Kim et al., 2008). Pedestrian characteristics (e.g. age, weight, height, gender), driver characteristics (e.g. age, intoxicated driving, speed behaviour), vehicle characteristics (e.g. vehicle body type, impact speed), temporal, environmental, land use and traffic control characteristics (e.g. existence of traffic signals) are the significant factors contributing severity of the pedestrian accidents (Henary et al., 2006; Kim et al., 2008; Onieva-García et al., 2016). Traffic education, engineering interventions, strict enforcement of traffic regulations have been proven to be effective strategies to prevent these accidents (Pucher and Dijkstra, 2003). For instance, many previous studies showed that older pedestrians do not take into account their slower walking speeds and frequently engage in more dangerous crossings (Charthy et al., 1995; Oxley et al., 1997). Sheppard and Pattinson (1986) indicated that older pedestrians get benefit from advices to choose safer walking routes. Crossing facilities with pedestrian islands in the middle of road, adopting green light periods to the walking speed of older people are some of the successfully implemented engineering interventions to improve pedestrian safety (Bernhoft and Carstensen, 2008).

Pedestrian fatalities in traffic accidents have a significant share among other fatalities in traffic accidents both in developed and developing countries. Globally, pedestrian fatality constitutes 22% of the fatalities in traffic accidents. It is 24% in Turkey (TurkStat, 2016a). When the statistics are reviewed, it is seen that the pedestrian fatalities in Turkey are high compared to the mobility in the traffic. However, the studies on pedestrian safety in Turkey are quite limited. In this study, the pedestrian accidents in Turkey were examined in detail at national level and at provincial level to fill the gaps the literature.

In Turkey, many pedestrians (95.2%) were involved in accidents in urban areas in 2015. On the other hand, the fatality percentage (22.1%) of the pedestrians involved in accidents in rural areas is more than five times of those involved in residential areas (4.1%). The higher fatality percentage in rural areas with high speed limits are in line with the studies in the literature. The previous studies showed that the fatality risk, which is at 10% level in crashes at 50 km/h, increased to 50% at 70 km/h and to 75% at 85 km/h (Davis, 2001; Rosén, 2009; Richards, 2010 and Tefft, 2013).

When the distribution of fatality in pedestrian accidents by gender are reviewed, despite the equal distribution in the population, men constitute 70% of the fatalities. It is necessary to investigate the mobility levels and risk perceptions of women and men in pedestrian traffic in detail to explain the causes of this case. The values obtained in this study are similar to the results of the previous studies. In 2014, men who represent 49% of the population in the US constituted 70% of the fatality in pedestrian accidents (NHTSA, 2016). Likewise, it was published that fatality of men in pedestrian accidents constitute 76% of the fatalities in South Africa and 66% in Spain (Mabunda et al. 2008; Onieva-García et al., 2016).

Tthe 65+ years age group has the highest *FMP* value by far both in women and men. Similarly, in many studies in the literature, the *FMP* value in pedestrian accidents increased, depending on the increasing age (65 years and later) (Henary et al., 2006; Bernhoft and Carstensen, 2008; Kim et al., 2008; Mohamed et al., 2013; NHTSA, 2016; Onieva-García, 2016). This situation is explained by the substantial damage in the body caused by the traffic accidents in older population due to the physical deterioration because of aging (Mohamed et al., 2013). The 65+ years age group had the highest *PIMP* values in Turkey. This is contradictory to the results of the studies in the literature. In the previous studies, it was mentioned that *PIMP* values were not higher in 65+ years age group (NHTSA, 2016), and that they were even lower (Onieva-García et al., 2016). This situation was explained by the avoidance of older age group from risky behaviours in pedestrian traffic and by higher compliance with traffic rules (Oxley et al., 1997; Holland, 2007; Bernhoft, 2008). In studies in United States of America and in Spain, it was revealed that *PIMP* values are higher in 15-24 years age group (NHTSA, 2016; Onieva-García et al., 2016). The reason for this situation was indicated to be the risky behaviours of the young population in the pedestrian traffic (e.g. using mobile phone, listening to music) (Pollack et al., 2014).

In this study, to remain consistent with previous studies, four age groups of 0-14, 15-24, 25-64 and 65+ were used. In the literature, the 25-64 years and 65+ years age groups were divided into smaller age ranges within themselves. Likewise, publishing the age groups of those involved in accidents in Turkey in more details would allow more comprehensive analyses. The number of pedestrians involved in accidents in Istanbul, Ankara and Izmir are the highest for those who died in these accidents. According to the results of the clustering analysis performed, *FMN* and *PIMP* values were not clustered and were randomly distributed. On the other hand, provinces with high *PIMP* values were significantly clustered at a 95% confidence level and *FMN* values were significantly clustered at a 90% confidence level. When these results are reviewed, while no clustering is observed in the analysis conducted using the million population measure, clustering behaviour is observed in the analysis made using million registered vehicle. It is necessary to repeat these analyses using province level vehicle-km values to explain the causes of these results in more detail. The statistical correlations between pedestrian accident rates and provincial level indicators indicated that there were moderate negative correlations between provincial level literacy ratios and both FMV and PIMV values ($r=-0.48$ and $r=-0.57$, respectively). However, it is difficult to explain the causes of this behaviour with aggregate data used in this study. It should be further analysed using accident level disaggregate data.

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