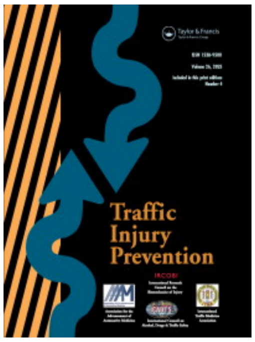

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The value of a statistical life in the context of road safety: a new value transfer approach

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ABSTRACT

Objective: The value of a statistical life (VSL) is a key input for cost-benefit analysis (CBA) in the context of road safety and for calculations of the socio-economic costs of road crashes. However, many countries, especially low- and middle-income countries (LMIC), lack country-specific VSL estimates. To address this, value transfer is often used, where VSL estimates from other countries are adapted to local situations to estimate the VSL in the countries with no VSL estimates. This paper presents new guidance for VSL value transfer in the context of road safety.

Method: A unit value transfer approach is applied, which implies that a base VSL is determined and used to estimate the VSL in other countries. We collected VSL estimates from 32 countries worldwide to determine base VSLs for both high-income countries (HIC) and LMIC. According to the literature, the VSL is strongly correlated with income per capita. Therefore, income elasticities from the literature are applied to account for the impact of per capita income on the VSL.

Results: The resulting VSL transfer functions are VSL = $0.404*(Y/5{,}726)^{1.2}$ for LMIC and VSL = $3.206*(Y/42{,}087)^{0.8}$ for HIC, where VSL is the VSL in million USD and Y is the Gross National Income per capita (USD, 2020 prices). The VSL ranges from approximately 22,000 USD to 1.1 million USD in LMIC and from 1.2 million USD to 4.8 million USD in HIC.

Conclusions: We recommend applying this VSL transfer approach for cost-benefit analysis and road crash costing in countries lacking appropriate country-specific VSL. Moreover, this study highlights that, despite the growing interest in LMIC in research on VSL, the number of studies in these countries is still limited, emphasizing the need for more VSL studies. Finally, developing transfer functions for non-fatal injuries is recommended, which is an essential input for CBA as well.

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Value of a statistical life; value transfer; road safety; cost-benefit analysis; costs; low- and middle-income countries

Introduction

Monetary valuation of road safety impacts provides a systematic quantitative approach to assessing the benefits associated with various road safety measures. It is useful for two main reasons, first, to emphasize the large socio-economic burden of road crashes, and second, to serve as input for decision-making on road safety investments through cost-benefit analysis (CBA) (Wijnen and Stipdonk 2016). Road crash cost studies are conducted on a regular basis in mainly high-income countries. These studies assess the impacts of road crashes on society from an economic perspective, usually expressed in monetary terms, typically incorporating a monetary valuation of the intangible impacts related to the loss of quality of life and life years ("human costs"). This serves to provide the rationale for increased investments in road safety measures. The socio-economic burden of road crashes is often stressed in road safety (policy) documents of international organizations (World Bank 2014; EC 2019), as well as in national policy documents of some countries (Wijnen 2024).

Monetary valuation of the impact on road safety is essential for CBA. CBA provides an overview of the costs of road safety measures, the safety benefits, and possibly other societal impacts, quantified in monetary terms as much as possible. It plays an important role in effectively allocating available resources and prioritizing different road safety measures (Bliss and Breen 2009). Various national and international organizations advocate using CBA for assessing road safety investments and prioritizing interventions (e.g., World Bank 2017; EC 2018). A large variety of road safety measures has been assessed in CBA-studies (Polinder et al. 2012; Daniels et al. 2019). CBA has played a role in decision

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making on road safety investments in several countries, such as Malaysia and New Zealand (Bliss and Breen 2009)

The "value of a statistical life" (VSL) is a key input for CBA in the context of road safety and in calculations of the socio-economic costs of road crashes (Wijnen and Stipdonk 2016). The VSL has two main components, human costs, and consumption losses (Evans 2009; Wijnen et al. 2009). The human costs component of the VSL reflects the (avoidance of) the intangible losses related to the loss of life years and quality of life. The material component of the VSL is the loss of consumption that someone would have enjoyed if he/she was not killed in a road crash. Additional costs of road crashes, which are not part of the VSL, include medical costs, property damage and administrative costs, among others (Bougna et al. 2022). Usually, the VSL comprises by far the largest monetary component in the total value of a prevented fatality (Wijnen et al. 2019).

There are two dominant approaches for the monetary valuation of preventing road casualties: the human capital (HC) and the willingness to pay (WTP) approaches (World Bank 2005; Bahamonde-Birke et al. 2015; Bougna et al. 2022). The HC approach concentrates on the valuation of people's productive capacities, using for example income as the valuation indicator. The scope of this approach is limited, mainly because it only includes a material component and does not consider the wider (intangible) value of life. On the other hand, the WTP approach derives the value of preventing a fatality from the amount of money people are willing to pay for reducing the risk of dying. The WTP is obtained from stated preference methods, which use questionnaires asking people how much they are willing to pay for (hypothetical) crash rate reductions, or from people's actual behavior and choices with respect to risk taking (revealed preference) (De Blaeij et al. 2003; Robinson and Hammitt 2013).

The WTP approach includes a valuation of the intangible aspects of life (the joy of life, quality of life, etc.), in addition to a material component (consumption). Due to this wider scope, monetary valuations based on WTP are found to be much higher than human capital values (Wijnen and Stipdonk 2016; Bougna et al. 2022). WTP is generally regarded as the preferred approach (Alfaro et al. 1994; Freeman et al. 2014; Bahamonde-Birke et al. 2015) because it entails a more comprehensive valuation of saving human lives. Moreover, WTP values are better suited for application in CBA, since they are based on individual preferences. This is consistent with the principles of CBA and the underlying welfare economic theory, which says that welfare assessment should be based on individual preferences (Boardman et al. 2011). It also corresponds to the premise that public decision-making on the allocation of scarce resources should reflect the preferences of the people affected by these decisions (World Bank 2005).

Country-specific VSLs have been estimated in only a limited number of countries, mainly high-income countries (Milligan et al. 2014; Bougna et al. 2022). As an alternative, researchers and policy analysts tend to use "value transfer," which implies that available values from other countries are used and adapted to the local situation (Freeman et al. 2014). This offers the opportunity to estimate the VSL without the need for conducting a resource consuming WTP-study.

There is no recent guidance for conducting VSL transfer in the context of road safety. Most VSL transfer studies and recommendations (Milligan et al. 2014; Robinson et al. 2019; Van Essen et al. 2019) rely on the data and results of an OECD-conducted meta-analysis of VSL studies published until 2010 (OECD 2012). Moreover, a VSL transfer method developed by McMahon and Dahdah (2008) is based on VSLs from 2008 or earlier. These value transfer approaches include VSLs from only a few LMIC, while several road safety valuation studies using a WTP approach have been conducted recently in LMIC (Bougna et al. 2022). Consequently, there is a need to develop a new value transfer approach that includes recent VSLs in LMIC. The objective of this paper is to develop this new value transfer guidance for the VSL in the context of road safety. We create a database containing recent VSL estimates from across the world as well as income statistics, and specify equations that relate to VSL to income per capita, separately in high-income and low- and middle-income countries. This allows estimating a country-specific VSL in any country using its measure of income per capita. We concentrate on WTP values only for the reasons mentioned above.

Value transfer methodology

Value transfer methods have been developed to help conducting CBA in countries without a VSL. Value transfer means that the results of primary valuation studies, in this case VSL studies, are used to estimate values in another context (Freeman et al. 2014) by drawing on evidence from existing VSL in other countries, and its relation with explanatory variables, particularly income per capita.

Two approaches are distinguished to transfer a VSL from one country to another (OECD 2012; Narian and Sall 2016): unit value transfer and function-based transfer. Unit value transfer implies that a VSL is taken from one or more primary VSL studies and used directly to estimate the VSL in another country. Per capita income is an important predictor of the VSL: several studies found a statistically significant positive correlation between the VSL and per capita income (Miller 2000; Lindhjem et al. 2011). This is consistent with the theoretical notion that safety is a "normal good" whose demand increase if income increases (Hammitt and Robinson 2011). Consequently, usually adjustments related to income are made when transferring a VSL from one country to another (Milligan et al. 2014; Robinson et al. 2019). Unit value transfer has been applied commonly in road safety studies, for example, studies from Europe on the costs of road crashes (Wijnen et al. 2019) and the external costs of transport (Van Essen et al. 2019). Function-based transfer specifies the relation between the VSL and income per capita and possibly other explanatory variables using regression models. A value transfer function for road safety was first developed by McMahon and Dahdah (2008), which indicates that the VSL is 70 times GDP/cap as a rule of thumb. Following a comprehensive OECD meta-analysis of stated preference studies as published in the academic literature (Lindhjem et al. 2011), Milligan et al. (2014) presented more complex value transfer functions for high-income countries (HIC) and low and middle-income countries (LMIC). Particularly the McMahon and Dahdah (2008) function has been applied regularly, presumably due to its practicality.

Examples include the CBA-methodology of the International Road Assessment Programme (iRAP 2015), which relies on this transfer function. It has been applied, among many other countries, in the Philippines to assess the benefits of road safety investments (iRAP 2018). Furthermore, the McMahon and Dahdah function was applied in calculations of the costs of road crashes worldwide (World Bank 2020) and in individual countries (e.g., in Azerbaijan; World Bank 2021).

Unit value transfer is the most straightforward value transfer approach. The OECD recommends this method as the most transparent approach which is just as reliable as the more complex function-based approaches (OECD 2012). Therefore, we follow this approach in this paper. We use the following equation to calculate the VSL jn any country, following Robinson et al. (2019) and OECD (2012):

$$VSL_{transfer} = VSL_{base} * \left(Y_{trasnsfer} / Y_{base}\right)^{\varepsilon}$$

where $VSL_{transfer}$ and VSL_{base} are the transfer VSL and the base VSL, $Y_{trasnsfer}$ and Y_{base} the per capita incomes of the transfer and base countries and ε is the income elasticity of the VSL. The income elasticity reflects the percentage change in the VSL associated with a percentage per capita income change.

Either gross domestic product (GDP) or gross national income (GNI) per capita are used as income indicator in VSL transfer studies (OECD 2012; Milligan et al. 2014; Robinson et al. 2019). In this study we use GNI. GNI includes income received from sources outside a country and therefore better reflects the income of the residents of a country. However, GNI also includes income generated by citizens living abroad, who may not be affected by the national road safety policies. GDP, on the other hand, is less suitable to measure the income of the residents of a country, since it includes income generated domestically which is received by foreign investors or entities. A practical reason for using GNI is the fact that the World Bank income classification, which is generally accepted as the standard classification, is based on GNI. This ensures that value transfer functions for different income groups, specifically high-income and low- and middle-income (see below), are applicable to the countries classified by the World Bank as such. Note that the difference between GNI and GDP is very small in most countries.[1]

Applying the value transfer equation specified above implies that a base VSL and an income elasticity need to be determined. The primary focus is on VSLs as officially determined and used by national governments for transport and road safety analysis, because the value transfer approach presented in this paper will be used by governments and organizations affiliated with them or working with them such as the Multilateral Development Banks. By using official national VSLs, the value transfer function complies with the values as already adopted by governments. Since the VSLs found in individual studies show large variations (De Blaeij et al. 2003; Lindhjem et al. 2011), it is preferred to use a base VSL that is based on a larger number of studies or a meta-analysis. Consequently, we conducted a search for VSLs in individual countries utilizing several sources to determine the base VSLs in HIC and LMIC. The income elasticities are determined based on a literature review, as discussed in the next section. Separate transfer equations will be presented for HIC and LMIC, since the literature indicates that different elasticities apply to HIC and LMIC (see next section). Consequently, separate base VSLs are determined for HIC and LMIC, which avoids transferring VSL over large income intervals that would yield less reliable VSL-estimates (Hammitt and Robinson 2011).

Data

Base VSLs

We leveraged three types of sources to collect existing VSLs in individual countries. First, we conducted an online search for official government VSLs. This search concentrated on road safety annual reports, road safety action plans and strategies, road safety assessment and management manuals and guidelines for CBA of transport projects. We found VSLs for seven countries, mainly large HICs. Second, we used the data collected in the European project SafetyCube. In that project, detailed data on the official estimates of road crash costs were collected from 31 European countries (Wijnen et al. 2019). For 17 countries, all HIC, a VSL estimation based on WTP was available.[2] 15 of them were included in the dataset, and for two countries (France and The Netherlands) we replaced the VSL estimates from the SafetyCube study with more recent official VSLs we found in the online search described above. Third, we conducted a literature review to search for road safety VSL-studies in other countries using Scopus. The search string was: TITLE-ABS-KEY (({value of a statistical life} OR {value of statistical life} OR {value statistical life}) AND (traffic OR transport OR road)). This resulted in 142 publications. We only included articles published in peer-reviewed journals after 2010 as a quality and recency criterion. We selected the studies in which a WTP-based VSL was determined (38 publications) and applied "backward snowballing" (Van Wee and Banister 2016), which resulted in six additional publications. In cases where more than one study from the same country was found, the study that used the most representative sample for the country (e.g. with respect to age and transport mode) was selected for the final dataset. If the sample representativeness was equal, we included the most recent study. In cases where more than one VSL was estimated in the same study, the VSL presented by the authors

1. The mean GNI/cap of the countries on which the value transfer functions presented in this paper are based, is 4.1% and 0.3% higher than the mean GDP/cap in HIC and LMIC respectively. Using a function based on GDP/cap will only result in a significantly different VSL if the ratio GNI/cap to GDP/cap in a country deviates significantly from the mean ratio for the countries on which the function is based.

2. More precisely, data on the human costs and production loss were collected in the SafetyCube project. The sum of human costs and production loss is very close to the VSL and is used as a proxy for the VSL.

Table 1. Summary statistics of the VSL data.

		HIC	LMIC	All countries
Number of VSLs		25	7	32
VSL (USD)	Minimum	581,254	91,756	91,756
	Maximum	11,270,527	843,794	11,270,527
	Mean	3,205,913	404,260	2,593,051
	Median	2,872,947	382,638	2,231,311
Ratio VSL/ (GNI/cap)	Minimum	31	37	31
	Maximum	166	121	166
	Mean	76	74	75
	Median	69	65	67

as the best estimate was selected. If no best estimate was made, we included the average of the VSLs in the dataset. The results from studies in Ethiopia (Mekonnen et al. 2022) and Egypt (Abdallah et al. 2016) were regarded as outliers and excluded from the dataset. In these studies VSLs of 1.2 million and 0.9 million USD (2020 prices) respectively were found, implying VSL to GNI/cap ratios of 1,491 and 311, which are far beyond the range of ratios found in other countries (31–166). The authors of the Egypt study admit that the VSL is high as compared to income.

This literature search delivered VSLs for 11 additional countries, including 6 LMICs and 4 HICs. Although the VSL transfer function established in this paper is aimed at government VSLs, these VSLs from academic literature were added to the dataset to cover more countries, in particular, LMICs whose governments had not established official VSLs. The data collection resulted in a dataset containing VSLs from 32 countries, among which 25 HICs and 7 LMICs (see the Supplementary material for a list of the countries). In addition to VSLs, we checked the availability of the total value per prevented fatality, which includes other elements besides the VSL such as medical costs, in all sources we used. These total values were found to be available in 21 countries, among which 19 HIC and 2 LMIC.

We converted all VSLs into USD price level 2020 in using consumer prices indices (CPIs) and exchange rates in 2020; which were retrieved from the World Bank (World Bank 2022). Exchange rates were chosen instead of purchasing power parities because exchange rates allow using the World Bank income classification, which is also based on exchange rates (World Bank 2023). Moreover, CBA usually adopts the national price level, which implies that adjusting for purchasing power differences is not needed.

Table 1 presents the summary statistics of the VSLs and the ratio of the VSL to GNI/cap.[3] Detailed data per country are found in the Supplementary material. The mean VSL is 2.6 million USD and the median 2.2 million USD. As expected, the mean and median VSLs are much higher in HICs than in LMICs. A wide range of VSLs is found, the

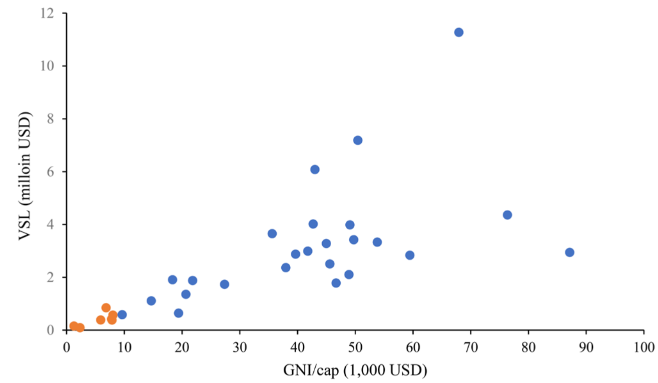

Figure 1. VSLs And GNI/cap (2020 prices). Orange: LIMC, blue: HIC.

highest VSL being about 10 and 20 times higher than the lowest VSL in LMICs and HICs respectively. The mean and median ratio of the VSL to GNI/cap are quite similar in HIC and LMIC (76 versus 74 and 69 versus 65 respectively).

Figure 1 shows a scatterplot of the VSLs and GNI/cap, clearly demonstrating that VSL are lower in LMIC (orange dots) than in most HIC (blue dots) as well as a positive relation between the VSL and GNI/cap.

Two base VSLs are adopted for the purpose of this paper, one for LMICs and another one for HICs. Based on the data presented above, the mean VSLs are used a base VSLs for the value transfer: 0.40 and 3.21 million USD for LMIC and HIC respectively. We use two base VSLs because it is important that the characteristics of study on which the base VSL is based, such the per capita income and risk level, resemble the characteristics of the transfer country as much as possible (OECD 2012; Robinson and Hammitt 2013).

VSL income elasticities

The literature indicates that different elasticities apply to HIC and LMIC. Narian and Sall (2016) provide an overview of the literature on the income elasticity of the VSL and recommend 0.8 as the elasticity for HIC. Based on a comprehensive meta-analysis of VSLs, OECD (2012) recommends the same value. For LMICs, Narain and Sall (2016) recommend using a higher VSL (1.2). This is consistent with the literature as several studies have indicated that the elasticity is likely to be higher in LMICs (Hammitt and Robinson 2011; Narain and Sall 2016). This is explained, among others, by the fact that a larger proportion of income is spent on basic needs, by higher general health risks and (related to that) differences in risk attitudes.

Two recent comprehensive reviews of stated preference studies (Masterman and Viscusi 2018) and revealed preference (labor market) studies (Viscusi and Masterman 2017) found elasticities in the same order of magnitude. The first study found an elasticity ranging from 0.55 to 0.85 for countries with an income above USD 2,312 per capita (2015 prices) and 1.0 for countries with incomes lower than USD 2,312. The latter study found an elasticity of 0.5–0.7 for transfer within the US and 1.0 for transfer to other countries. Robinson et al. (2019) reviewed stated preference VSL studies in LMICs and by comparing these VSLs with the

3. The GNI/cap in local currency in the year to which the VSL refers was taken from World Bank (2022) and translated into USD price level 2020 using the same conversion method as applied for the VSL. For North-Cyprus the GNI/cap in local currency was taken from the VSL study (Niroomand and Jenkins 2016) and the conversion results in a GNI/cap below the threshold income for high-income countries. However, since Cyprus was a high-income country in 2014, we classify North-Cyprus also as such.

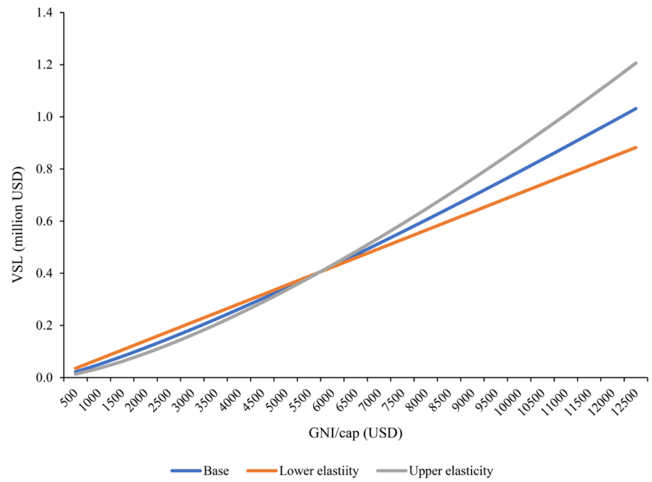

Figure 2. Transfer VSL in LMIC (2020 prices).

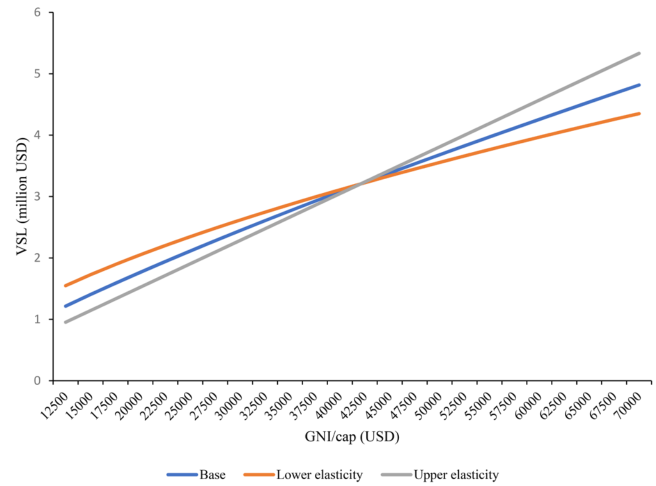

Figure 3. Transfer VSL in HIC (2020 prices).

VSL in the US they found an implicit elasticity of 1.5. Based on this result and other literature on the income elasticity of the VSL, they recommend using elasticities of 1.0 and 1.5 (depending on the base VSL) for transferring VSLs from HIC to lower income countries.

Recent studies on the costs of air pollution (World Bank and IHME 2016; Landrigan et al. 2018) assume an income elasticity of the VSL of 0.8 for HIC and 1.0 to 1.2 for LMIC. These elasticities are broadly in line with the literature.

Following this literature and current VSL transfer practices, 1.2 and 0.8 are chosen as the most appropriate elasticities for LMICs and HICs respectively for the purpose of this paper. Given the variation found in the literature, ranges are used for sensitivity analysis (1.0–1.4 for LMICs and 0.6–1.0 for HICs), as recommended by Narain and Sall (2016) and Landrigan et al. (2018). Note that we assume that income elasticities as determined in other contexts than road safety also apply to the VSL for road safety, since there are no studies on the income elasticity of the VSL in different contexts.

Results

Using on the base VSLs and income elasticities as discussed in the previous sections, the value transfer equations for LMICs and HICs are:

$$\text{LMIC}: \text{VSL} = 0.404\,^{*}\left(\text{Y}/5{,}726\right)^{1.2}$$

$$\text{HIC}: \text{VSL} = 3.206^{*}\left(\text{Y}/42{,}087\right)^{0.8}$$

where VSL is the VSL in million USD and Y is the GNI/cap in USD (2020 prices) in the country for which the VSL is calculated.

Figures 2 and 3 show the resulting VSLs in LMIC and HIC respectively. The base curve is based on the above equations, while the other two curves represent the VSL when the lower and upper elasticities as discussed above are applied. In LMIC, the VSL ranges from 22,000 (13,000–35,000) USD at GNI/cap = 500 USD to 1.05 (0.90–1.23) million USD at GNI = 12,695 USD (which is the threshold HIC income). The VSL in HIC ranges from 1.23 (0.97–1.56) million USD at GNI/cap = 12,695 USD to 4.82 (4.35–5.33) million USD at GNI/cap = 70,000 USD. Due to the elasticity above 1, the base curve of LMICs is slightly steepening, while the base curve of HICs is slightly flattening as a result of the elasticity smaller than 1. Note that the VSL at the end of the LMIC income range is close to the VSL of countries at the bottom of the HIC income range, which confirms that the chosen elasticities, in combination with the base VSLs, yield consistent results. The lower elasticities result in flatter curves while the upper elasticities result in steeper curves.

Table 2. Income (GNI) per capita, VSL and VSL to per capita income ratio in low, lower Middle, upper Middle and high income countries (2020 prices).

Income group	Low	Lower-middle	Upper-middle	High
Average GNI/cap (USD)	650	2,126	8,852	43,959
VSL (million USD)	0.03 (0.02–0.05)	0.12 (0.10–0.15)	0.68 (0.62–0.74)	3.32 (3.29–3.35)
VSL/(GNI/cap)	46 (30–71)	58 (48–71)	77 (71–84)	76 (75–76)

Table 2 presents the average VSLs of the income groups according to the World Bank income classification (World Bank 2023), as well as the ratio of the VSL to GNI/cap. The VSLs are calculated using the average income for each income group. The lower and upper values are based on the income elasticity intervals (1.0–1.4 in LMIC and 0.6–1.0 in HIC).

The VSL to income ratio ranges from 46 in low-income countries to 77 in upper middle-income countries. Due to the elasticity above 1 in LMIC, the VSL increases more than proportionally if income increases, resulting in higher VSL/income ratios in higher income groups. However, the average ratio in HIC is slightly lower than in upper middle-income countries. This is because the income elasticity in HIC is smaller than 1, resulting in smaller ratios if income increases. The ranges of the VSLs and VSL/income ratios are wider for lower income groups. This follows from the equations above, which show that the width of this range is dependent on the difference between the average income and the income related to the base VSL (5,726 USD in LMIC).

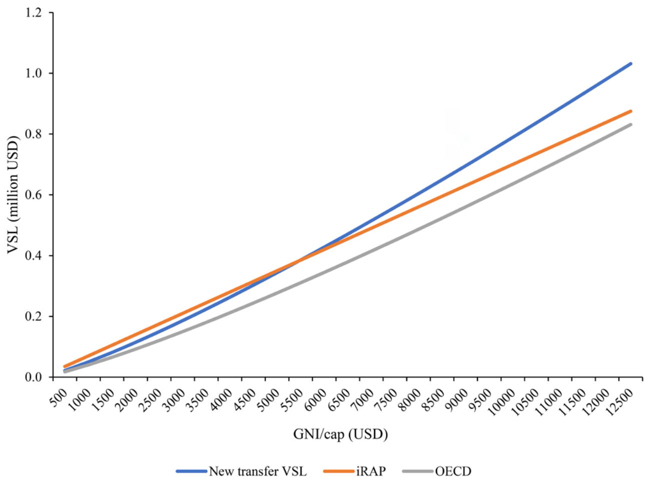

Figure 4. Comparison VSL obtained in this study (base value) for LMIC with VSLs resulting from value transfer as developed by iRAP and OECD transfer (2020 prices).

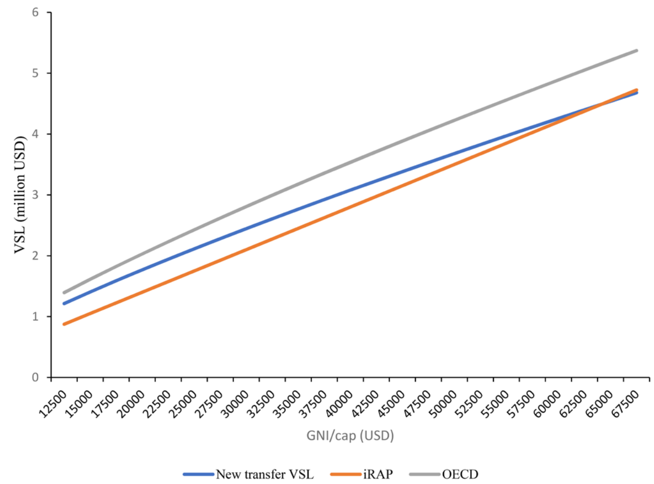

Figure 5. Comparison VSL obtained in this study (base value) for HIC with VSLs resulting from value transfer as developed by iRAP and OECD transfer (2020 prices).

Figure 4 (LIMC) and 5 (HIC) compare the VSL to GNI/cap ratio according to the value transfer presented above with two other value transfer approaches which are commonly applied until now: the rule of thumb developed by McMahon and Dahdah (2008) and a unit value transfer using the base value recommended by OECD (3.9 million USD, 2020 prices; OECD 2012).[4] As compared to the iRAP rule of thumb, the new value transfer results in lower ratios in LMIC up to an income of 5,500 USD per capita. For higher incomes, the new value transfer yields higher VSLs. The differences are explained by the fact that the VSL is assumed to increase (decrease) more than proportionally if income increases (decreases), whereas the iRAP rule of thumb is based on a linear relation. Applying the OECD base value results in lower VSLs for all LMIC because the relatively high base VSL is transferred over a large income interval using an elasticity higher than 1.

Figure 5 shows that the VSLs obtained from the transfer function are higher than the iRAP VSLs, except for very high income levels (above 64.000 USD per capita). The difference decreases with higher income levels because an income elasticity lower than 1 is applied in the new transfer function. The OECD VSLs are higher due to the higher base VSL.

As noted in the Introduction, the full value of a prevented fatality consists of several other elements in addition to the VSL. According to the data we collected on the total value per fatality, the VSL accounts for more than 90% of the total value in most (18 out of 21) countries and the (unweighted) average proportion is 94%. Consequently, the other elements account for a relatively small proportion of the total value of a fatality. The Supplementary material includes an overview of the full value per fatality and the cost components included in each country in addition to the VSL, using a standard classification of cost items (Wijnen and Stipdonk 2016). This shows that medical costs and production loss are included in all countries for which this information is available. The majority of countries also take into account additional cost items, such as property damage and administrative costs.

4. OECD recommends using an elasticity of 0.8. However, this elasticity applies to high-income countries. Therefore, an elasticity of 1.2 is applied for this comparison. Note that the OECD results for LMIC are very sensitive to the elasticity due the large difference between the average income in OECD countries and in LMIC. For example, an elasticity of 1 results in a VSL to GNI/cap ratio of 86 for all LMIC.

Discussion

This paper concentrates on valuation of fatalities, which is a key input for cost-benefit analysis of road safety measures or other transport projects. However, only a part of the benefits of road safety investments are related to the prevention of fatalities, as the investments will also have an impact on non-fatal injuries and property damage only crashes. The benefits of preventing these injuries and crashes are likely to be larger than the benefits related to preventing fatalities, as reviews of road crash cost studies indicate that non-fatal injuries and crashes account for 70–80% of the total costs (Wijnen and Stipdonk 2016). Despite this fact, the number of studies on monetary valuation of non-fatal road injuries is very limited. In a literature review (Wijnen 2024), only 13 studies were found on monetary valuation of non-fatal road injuries, while there is an abundance of literature on the VSL (Lindhjem et al. 2011). Moreover, that review showed that the values per serious injury vary widely, from 1% to 48% of the VSL. Guidelines for CBA and road crash costing include different recommendations for including the value of a serious injury in CBA. The iRAP methodology uses a value of 25% of the VSL (McMahon and Dahdah 2008), while in a European context 13% of the VSL is commonly applied (Van Essen et al. 2019). However, both percentages are outdated as they are based on data from more than 15 years ago. Given these facts, the VSL transfer function presented in this paper can be regarded as a first step for providing key inputs for CBA in the field of road safety. An important next step will be to conduct more studies on the monetary value of preventing non-fatal injuries and develop new guidelines for the value of these injuries in CBA.

Several previous VSL review studies and meta-analyses have shown that there is a large variation in VSL estimates, which is confirmed by our study. The variation is explained, among others, by the study design, risk levels and population characteristics (De Blaeij et al. 2003; Lindhjem et al. 2011). In addition, cultural differences may have an impact (Miller 2000; Robinson et al. 2019), although to the authors knowledge this influence has not been studied or included in meta-analyses. Concerning country differences, income differences are generally regarded as the key explanatory variable and therefore only this variables is commonly used in VSL transfer functions (OECD 2012; Milligan et al. 2014; Robinson et al. 2019). Despite the variability of the VSL, there is a need for a single base value for applied studies. For example, usually a single VSL is used in road crash cost studies (Wijnen and Stipdonk 2016). For that reason, base VSLs for usage in CBA and crash cost studies have been recommended in several studies (Van Essen et al. 2019; OECD 2012). This paper is aimed at providing new guidance for the VSL to be used. Nevertheless, analysts may wish to take into account uncertainty in VSL estimates, for example by using the upper and lower income elasticities as presented in this paper. Obviously, a country-specific VSL, if based on a solid WTP-study, is preferred above a value derived from value transfer, as this would include country-specific characteristics with respect to demography, crash risks and cultural aspects among others.

Despite a growing interest in LMIC in research on the VSL, our study reveals that the number of VSL studies in these countries is still limited. The VSL transfer results for LMIC presented in this paper are based on estimated VSLs from a limited number (7) of middle-income countries. No VSL estimates were found in low-income countries.[5] To enlarge the evidence on the VSL in LMIC, it is recommended to conduct more VSL studies in LMIC and particularly in low-income countries.

Conclusions and recommendations

In this paper, we developed an improved and updated VSL transfer approach for road safety as compared to previous value transfer approach, by using unit value transfer as recommended by the OECD and incorporating recent VSL estimates. Separate base VSLs for LMIC and HIC were determined, based on recent VSLs used by governments and VSLs from the literature in countries which do not have an official VSL. The elasticity was based on recommendations in the literature. This approach results in the following VSL transfer equations:

$$\text{LMIC}: \quad \text{VSL} = 0.404^{*}\left(\text{Y}/5{,}726\right)^{1.2}$$

$$\text{HIC}: \quad \text{VSL} = 3.206^{*}\left(\text{Y}/42{,}087\right)^{0.8}$$

where VSL is the transfer VSL in million USD and Y is the GNI/cap in USD (2020 prices) in the country for which the VSL is calculated.

Applying this VSL transfer approach is recommended to calculate a country-specific VSL for usage in CBA in the context of road safety. For sensitivity analyses, lower and upper elasticities may be used. Based on the literature, the recommended elasticity ranges are 1.0–1.4 for LMIC and 0.6–1.0 for HIC. This VSL transfer approach is aimed at providing a VSL for countries without a sound (WTP-based) country-specific VSL. The large majority of LMIC belongs to this group. Using the VSL transfer has the advantage of producing comparable VSLs in different countries, which is particularly beneficial for multi country studies and international comparisons. On the other hand, value transfer does not consider differences between countries that influence the VSL, apart from income.

The value transfer equations yield the following ratios of the VSL to GNI per capita:

- Low-income countries: 46 (30–71)
- Lower middle-income countries: 58 (48–71)
- Upper middle-income countries: 77 (71–84)
- High-income countries: 76 (75–76)

These ratios can serve as a simple rule of thumb to obtain a rough estimate of the VSL in a country, although applying the equations is recommended for a more precise VSL estimate.

For usage in CBA, a valuation of other elements, such as medical costs and property damage, may be added to the VSL. The data collected in this study indicates that these elements account for a small proportion of the total value of a fatality, as the VSL on average accounts for 94% of the total value of a fatality.

It is recommended to concentrate future research on the VSL in LMIC, as the number of studies in these countries is still limited.

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5. A VSL from Sudan was included, which is currently a low-income country. However, Sudan was a lower middle-income country at the time of the VSL study in country.

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