Estimating the Value of Life and Injury for Pedestrians Using a Stated Preference Framework

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Abstract

Introduction: The incidence of pedestrian death over the period 2010 to 2014 per 1000,000 in North Cyprus is about 2.5 times that of the EU, with 10.5 times more pedestrian road injuries than deaths. With the prospect of North Cyprus entering the EU, many investments need to be undertaken to improve road safety in order to reach EU benchmarks.

Method: We conducted a stated choice experiment to identify the preferences and tradeoffs of pedestrians in North Cyprus for improved walking times, pedestrian costs, and safety. The choice of route was examined using mixed logit models to obtain the marginal utilities associated with each attribute of the routes that consumers chose. These were used to estimate the individuals' willingness to pay (WTP) to save walking time and to avoid pedestrian fatalities and injuries. We then used the results to obtain community-wide estimates of the value of a statistical life (VSL) saved, the value of an injury (VI) prevented, and the value per hour of walking time saved.

Results: The estimate of the VSL was €699,434 and the estimate of VI was €20,077. These values are consistent, after adjusting for differences in incomes, with the median results of similar studies done for EU countries. The estimated value of time to pedestrians is €7.20 per person hour.

Conclusions: The ratio of deaths to injuries is much higher for pedestrians than for road accidents, and this is completely consistent with the higher estimated WTP to avoid a pedestrian accident than to avoid a car accident. The value of time of €7.20 is quite high relative to the wages earned.

Practical Applications: Findings provide a set of information on the VRR for fatalities and injuries and the value of pedestrian time that is critical for conducing ex ante appraisals of investments to improve pedestrian safety.

Keywords: Willingness to pay; choice experiment; value of a statistical life; value of an injury; pedestrian time.

1. Introduction

Nearly 90% of the world's 1.25 million road fatalities occur in low- and middle-income countries, which account for just 54% of the world's motorized vehicles. Almost 22% of those killed are pedestrians (World Health Organization, 2015). A fatality is defined as a pedestrian who dies within 30 days as a result of injuries sustained in an accident involving an automobile. An injury is defined as a pedestrian who was severely injured, hospitalized, or suffering minor injuries as a result of an accident involving an automobile.

While total EU road fatalities fell by 18% over the 2010–2014 period, pedestrian fatalities decreased by just 11%. In the period 2010-2014, the average incidence of pedestrian fatalities in North Cyprus was around 8 per year, or 28 pedestrian fatalities per million population. This was about two and half times the EU rate of 11 pedestrian fatalities per million population per year. The incidence in North Cyprus of various non-fatal pedestrian injuries averaged 84 injuries per year, or 294 injuries per million population, which is about 10.5 times greater than the number of pedestrian fatalities. (European Commission Road Safety Statistics website, 2013 Census; 2015; Road Traffic Accident Prevention Association, 2014).

This paper investigates Turkish-Cypriot pedestrians' attitudes to road safety in order to estimate their willingness to pay (WTP) to reduce the risk of an accident, and so determine the value of risk reduction (VRR) (Hensher, 1994; Hensher, Rose, & Greene, 2005). This method has also been used to establish Turkish-Cypriot drivers' attitudes to road safety (Niroomand & Jenkins, 2016).

Attitudes to the risk of an accident are often assessed using stated preference methods such as contingent valuation (CV), which basically presents the risk of injury as the probability of an accident occurring (Beattie et al., 1998; Carthy et al., 1998; Jones-Lee, 1994; Jones-Lee, O'Reilly, & Philips, 1993; Viscusi, Magat, & Huber, 1991). This approach assigns a cost to road safety that implies a tradeoff between risk and cost of travel.

Although CV is theoretically more precise among the stated preferences methods in defining the economic welfare arising from environmental goods and services, it has been criticized by behaviorists (Fischhoff, 1991, 1997) as well as some economists (Diamond & Hausman, 1994; Hausman, 1993). They have argued that embedding is a common problem that could discredit CV studies. The embedding effect arises when people have a positive feeling towards supporting an activity in general. The value (stated as WTP) that respondents assign to individual public goods or services through answering a questionnaire is often not the same as the value that they would assign to a bundle of such goods and services through a market mechanism. The absence of a direct market affects the quality of CV responses.

To address some of the defects of the CV method, a number of recent road-safety studies have used stated choice (SC) or conjoint analysis techniques, in which individuals choose between bundles of attributes presented as hypothetical scenarios (Hensher, Rose, Ortúzar, & Rizzi, 2009, 2011; Iragüen & Ortúzar, 2004; Rizzi & Ortúzar, 2003, 2006; Svensson & Johansson, 2010). As such, the SC method is better able to establish likely choice behavior (Louviere, Hensher, Swait, & Adamowicz, 2000; McFadden, 1998).

In this study, the benefits of improved pedestrian road safety are quantified by means of an SC survey of residents of North Cyprus. Once respondents have selected preferred scenarios, the value of each attribute—for example, road type or safety feature—is estimated, in order to quantify the overall benefit of improved road safety. These results are used to measure pedestrians' WTP to reduce the risk of fatality and injury, and thus to estimate a measure of the value of a statistical life (VSL) and the value of an injury (VI) (Andersson, 2007; Elvik, Høye, Vaa, & Sørensen, 2009).

1.1 Pedestrian safety in North Cyprus

Cyprus is the third-largest island in the Mediterranean, the northeastern part of which is populated by some 286,000 Turkish Cypriots. According to the 2013 Census, the average age of the Turkish-Cypriot population was 33 years. Annual per capita gross national income (GNI) in 2014 was €10,989 and the minimum wage was TL1,675 (€572) per month (€6,864 per year).[1] The economy is heavily dependent on tourism (21% of GDP), higher education services (11.5%), and transportation and communications (12%).

The only significant pedestrian-safety feature in North Cyprus is the zebra crossing: there are very few pedestrian overpasses, traffic lights, sidewalks or walkways. As a result, most pedestrian accidents in North Cyprus occur while attempting to cross a road. This lack of pedestrian safety is of particular concern given the 50,000 or so international students and many long-term foreign residents in North Cyprus—two groups that tend to walk rather than drive. Those aged 21-44 are most likely to be involved in pedestrian accidents involving automobiles (Road Traffic Accident Prevention Association, 2014).

Carefully selected investments in transport, road safety, and driver education could play a major role in alleviating the social and economic consequences of poor road safety in North Cyprus. However, the process of identifying which projects would provide the greatest benefit requires detailed cost-benefit analysis (CBA), based on the values of key parameters. The objective of this paper is to derive three such parameters: the value of time saved by walkway enhancements; the value per life saved; and the value of prevented injury.

Pedestrians were asked to choose among alternative combinations of road type, walkways, and additional safety measures. Each of these choice sets was then adjusted to maximize the accuracy of the estimates.

[1] Based on an average exchange rate of 2.93TL/euro for May 2014 (Central Bank of the Republic of Turkey website).

The paper comprises six sections. Section 2 presents the authors' approach to valuing risk reduction, while Section 3 presents the design of the stated choice experiment. Section 4 describes the process of data collection and analysis; Section 5 presents model findings and limitations; and Sections 6 and 7 present discussions and conclusions.

2. The value of fatality and injury risk reductions

This section presents the concept of value of risk reduction (VRR) in the context of road safety, setting out how estimates of pedestrians' willingness to pay (WTP) for incremental or marginal improvements in road safety can be used to derive VRRs for pedestrian death or injury. It is important to note that this exercise is an attempt to estimate the marginal economic welfare benefits arising from interventions that improve pedestrian safety, not the total value of pedestrian safety.

2.1 Modeling the valuation of risk reduction

Risk is measured by the number of fatalities as a proportion of the pedestrian population. Pedestrians' willingness to pay (WTP) to avoid death or injury on the road is equal to the marginal rate of substitution (MRS) between the risk of death (or injury) and income (Hojman, Ortúzar, & Rizzi, 2005; Veisten, Flügel, Rizzi, & Elvik, 2013).

Because road safety is a public good, the value to society of improving road safety is equal to the MRS between individual risk of fatality (or injury) and income, summed over all individuals walking a particular route. This yields the subjective value or WTP for reducing by one the expected number of fatal accidents (or injuries) on that route. The estimated value of risk reduction (VRR) is equal to the value of avoiding death (or injury) per unit of society's demand for this public good of road safety (Drèze, 1962; Jones-Lee, 1974).

2.3 Estimating values of statistical lives and injuries

The average pedestrian WTP for a reduction in the risk of fatality or injury per trip is calculated as follows. The pedestrian population's exposure to risk is measured by the number of pedestrian trips and associated kilometers per walking trip undertaken by each pedestrian[2]. The average WTP per pedestrian per trip to reduce fatalities or injuries will be determined by the risk of such an event occurring during a trip, as well as other factors. The WTP per kilometer is found by dividing the WTP per trip by the number of kilometers per trip. The estimated VRR is be derived from (WTP per km)/(risk per km). Risk per kilometer of a given route is derived from (number of fatalities or injuries per year)/(annual average number of walking kilometers—AAWKM). Aggregated average WTP per trip is calculated based on actual trip activity.

3. Designing the stated choice experiment

The stated choice (SC) experiment expresses alternatives in terms of different combinations of road-safety attributes, estimating the marginal WTP for each alternative attribute. Improvements in road safety, walking times, and municipality charges for a given route are then expressed as costs (Hensher, 2004; Veisten et al., 2013).

To generate the SC experiment, pedestrians were asked to choose between a pair of alternative routes and the current route. The SC experiment derives the independent contributions of each of the attributes of a given route, to elicit pedestrians' preferences for road safety, walking times, and municipality charges.[3]

A number of pilot questionnaires were conducted in order to identify the most realistic attributes possible (Hensher et al., 2005, 2009; Hojman et al., 2005; Rizzi & Ortúzar, 2003, 2006; Veisten et al.,

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[2] Data used to calculate the chance of fatality or injury was obtained from the Road Safety Branch of the Road and Traffic Authority of North Cyprus and the State Planning Organization.

[3] Higher municipality charges will be necessary if pedestrian infrastructure is to be upgraded.

2013).[4] The final questionnaire was further modified to take account of additional insights gathered from pilot-study focus groups. Respondents were also provided with a description of the aims of the study and attributes of the choice sets, and were advised to consider each choice set as a separate decision.

The questionnaire was designed to ascertain the non-market value of road safety improvements and comprised three parts. Part one addressed current pedestrian crossing road-safety features, walking times, municipality charges, the purpose of pedestrian trips, and respondents' understanding of road safety and policy. Part two presented the choice experiment questions, and part three aimed to elicit socioeconomic data about the respondents.

3.1 Statistical design of the stated choice experiment

The attributes and attribute levels considered in the initial design of the SC experiment are shown in Table 1.

Table 1. Attributes and attribute levels

Attributes	Levels
Average speed limits per km/h posted on one- and two-lane each-way sections of the route	60, 80, 90, 100
Crossing type	None, Zebra Crossing, Traffic Lights, Pedestrian Overpass
Number of lanes to cross (each way)	1, 2
Walking time for the entire trip	15 min or less 16 to 30 min
Number of pedestrian injuries per year, representing the number of pedestrians who have been injured using this road	Fewer than 20 people 20 people or more
Number of pedestrian fatalities per year, representing the number of pedestrians who have been killed using this road	Fewer than 5 people 5 people or more
Percentage change in monthly municipality charges	5% higher than now 10% higher than now

[4] A total of 40 initial respondents from different part of North Cyprus were questioned for the pilot interview.

	15% higher than now
	20% higher than now

After determining the number of attributes and their levels, we constructed two unlabeled, hypothetical routes (yielding 1,296 ($4^2 \times 3^4$) choice sets). Within each experiment, the 32 possible profiles were subsequently grouped into four versions of eight choice sets.[5] Each survey participant was therefore presented with eight option cards throughout the experiment process (see Table 2 for sample card) (Hensher et al., 2005; Louviere et al., 2000; Winer, 1971).

The current-route option (no road-safety improvements and no payment required) was included in each choice set, enabling participants to choose their current route if preferred to the alternatives presented (see sample card presented in Table 2).

Table 2. Typical card from SC sets

	Route A	Route B	Current Route
Average speed limit (km/h)	90	80	Neither route A nor route B: I prefer to stay with my current route
Crossing type	Pedestrian Overpass	Traffic Lights	
Number of lanes to cross	2	1	
Walking time	15 min or less	16 to 30 min	
Municipality charges (TL)	20%	10%	
Fatalities (per year)	Fewer than 5 people	5 people or more	
Injuries (per year)	20 people or more	Fewer than 20 people	

4. Data collection and descriptive statistics

[5] The large number of scenarios is too much of a burden on the respondents. The orthogonal fractional factorial with 32 profiles (four 8-choice sets) was generated from this full factorial in order to reduce the number of choice sets to be used in the experiment. Therefore, each respondent saw only eight of the 32 profiles during the questionnaire process.

The main survey was conducted from the beginning of February to the end of May 2014, using face-to-face interviews in the districts of Lefkoşa (33.1% of total population), Gazimağusa (24.4%), Girne (24.2%), Güzelyurt (10.5%), and İskele (7.9%) (2013 Census)[6].

Of the 514 interviewees asked to participate, the number of usable responses was 378, or 3,024 observations. Each individual selected from eight choices. Of the remaining 136 responses, 15 questionnaires were marked as protest bids. A protest bid is identified when a respondent refuses to pay anything to improve road safety and justifies his refusal by saying that it is the government's responsibility to improve safety.

The remaining 121 questionnaires were excluded from final survey data because the respondents answered on the basis of valuing only one of the attributes. They were not willing to consider trade offs between the single attribute they focused on and the other attributes. The data from these respondents was not included in the data set used for the econometric analysis as these respondents might have had difficulty evaluating the choice scenarios (Johnson, Matthews, & Bingham, 2000; Rizzi & Ortúzar, 2003; Saelensminde, 2001).

Of the 378 respondents, 162 were single and 191 were married, with the remaining 25 either separated or widowed. About 70% had children and, of these, two-thirds had children younger than 18 years of age. The average age of the individuals interviewed was 36.7 years (ranging from 20 to 61). Approximately 92% of respondents had a high school diploma and 70% had a university degree. The average monthly family income was TL6,010.58 (€2,051), ranging from TL5,501 (€1,877) to TL7,500 (€2,260), as reported in Table 3.

Of the 63% of survey participants who were employed, 68.4% were employees of the public sector and the remaining 31.5% of the private sector. The 37% of participants who were unemployed consisted of retired people (8%), property owners and those undertaking household duties (12.5%), and foreign

[6] We calculated the sample size that we needed to obtain reliable empirical results according to the exogenously stratified random sample strategy (ESRS). The required number was 350 usable questionnaires.

students with family support (79.5%). Of the working participants, 89% were employees, 6.2% employers, and 4.7% self-employed. Table 4 provides a summary of the age and gender distribution of the final sample. We also obtained information on the walking experience of participants who had been personally involved in road accidents resulting in injury, or knew someone close (friend or relative) who, as a pedestrian, had died or been injured in a road accident (Table 5).

Table 3. Household income (per month)

	Frequency	Percentage
Less than TL1,500	22	5.9
TL1,501–2,000	24	6.4
TL2,001–2,500	17	4.5
TL2,501–3,000	28	7.5
TL3,001–3,500	26	7.0
TL3,501–5500	14	3.5
TL5,501–7,500	50	13.1
TL7,501–12,000	97	25.4
More than TL12,000	100	26.7
Total	378	100

Table 4. Number of respondents by geographical and socioeconomic segment

Age	Gender	Lefkoşa	Gazimağusa	Girne	Güzelyurt	İskele	Total
22–34	Male	35	30	24	15	3	107
	Female	17	18	13	5	2	55
	Total	52	48	37	20	5	162
35–44	Male	31	17	19	5	6	78
	Female	13	13	10	1	4	41
	Total	44	30	29	6	10	119
45–54	Male	8	3	4	4	3	22
	Female	12	3	10	5	5	35

	Total	20	6	14	9	8	57
55–64	Male	7	5	7	2	3	24
	Female	7	0	4	2	3	16
	Total	14	5	11	4	6	40
Total	Male	81	55	54	26	15	231
	Female	49	34	37	13	14	147
	Total	130	89	91	39	29	378

Table 5. Awareness of pedestrian accidents

	Died	Injured
Personally involved	-	11
Someone close (friend/relative)	5	74

5. Model analysis and results

Attributes considered were number of lanes to be crossed, speed limit, crossing type (no crossing, zebra crossing, traffic lights, pedestrian overpass), total number of fatalities and injuries, walking time, and change in monthly municipality charges (Birol & Villalba, 2006).[7]

Socio demographic factors were found to affect respondents' preference for a given road-safety attribute. However, a statistically significant trend toward preference heterogeneity among respondents indicated that a single parameter was not sufficient to represent the entire population. Of the interactions considered (between age, gender, education, and personal income), only three interactions, fatalities and income, injuries and income and fatalities with age, explained heterogeneity in preferences (See

[7] A number of socio demographic variables were considered as interaction attributes, including age, education, income, gender, marital status, and occupation. The only variables found to be independent and to have a significant impact were age and income.

Table 6 for mixed logit model with interaction results).

Table 6. Mixed logit with interaction results

Attributes	Parameters	(t-ratio)
Random parameters		
Constrained triangular distribution		
Lane	−0.0200	−1.963
Traffic speed limit	0.0060	1.993
No crossing	0.1432	3.368
Zebra crossing	0.7390	4.754
Traffic light	0.1672	2.394
Fatality	−0.4226	−5.827
Injury	−0.1273	−2.546
Walking time	−0.4520	−5.765
Cost	−0.1180	−2.618
Non-random parameters		
ACS	0.1385	−3.274
Fatality and Income	0.0001	2.594
Injury and Income	−0.0001	−3.340
Fatality and Age	0.0078	3.748
Derived standard deviations of parameter distributions		
Lane	0.0100	1.963
Traffic speed limit	0.0030	1.993
No crossing	0.0716	3.368
Zebra crossing	0.3695	4.754
Traffic light	0.0836	2.394
Fatality	0.2113	5.827
Injury	0.0636	2.546
Walking time	0.2260	5.765
Cost	0.0590	2.618
WTP (TL)		
Fatality (per pedestrian/month)	7.16	
Injury (per pedestrian/month)	2.16	
Walking time (min)	0.34	

The average number of pedestrian trips per month	22
Model fits	
Halton draws	1,000
Number of observations	3,024
LL (0)	−3,315.70
LL (β)	−3,253.40
Pseudo R^2	0.307

The mean and standard deviation of all attribute coefficients were statistically significant, with signs as expected. The interaction parameters had no prior expected signs. As may be expected, our findings indicate that respondents had a larger marginal utility to avoid fatalities than to avoid injuries. In terms of crossing types, the dummy variable (installation of a zebra crossing) had a larger positive impact on utility than no crossing, which suggests that the installation of a zebra crossing was preferred. A dummy variable for installation of traffic lights was also preferred to the option of an overpass.

Furthermore, respondents indicated a preference for reduced walking time and a reduction in the number of lanes to be crossed. The subjective value of travel time (SVT) per trip at the mean of the conditional estimates was TL21(€7.2) per pedestrian hour.[8] Thus, for a given level of safety route choice was determined by a tradeoff between walking time and cost.

As anticipated, the marginal utility of municipality charges was found to be negative (–0.118) for all respondents. Furthermore, the alternative specific constant (ASC) had a positive mean (0.138), which is associated with unobserved influences on respondents' choice between a particular route, A or B.

Interactions between number of fatalities by income, and number of fatalities by age, were positive. The interaction between the number of fatalities by income implies that as income increases, all other

[8] The value of travel time per hour is calculated as [(2(-0.4520/-0.1180))/22] *60, where the coefficient for travel time is (-0.4520) and the coefficient for cost is (-0.1180), the average number of pedestrian trips per month is 22 and 60 is number of minutes/hour. The attributes variables are effects coded as –1 and 1 (a difference of 2), instead of as a dummy variable (0,1). Hence, the estimated coefficient will be half as large as it would be if it were coded as 0,1. To adjust for this, we must multiply the expression by 2 in order to measure the marginal WTP for a unit change in the variable (Hu, Hunnemeyer, Veeman, Adamowicz, & Srivastava, 2004).

influences being constant, the marginal disutility of being killed as a pedestrian declines more than that of being injured. However, the interaction between the number of injuries by income was negative. The interaction between the number of fatalities by age implies that as age increases, the marginal disutility of being killed as a pedestrian declines. However, when evaluated across all respondents, the interaction effect of socio demographic variables on utility was small relative to the overall impact of the number of fatalities and injuries.

5.1 Deriving value of risk reduction

Table 7 presents average willingness to pay (WTP) based on number of fatalities and injuries as random parameters to avoid traffic casualties. Average WTP for a reduction in fatalities per pedestrian per month (TL7.16 or €2.44) was higher than WTP for a reduction in number of injuries per pedestrian per month (TL2.16 or €0.74).

Table 7. Willingness to pay (TL/ pedestrian per month)

Attribute	Average	Std. dev.
Fatalities	7.16 (€2.44)	2.47
Injuries	2.16 (€0.74)	0.79

Average value of risk reduction (VRR) was calculated by converting WTP parameters for fatalities and injuries from per pedestrian per month to per pedestrian per trip, and then dividing this result by the chance of an event occurring.[9] The final estimated values of the chance of fatality or injury and VRR

[9] The chance of fatality or injury is defined by the relationship between the risk of fatality or injury per annum and average annual walking done in kilometers (AAWKM) on a given route. We estimated the average annual walk in kilometers in North Cyprus by multiplying the average number of round trips per month in the relevant population with a mean distance per trip of 1 kilometer.

are reported in Table 8.

Table 8. The chance of fatality and injury, and the estimation of VRR

Number of			Exposure	Chance of		VRR (TL) per	
Fatalities	Injuries	Average walking trip (km)	AAWKM	Fatality	Injury	Fatality	Injury
8	84	1	50,381,232	1.59E−07	1.67E−06	2,049,341	58,826

6. Discussion

The value of statistical life (VSL) in road safety has been the subject of a number of recent studies using methodology similar to that presented here. According to our findings, the value of risk reduction (VRR) that pedestrians place on one avoided fatality is TL2,049,341, and TL58,826 on one avoided injury. The resulting euro-equivalent VSL is €699,434, with the 95% confidence interval between €226,544 and €1,172,501, while the value of injury (VI) is €20,077, with the 95% confidence interval between €5,691 and €34,505.

According to data from Access Economics (2007) based on 244 studies conducted in Western Europe from 1973 to 2007 in the health, occupational safety, transport, and environmental sectors, average VSL was around €5 million, with a range of €4 million to €5.8 million, while the median for the transport sector was €4.4 million.[10]

A review of 30 studies conducted in the USA, Europe, and New Zealand indicate a wide range of VSLs

[10] The values reported by Access Economics (2007) are in 2006 Australian dollars. These values were adjusted for Australian inflation between 2006 and 2014 (23.5%, see inflation calculator on The Reserve Bank of Australia website) and converted to euros using an exchange rate of A$1= €0.66 for May 2014 (US Federal Reserve Board website).

for road safety, from around €200,000 to more than €10 million (Sælensminde, 2001; De Blaeij, Florax, Rietveld, & Verhoef, 2003; Hensher et al., 2011). Of these 30 studies, the majority of which used contingent valuation (CV) models and related to automobile accidents, 18 reported lower and higher bounded estimates while 12 presented single point estimates; 11 reported values below €1 million, 15 ranged from €1 million to €10 million, and the remainder were over €10 million.[11] Overall, the studies indicated that countries with a good road-safety record, such as Norway, Great Britain, Sweden, and the Netherlands, have a higher VSL than countries with a poor road-safety record, such as Portugal, Spain, and Greece. (See Figure 1 for VSLs in 23 countries.)

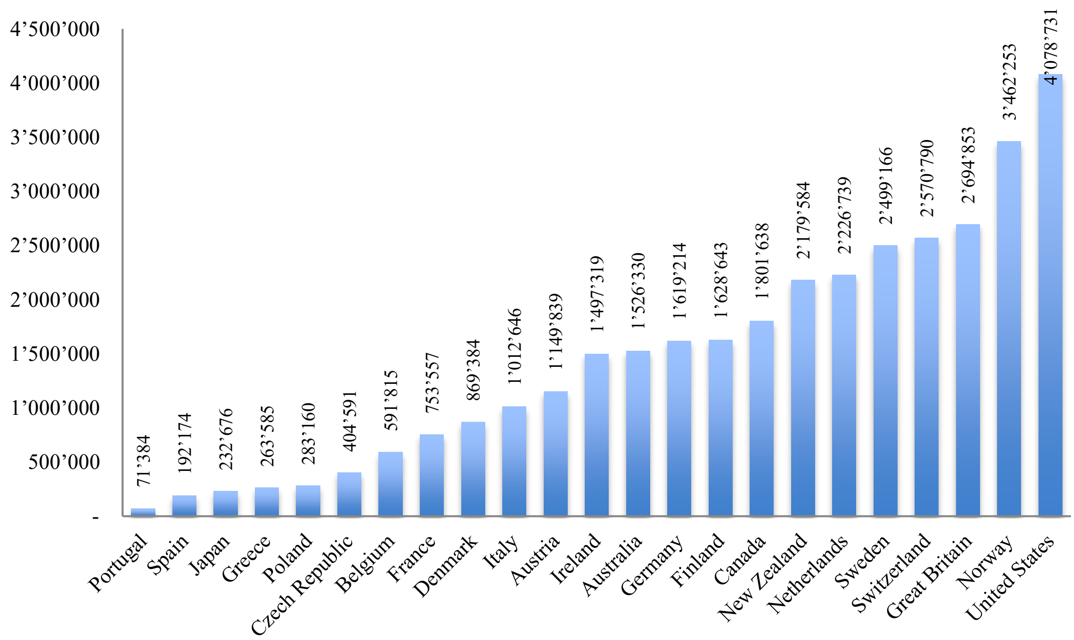

Fig. 1. Summary of VSL estimates in a number of countries.
Source: European Commission Road Safety Statistics (2009)

[11] The values reported by De Blaeij et al. (2003) are in 1997 USD. These values were adjusted for US inflation between 1997 and 2014 (42%, see inflation calculator on Federal Reserve Bank of Minneapolis website) and converted to euros using an exchange rate of €1=$1.36 for May 2014 (US Federal Reserve Board website).

The most frequently referred to VSL in the EU is €1 million. This is referred to as the ‘one-million-euro rule’ for the CBA of safety-improvement policies (Despontin, De Brucker, Coeck, & Verbeke, 1998; European Transport Safety Council, 2007) and is based on the statistical relationship that for each fatality prevented, there will also be a reduction in the number of accidents causing injury and property damage (Wesemann, 2000).

VSL is evaluated as the economic damage of a fatality, which can be used as a benchmark to justify safety improvements in the road environment. The point estimate of the VSL for North Cyprus as evaluated by this research was less than €1 million, which put it among the bottom 30% of estimates presented by De Blaeij et al. (2003). An important consideration is that the average income of Europeans is much higher than that of North Cypriots. By definition, any normal good that has an income elasticity greater than zero. Furthermore, numerous empirical studies indicate that in lower-income populations, the income elasticity of VSL is equal to or greater than 1. An income elasticity greater than one will result in WTP estimates that allocate a greater fraction of income to road safety improvements by high-income countries. Consequently, VSL is considered a luxury good (Hammitt & Robinson, 2011; Milligan, Kopp, Dahdah, & Montufar, 2014).

In order to examine the consistency of our findings with those for European countries, we adjusted our results for differences in income between North Cyprus and Europe. We then used our estimate to extrapolate the benefit transfer for Europe based on GNI and with appropriate assumptions of the income elasticity of VSL. In 2014, GNI was about €10,989 in North Cyprus, compared to €26,262 in the EU.[12] If income elasticity was 1, the benefit transfer function would be about €1,671,538 $\left[VSL_{Europe} = 699{,}434\ \left(GNI_{Europe}\ /\ GNI_{\ Cyprus}\right)\hat{}\ 1\right]$, and if the elasticity was 1.2 it would be €1,989,667 $\left[VSL_{Europe} = 699{,}434\ \left(GNI_{Europe}\ /\ GNI_{\ Cyprus}\right)\hat{}\ 1.2\right]$. After adjusting for differences in income levels, this finding implies that these adjusted estimates are at least 50% higher

[12] These values are reported by the World Bank (EU data on World Bank website) and the Turkish Republic of Northern Cyprus State Planning Organization. We adjusted the value for the EU using an inflation calculator (HICP table on Eurostat website) and converted to euros using an exchange rate of €1=$1.36 for May 2014 (US Federal Reserve Board website).

than the value of €1 million per human life used by the EU in cost-benefit studies of safety-improvement policies. They are approximately similar to the median of the other presented estimates of the value of VSL, but less than the means for the USA, Europe, and New Zealand. There is little reason to believe that the residents of North Cyprus have a different level of risk aversion with respect to pedestrian fatalities than many other countries in Europe (Andersson and Treich, 2011)

7. Conclusions

Our study calculates new empirically based estimates of pedestrians' willingness to pay (WTP) to reduce pedestrian death and injury in road accidents in North Cyprus—€699,434 to reduce the incidence of death by one and €20,077 to reduce the incidence of injury by one. Furthermore, we determined the value of walking-time saved for pedestrians in North Cyprus as €7.20 per pedestrian-hour.

A comparison of our findings with those of a similar study of drivers' attitudes to road safety over the period 2010–2014 in North Cyprus is informative. North Cyprus experienced an annual average of 40 road accident fatalities and 1,067 injuries in the period concerned (Niroomand & Jenkins, 2016). The value of risk reduction (VRR) that automobile drivers placed on the reduction of fatalities by one was €717,000 and €16,885 on the reduction of injuries by one. The fact that the ratio of deaths to injuries for pedestrians from an accident involving an automobile is so much higher than for drivers is consistent with the finding that pedestrians' have a higher WTP than do drivers to avoid an accident.

The higher rates of pedestrian fatality and injury in North Cyprus compared to European countries is proof that greater investments are required to improve road safety. However, given the many possible projects that could be implemented, a key requirement will be to select those supported by cost-benefit analysis (CBA) (Jenkins, Kuo, & Harberger, 2014). Our findings provide an important insight into the VRRs of residents. These parameter values are critical when undertaking an ex ante appraisal of road projects aimed at achieving specific policy measures such as saved walking times, as well as alleviating the unacceptably high risk of pedestrian casualties.

With the prospect of North Cyprus entering the EU in the near future, numerous investments will be required in order to meet EU norms of road quality and safety. However, the limited public investment budget of North Cyprus will mean that any proposed road-safety project must be subject to rigorous appraisal based on CBA.

Future research into road safety in North Cyprus should focus on differentiating between high- and moderate-risk routes, and issues related to accessibility (to bus stops, schools, public buildings). An additional area of potentially fruitful research would be to differentiate between injury type (non-severe, permanent, hospitalized)—data which is not currently but could easily be collected, given the small geographical area involved. Furthermore, as the number of injured people who move away from the region is rather low, North Cyprus is likely to be a very good place to measure the lifetime cost of such injuries.

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