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TRAFFIC RELATED MORTALITY AND ECONOMIC DEVELOPMENT

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ABSTRACT

An increasing number of traffic-related mortality not only means a considerable loss of human lives but also important economic costs to societies. The aim of this paper is to analyse relationship between economic development and traffic-related mortality. Canonical Correlation Analysis method is used in this study to examine the relationship between traffic-related mortality and economic development. Data were collected from 36 countries by using World Bank, International Road Federation, United Nations, International Monetary Fund and World Health Organization statistics. GINI Index (measure of inequality of a distribution of income), Human Development Index (HDI) and Motor vehicles per 1000 population (V/P) have a heavier influence on the traffic-related mortality. The relationship between GINI Index and traffic-related mortality is positive and very strong. HDI and V/P is highly negatively correlated to traffic-related mortality variables. There is a negative and significant relationship between economic development and traffic-related mortality.

KEYWORDS
Traffic-related mortality; economic development.

1. INTRODUCTION

Road traffic injuries and fatalities are a global public health problem and constitute a large majority of the deaths caused by all injuries. Low and middle income countries contribute 90% of the all Disability Life Years lost due to crashes and 85% of all road deaths per 100 000 population from road crashes (WHO, 2001; Garg and Hyder, 2006). An increasing number of road accidents not only means a considerable loss of human lives but also important economic costs to society (Garcia-Ferrer et al., 2007). The relation between traffic fatalities and economic growth has also been largely analyzed in the literature (Smeed, 1949; Haight, 1980; Jacobs and Sayer, 1983; Joksch, 1984; Wintemute, 1985; Grossman and Krueger, 1995; Soderlund and Zwi, 1995; van Beeck *et al.*, 2000; Dano, 2005; Kopits and Cropper, 2005; Bishai *et al.*, 2006; Hyder and Garg, 2006; Garcia-Ferrer *et al.*, 2007; Paulozzi *et al.*, 2007). Prior studies have recorded a biphasic relationship between traffic fatalities and economic development with fatalities rising for the low income countries and falling for the high income countries (van Beeck *et al.*, 2000; Bishai *et al.*, 2006). Road traffic fatality in international comparisons, like other environmental factors described by Kuznets curves (Grossman and Krueger, 1995), follow an interved U-Shaped pattern in relation to economic development (Kopits and Cropper, 2005; Garg and Hyder, 2006). The growth in motor vehicles that accompanies economic growth usually brings an increase in deaths due to traffic accidents for developing countries. But the situation in industrialized countries was the opposite (Kopits and Cropper, 2005). However, increases in Gross Domestic Product (GDP) per capita in high-income countries appear to reduce the number of traffic deaths, but do not reduce the number of crashes or injuries (Bishai et al., 2006).

The objective of this paper is to analyse the relationship between economic development and traffic-related mortality. It is hypothesized that economic development is related to fatalities for different road users. The findings suggested that there is a strong relationship between economic development variables and traffic-related fatalities.

The specific objectives of this study are to examine the association between HDI, GINI Index, V/P, GNI, GDP and traffic related mortality; and to analyze the relationship between pedestrian, bicyclist, motorcyclist, motor vehicle occupant, total mortality rates per 100 000 population and economic development.

2. MATERIAL AND METHODS

2.1. DATA

Data of this study was collected from 36 countries (Argentina, Australia, Brazil, Canada, Colombia, Costa Rica, Croatia, Czech Republic, Denmark, Ecuador, Egypt, Estonia, Finland, Georgia, Germany, SAR, Hungary, Israel, Japan, Latvia, Lithuania, Mexico, Netherlands, New Zealand, Norway, Panama, Paraguay, Peru, Poland, Slovakia, Slovenia, Spain, Sweden, Thailand, UK, USA) by using World Bank, International Road Federation (IRF), United Nations (UN), International Monetary Fund (IMF) and World Health Organization (WHO) statistics. Data for the variables used in this study have been included in two groups. It was assumed that the traffic-related mortality data set (Y variables set) was the dependent variables (criterion), while the economic development data set (X variables set) was the independent (predictor) variables.

Traffic-related mortality variables (Y variables set) are;
Y1: Pedestrian mortality rates per 100 000 population,
Y2: Bicyclist mortality rates per 100 000 population,
Y3: Motorcyclist mortality rates per 100 000 population,
Y4: Motor vehicle occupant mortality rates per 100 000 population,
Y5: Total mortality rates per 100 000 population.

Data for Y variables set were obtained from the World Health Organization which collects and standardizes mortality data submitted by national vital records agencies worldwide (WHO, 2006).

The 10^{th} revision of the International Classification of Diseases (ICD-10) codes (WHO, 1992) used to define the categories of road users (pedestrian, bicyclist, motorcyclist, occupant and total).

In this study The Gross National Income (GNI), Motor vehicles per 1000 population (V/P), Human Development Index (HDI), GINI Index and Gross Domestic Product (GDP) nominal per capita have been used as the indicator of economic development.

Economic development variables (X variables set) are;

X1: The Gross National Income (GNI) per capita in current U.S. dollars (World Bank Group, 2005): GNI is the sum of value added by all resident producers plus any product taxes (less subsidies) not included in the valuation of output plus net receipts of primary income (compensation of employees and property income) from abroad. GNI is the gross domestic product modified to exclude goods and services produced domestically by foreign companies and to include goods and services produced abroad by domestic companies (Pulozzi *et al.*, 2007; The World Bank, 2007).

X2: Motor vehicles per 1000 population (V/P): It indicates number of motor vehicles per 1000 population included passenger cars, buses, coaches, lorries and vans (IRF, 2006). Motor vehicles per 1000 population (V/P) had been used in some previous studies (Smeed, 1949; Kopits and Cropper, 2005; Bishai *et al.*, 2006; Darcin and Darcin, 2007; Paulozzi *et al.*, 2007) as indicator of economic growth/development or quality of life. It has been revealed that V/P strongly correlates with national income (van Beeck *et al.*, 2000; Paulozzi *et al.*, 2007)

X3: Human Development Index (HDI) (UN, 2006): The Human Development Index is a comparative measure of life expectancy, literacy, education, and standards of living for countries worldwide (Wikipedia encyclopedia, 2007). HDI have been suggested as measures of socioeconomic development of a country (Marmot, 1998; Stewart *et al.*, 2001; UN, 2006).

X4: UN GINI Index (UN, 2006): The GINI Index is a measure of inequality of a distribution of income. GINI Index of 0 represents perfect economic equality and 100 represents perfect inequality (Wikipedia encyclopedia, 2007).

X5: Gross Domestic Product (GDP) nominal per capita (IMF, 2007): The Domestic Product is the value of all final goods and services produced within a nation in a given year, divided by the average population for the same year (Wikipedia encyclopedia, 2007). GDP has been used as an indicator of economic development in some previous studies (van Beeck *et al.*, 2000; Kopits and Cropper, 2005; Bishai *et al.*, 2006).

2.2. STATISTICAL APPROACH

The relationship between traffic-related mortality and economic development was examined by Canonical Correlation Analysis (CCA) method using NCSS (Number Cruncher Statistical System) packaged-software.

Canonical correlation is an exploratory statistical technique that examines the relationship between two sets of variables where each set contains more than one variable. It can be considered as a method of aggregating multiple associations into a few significant associations (Johnson and Wichern, 2002; Martin *et al.*, 2005).

CCA is a generalization of the ordinary Pearson correlation coefficient to multi-dimensional variables (Ridderstolpe *et al.*, 2005) and measures the association between two sets of multi-dimensional variables by assessing the correlation between the linear combinations of one set of variables with the linear combinations of a second set of variables (Johnson and Wichern, 2002; Martin *et al.*, 2005; Ridderstolpe *et al.*, 2005).

CCA can be viewed as an extension of multiple regression to situations involving more than one single response variable (Anderson, 1984; Borga, 1998; Ridderstolpe *et al.*, 2005). CCA finds the coordinate system that is optimal for correlation analysis. Canonical correlations are invariant to scaling of the variables (Ridderstolpe *et al.*, 2005).

The optimization criterion is to maximize the association between two groups of variables rather than to maximize the amount of multivariate variation (Martin *et al.*, 2005). CCA is not an indicator of causality (Khattree and Naik, 2000), but a common spatial structure of canonical variables pairs is evidence of the spatial association between these groups of variables (Johnson *et al.*, 2002; Wu *et al.*, 2002; Martin *et al.*, 2005)

CCA gives the maximum correlations between two sets of variables, and at the same time it gives the optimal explanation of variability within the subgroup of variables. Canonical correlation is the most appropriate and powerful multivariate technique if there are multiple dependent and independent variables, It has been used in many fields and represents a useful tool for multivariate analysis. Canonical correlation represents the only technique available for examining the relationship with multiple dependent variables. Canonical correlation derives the variates to maximize their correlation.This is another unique feature of canonical correlation (Hair *et al.*, 1998).

CCA is used to investigate the relationship between a linear combination of the set of X variables with a linear combination of a set of Y variables. Consider two groups of variables (X and Y) such that one has p variables (X1, X2,…,Xp), and the other has q variables (Y1, Y2, …,Yq). Linear combinations of the original variables can be defined as canonical variates (Wm and Vm) as follows:

$$Wm = am1X1 + am2X2 + \ldots + ampXp \quad (1)$$

$$Vm = bm1Y1 + bm2Y2 + \ldots + bmqYq \quad (2)$$

The two resulting linear combinations, one of x-variables and one of y-variables are called the first canonical variables or the first pair of canonical variables (Ridderstolpe *et al.*, 2005).

The correlation between Wm and Vm can be called canonical correlation (Cm). Squared canonical correlation (canonical roots or eigenvalues) represents the amount of variance in one canonical variate accounted for by the other canonical variate (Hair et al., 1998).

The linear combination of the components of X and the components of Y would be W=a'X and V=b'Y, respectively. Variances and (co)variances of canonical variates as follows:

$$Var(W) = a'Cov(X)a = a'\Sigma 11a \quad (3)$$

$$Var(V) = b'Cov(Y)b = b'\Sigma 22b \quad (4)$$

$$Cov(W,V) = a'Cov(X, Y)b = a'\Sigma 12b \quad (5)$$

Then the correlation coefficient between W and V canonical variates is

$$r(V,W)= \frac{a'\Sigma 12b}{[(a'\Sigma 11a)(b'\Sigma 22b)]^{1/2}} \quad (6)$$

The null hypotheses is that

$$H0 : r1 = r2 = \ldots = rm = 0 \quad (7)$$

and alternative hypotheses is that

H1: not all r's are equal. (8)

For testing the above hypothesis, the most widely used test statistic Wilks' lambda is defined as follows:

$$\Lambda=\pi(1- ri^2) \quad (9)$$

i=1

It is used Wilks' lambda statistic to develop an approximate chi-square test with pq degrees of freedom:

$$\chi^2 = -[n- 0.5 (p + q + 1)] \ln\Lambda \quad (10)$$

In formula (10) n is the number of cases, ln states the natural logarithm function, p is the number of variables in one set and q is the number of variables in the other set.

The statistical significance of χ^2 test is compared with α= 0.05, 0.01, 0.001 critical value of chi-square statistic with pq degrees of freedom.

Matrix scores on canonical variates of Vi and Wi are calculated by using values in original data. The sum of canonical scores for each variate is equal to zero. Correlation coefficients between canonical scores (Vi and Wi) and observed values (Xi, Yi) are called as canonical weights or canonical structure and calculated as follows:

$$CViXi = corr(Vi,Xi) \quad (11)$$

$$CViYi = corr(Vi,Yi) \quad (12)$$

Canonical weights are used to determine which variables effect markedly to which one of the canonical variates. The canonical weights allow the user to understand how each variable in each set uniquely contributes to the respective weighted sum of canonical variate.

Explained variance is the sum of the squared canonical weights divided by the number of variables in the set and defines how much variance each canonical variate explains.

$$\text{Explained Variance (X)}= \sum_{i=1}^{k} c^2\, vixi / p \quad (13)$$

$$\text{Explained Variance (Y)}= \sum_{i=1}^{k} c^2\, wiYi / q \quad (14)$$

The high number of explained variance can clarify whether or not eigenvalues of solution matrix are acceptable level to state correlation between observed two sets by canonical correlation of the sets.

3. RESULTS

Canonical correlation analysis was performed to examine the association between a set of independent (X) variables and a set of more than one dependent (Y) variable. Descriptive statistics (the mean values and standard deviation) of each variable considered in both sets are presented in Table 1.

TABLE 1: DESCRIPTIVE STATISTICS SECTION

Variable	Mean	Standard Deviation
Pedestrian	37,39286	219,697
Bicyclist	0,028	3,49E-02
Motorcyclist	7,43E-02	0,1844433
MV_occupant	0,2951429	0,4000689
Other_type_vehicle	2,37E-02	4,25E-02
Total	1,017714	1,399977
GNI_per_capita__US__	13041,71	11827,31
MV_per_1000_people	330,08	211,2793
Human_Developme_Index	0,8718857	7,52E-02
UN_GINI_Index	37,29714	10,37966
GDP__Nominal__per_capita_	20515,74	17904,04

The Pearson's correlations between variables of traffic-related mortality and variables of economic development are shown in correlation matrix (Table 2).

TABLE 2: CORRELATION MATRIX

	Pedestrian	Bicyclist	Motorcyclist	Occupant	Other_type	Total	GNI	V/P	HDI	GINI	GDP
Pedestrian	**1**	-0,09	-0,05	0,1	-0,01	**0,56**	-0,17	-0,23	-0,25	0,11	-0,17
Bicyclist	-0,09	**1**	**0,62**	0,1	0,15	**0,38**	**-0,41**	**-0,37**	**-0,31**	**0,32**	**-0,39**
Motorcycli	-0,05	**0,62**	**1**	0,13	0,14	**0,5**	-0,27	**-0,35**	**-0,31**	**0,41**	-0,29
Occupant	0,1	0,1	0,13	**1**	**0,9**	**0,7**	**-0,48**	**-0,57**	**-0,65**	**0,48**	**-0,49**
Other_type	-0,01	0,15	0,14	**0,9**	**1**	**0,66**	**-0,39**	**-0,49**	**-0,61**	**0,37**	**-0,4**
Total	**0,56**	**0,38**	**0,5**	**0,7**	**0,66**	**1**	**-0,55**	**-0,69**	**-0,75**	**0,61**	**-0,57**
GNI	-0,17	**-0,41**	-0,27	**-0,48**	**-0,39**	**-0,55**	**1**	**0,69**	**0,84**	**-0,49**	**0,95**
V/P	-0,23	**-0,37**	**-0,35**	**-0,57**	**-0,49**	**-0,69**	**0,69**	**1**	**0,84**	**-0,62**	**0,74**
HDI	-0,25	**-0,31**	**-0,31**	**-0,65**	**-0,61**	**-0,75**	**0,84**	**0,84**	**1**	**-0,62**	**0,86**
GINI	0,11	**0,32**	**0,41**	**0,48**	**0,37**	**0,61**	**-0,49**	**-0,62**	**-0,62**	**1**	**-0,57**
GDP	-0,17	**-0,39**	-0,29	**-0,49**	**-0,4**	**-0,57**	**0,95**	**0,74**	**0,86**	**-0,57**	**1**

An absolute value over 0.30 are accepted for significant at the five percent level for the degrees of freedom.

Any correlation coefficients with an absolute value over 0.30 are accepted for significant at the five percent level for the degrees of freedom available with data.

There is significant correlation within economic development set, between one economic development variable and others. Among traffic-related mortality set variables there is significant correlation between bicyclist and motorcyclist, between other type of vehicle and motor vehicle occupant, between total mortality and other traffic-related mortality variables.

Correlations between traffic-related mortality and economic development variables are significant except correlation between motorcyclist and GNI; motorcyclist and GDP; pedestrian and all economic development variables.

Total mortality is highly negatively correlated to economic development variables and HDI is also highly negatively correlated to traffic-related mortality variables.

The correlation between total mortality and HDI (-0.75) is stronger than among other variables. It can be said that the most suitable indicator of traffic mortality is HDI.

Through canonical correlation analysis, a composite (also called as canonical function) of the traffic-related mortality accounts that correlate with a composite of the economic development accounts is derived. The canonical correlation analysis procedure provides as many pairs as there are accounts in the smaller set, which is five in this study. The test statistics for the canonical correlation between the first pair (0.93) was found to be significant ($p<0.01$) from the likelihood ratio test. The remaining canonical correlations are not statistically significant ($p>0.05$). Therefore, only the first canonical correlation (the highest possible correlation on the x-variable and y-variable side) has been used. By construing the first canonical variate it is possible to find relationship between traffic-related mortality and economic development as rate of 87% (Table 3).

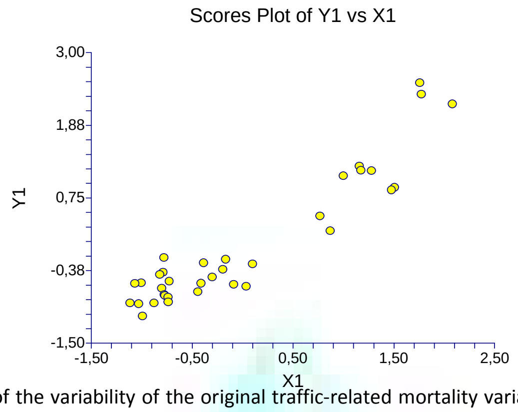
TABLE 3: CANONICAL CORRELATION SECTION

Variate Number	Canonical Correlation	R-Squared	F-Value	Num DF	Den DF	Prob Level	Wilks' Lambda
1	0,934831	0,87391	3,16	30	98	0,00001	0,06679
2	0,571934	0,327108	0,89	20	84	0,605152	0,529704
3	0,447807	0,200531	0,54	12	69	0,877469	0,787206
4	0,104278	0,010874	0,07	6	54	0,998564	0,984661
5	0,067191	0,004515	0,06	2	28	0,938617	0,995485

F-value tests whether this canonical correlation and those following are zero.

The results shown in Table 3 can also be visualized in Figure 1. The correlation coefficient of the data in the first plot (Y1 versus X1) is the first canonical correlation coefficient. There is strong relationship between the first pair of canonical variates. This supports the level of association between traffic-related mortality and economic development (r=0.93).

FIGURE 1



The first canonical variate suggests that 30.4% of the variability of the original traffic-related mortality variables (Y set) is explained by traffic-related mortality canonical variable Y1 (variate Y1) and 60.6% of the variability of the original economic development variables (X set) is accounted by the economic development canonical variable X1 (variate X1) (Table 4).

TABLE 4: VARIATION EXPLAINED SECTION

Canonical Variate Number	Variation in these Variables	Explained by these Variates	Individual Percent Explained	Cumulative Percent Explained	Canonical Correlation Squared
1	Y	Y	30,4	30,4	0,8739
1	Y	X	26,6	26,6	0,8739
1	X	Y	53	53	0,8739
1	X	X	60,6	60,6	0,8739

Explained variance for the first canonical correlation also determines how much of the variance in one set of variables is accounted for by the other set of variables. For the first canonical variate, 26.6 percent of the Y set's variance is explained by the canonical variable X1 (variate X1), and 53 percent of the variation in X set variables is explained by the canonical variable Y1 (variate Y1). These results indicate that the first canonical correlation has low practical meaningful if variation in Y variables explained by X variates. It has medium meaningful if variation in X variables explained by Y variates. It can be said that traffic-related mortality and economic development interdependencies are strong enough (Table 4).

Standardized canonical coefficients for the first X, Y variate are given in Table 5. It shows variation (kind of standard deviation) in canonical variate in parallel with 1 standard deviation increase in original variables. In other words these coefficients represent relative contributions of original variables to the related variate.

Equations of Y1 and X1 canonical variate are as follows:

Y1=-1,89(pedestrian) – 0.37(bicyclist) – 1.05 (motorcyclist) – 0.24 (V/P) – 1.42(other vehicles) + 3.65(total)

X1= 0.20(GNI) – 0.04(V/P) – 0.78(HDI) + 0.59(GINI) + 0.16(GDP)

TABLE 5: STANDARDIZED CANONICAL COEFFICIENTS SECTION

Standardized Y canonical coefficients section						Standardized X canonical coefficients section				
Pedestrian	Bicyclist	Motorcyclist	Occupant	Other_type	Total	GNI	V/P	HDI	GINI	GDP
-1,89	-0,37	-1,05	-0,24	-1,42	3,65	0,2	-0,04	-0,78	0,59	0,16

Since the canonical coefficients can see unstable due to small sample size or presence of multicollinearity in the data, the loading were also considered to provide substantive meaning of each variable for the canonical variate (Akbas and Takma, 2005).

The relationship between the original variables and canonical variables was evaluated with the correlation coefficients between canonical variables commonly called structure coefficients (Khattree and Naik, 2000; Johnson and Wichern, 2002; Martin *et al.*, 2005).

Canonical loading/cross-loading analysis was performed to investigate any correlation between variables within and between Y and X set's variables. The correlations between variables and canonical variates provide information about the relative contributions of variables to each canonical relationship (Hair *et al.*, 1998; Wong and Lau, 2001).

To evaluate the important accounts of the significant canonical function, canonical loading and cross-loading were used in this study. The criteria of selecting canonical loading over 0.40 (Avlonitis and Gounaris, 1999; Wong and Lau, 2001; Hosany, 2007) and canonical cross-loading over 0.30 (Hair *et al.*, 1998; Chengalur-Smith and Duchessi, 2000; Wong and Lau, 2001; Wu and Chen, 2006) were considered to be important.

The variable-variate correlations (canonical loadings and canonical cross-loadings) of the first significant pairs of canonical variables (canonical variate) are presented in Table 6 and 7.

TABLE 6: VARIABLE-VARIATE CORRELATIONS (CANONICAL LOADINGS)

	Y variable set							X variable set				
	Pedestrian	Bicyclist	Motorcyclist	Occupant	Other_type	Total		GNI	V/P	HDI	GINI	GDP
Y1	0,22	0,32	0,42	0,68	0,6	0,82	X1	-0,61	-0,8	-0,86	0,9	-0,68

TABLE 7: VARIABLE-VARIATE CORRELATIONS (CANONICAL CROSS-LOADINGS)

	Y variable set							X variable set				
	Pedestrian	Bicyclist	Motorcyclist	Occupant	Other_type	Total		GNI	V/P	HDI	GINI	GDP
X1	0,2	0,3	0,39	0,64	0,56	0,77	Y1	-0,57	-0,75	-0,81	0,84	-0,64

Canonical loadings of function 1 revealed that four of six traffic-related mortality variables (total traffic mortality, MV occupant mortality, other type vehicle mortality, motorcyclist mortality) were found to be correlated with the same canonical variable set. Total traffic mortality (0.82) and MV occupant mortality (0.68) are the most influential variables in forming Y1 (Table 6).

Judging from the result of canonical loadings individually by the subset (economic development set) itself, it was found that all of the economic development variables significantly correlated within the subset. GINI Index (0.90), HDI (-0.86) and V/P (-0.80) are the most influential variables in forming X1 (Table 6).

All of the variables have positive loadings on the traffic-related mortality set. GINI Index have positive loading on the economic development set, but there were negative correlations between other economic development variables and canonical variables.

Canonical cross-loadings revealed that all of the economic development variables correlated (-0.57 to 0.84) with traffic-related mortality canonical variate (Table 7). Five traffic-related mortality variables (bicyclist, motorcyclist, MV occupant, other type vehicle, and total mortality) correlated with economic development canonical variate.

4. DISCUSSION

There is consensus regarding the effect of economic development on traffic-related mortality. In previous studies it is found that there is lower risk for total traffic accident mortality among rich countries (Joksch, 1984; Soderlund and Zwi, 1995; Dano, 2005; Bishai *et al.*, 2006; Paulozzi *et al.*, 2007). Findings of this study suggest that there is a negative and significant relationship between economic development and traffic-related mortality.

Income inequality generally effects health (Kawachi *et al.*, 1999; Lynch *et al.*, 2000; Jones and Wildman, 2005). While some studies have expressed no strong relationship between income inequality and mortality or health (Judge *et al.*, 1998; Mellor and Milyo, 2001; Muller, 2002; Osler *et al.*, 2002; Sturm and Gresenz, 2002; Gerdtham and Johannesson, 2004; Lorgelly and Lindley, 2007), some studies expressed significant and strong relationship (Wilkinson, 1996; McIsaac and Wilkinson, 1997; Blakely *et al.*, 2000; Deaton 2001; Judge and Peterson, 2001; Subramanian and Kawachi, 2004). This study concludes that relationship between GINI Index and traffic-related mortality is positive and very stronger.

There is nonlinear relation between per capita GDP and traffic accident (Anbarci *et al.*, 2006). Higher levels of GDP per capita are associated with lower mortality (Bester, 2001; Kennelly *et al.*, 2003; Tapia Granados, 2005). Lower levels of GDP per capita mean poorer health and higher mortality (Davey *et al.*, 1994; Benzeval and Judge, 2001; Kennelly *et al.*, 2003; Tapia Granados, 2005). Van Beeck and colleagues (2000) showed mortality rates rose and fell with gross domestic product. Anbarci et al., (2006) find that 'as per capita income initially rises, as expected, traffic fatalities also increase. This relation remains positive up to a level of per capita GDP of approximately $15,000. Beyond that level, further increases in per capita GDP lead to falling rates of traffic fatalities'.

Bishai et al. (2006) suggest that 'increase in GDP in a lower income country is associated with a rise in the number of crashes, the number of traffic injuries, and the number of deaths. Increases in GDP in richer countries appear to reduce the number of traffic fatalities, but do not reduce the number of crashes or injuries. The negative association between GDP and traffic deaths in rich countries may be mediated by lower injury severity and post-injury ambulance transport and medical care'.

Paulozzi and colleagues (2007) suggest that 'increases in GNI per capita are associated with reductions in total mortality rates and also in pedestrian mortality rates'. In this study it is found that there in no correlation between GNI and pedestrian mortality rates and also GDP and pedestrian mortality rates. GINI Index, HDI and V/P are more associated with reduction traffic-related mortality than GNI and GDP.

V/P is a good predictor of the variation in total deaths per vehicle (Allen, 2005; Paulozzi et al., 2007) and strongly correlates with national income (Van Beeck *et al.*, 2000; Anbarci *et al.*, 2006; Paulozzi *et al.*, 2007). In developing countries as per capita income rises, motorization rates also rise as do rates of traffic fatalities (Anbarci *et al.*, 2006). But developed countries with a higher vehicle ownership usually have a lower fatality rate. Bhalla et al. (2007) found that "in the absence of road safety interventions, the historical trend of initially rising and then falling fatalities observed in industrialized nations occurred only if motorization was through car ownership. In all other cases studied (scenarios dominated by scooter use, bus use, and mixed use), traffic fatalities rose monotonically". In this study it is found that V/P is a good predictor of traffic related mortality.

In addition to this HDI is clearly a significant factor in the fatality rate of a country (Bester, 2001). The variable HDI seems to have a very strong relationship with mortality as well as the other economy variables, and seems to contain in it some of the main elements related to why some countries do better in safety development than others. HDI shows how far a country or province has to go to provide essential needs to all its people (Justus, M., 1995). It is a measure of development based on relative achievement in economic growth, education and health, and a powerful predictor of infant and maternal mortality rates (Lee et al., 1997). This study concluded that HDI is the most suitable indicator of traffic-related mortality.

5. CONCLUSION

This study which examines the relationship between two sets is different from the previous research. Because the relationships among multiple dependent traffic-related mortality and multiple independent (economic development) variables was analyzed in this study. Then, the answer of the question "what is the relationship between economic development and traffic-related mortality?" was incestigated. Different from other studies GINI Index and HDI are used in this study to examine the effect of traffic mortality

It can be said that GINI Index, HDI and V/P have a heavier influence on the traffic-related mortality. Similarly total traffic accident mortality has the heaviest influence on economic development. In other words the lower GINI Index or the higher HDI or the higher V/P means the lower traffic-related mortality. If a country has the higher total traffic-related mortality, the country has the lower economic development level.

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