From Diye to Value of Statistical Life: A Case Study for the Islamic Republic of Iran

Victor Brajer
California State University, Fullerton

Morteza Rahmatian
California State University, Fullerton

I.   Introduction.

In recent years, environmental economists and public policymakers have increasingly attempted to value the benefits of environmental changes, such as reductions in air pollution, in the developing world. One of the most important potential benefits is the reduction in premature mortality; it is therefore essential to understand what range of dollar values are appropriate for this benefit.

Many economic studies have been published in the United States to value the health (specifically, mortality) effects of air pollution, but relatively few studies have taken place in countries with significantly lower incomes. Transferring economic values to other countries typically relies on a simple scaling based on national per capita output (or income) ratios between the country of interest and the United States. Such a procedure contains many drawbacks; the most obvious is the implicit assumption that preferences for averted mortality are similar between the countries and, further, that they are determined largely by income. Use of such a simple transfer procedure also basically assumes that the income elasticity of willingness-to-pay (α-WTP) for improved health (or death avoided) is equal to 1.0 (or that treating it as 1.0 captures all other factors that may influence the WTP). This, of course, ignores the potential importance of cultural factors, where by *culture* we mean "the sum total of ways of living, built up by a group of human beings and transmitted from one generation to another," or the "behaviors and beliefs characteristic of a particular social, ethnic or age group."[1] At the current time, we have very little data on how cultural factors might affect preferences and how these would relate to willingness-to-pay to avoid premature death--the theoretical basis for the Value of a Statistical Life (VSL) calculation.

Some recent valuation studies have addressed the issue of preferences for health and income in developing countries. In a Bangkok, Thailand study, Chestnut et al. (1997) find that the WTP for avoiding a respiratory-illness day actually exceeds what would be predicted following a simple national income adjustment, suggesting that health may be viewed as a basic necessity and "that those with lower incomes may be willing to pay a higher share of that income to protect their health." Alberini and Krupnick (1998, 2000) reach a similar conclusion in a comprehensive health valuation study of three urban areas in Taiwan. In a meta-analysis, Bowland and Beghin (2001) derive a prediction function for developing countries, which

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[1] These definitions appear in Webster's College Dictionary, 1996 edition.

accounts for differences in income, estimating an income elasticity of WTP (α-WTP) of 2.27 for averted mortality. This, of course, implies that health (and avoiding premature death) is a "luxury" good. Viscusi and Aldy (2003), on the other hand, recently reviewed more than 60 studies of mortality risk premiums from ten countries, and estimate an income elasticity of the VSL of between 0.5 and 0.6, a finding consistent with health (and VSL) being a normal good.

In this paper, we attempt to explore the influence that cultural factors can have on VSL and α-WTP. We do so by considering the value of a statistical life in the developing country of Iran, and examining a specific cultural factor directly connected to this value--the Diye. The Diye is a form of financial compensation offered in cases of unintentional death (and injury) to the victim's family, paid by the perpetrator. With the payment being made after the death of a specific individual, it obviously represents an ex ante valuation measure. In the first half of the paper, we describe the tradition of the Diye and use it to estimate a modern-day VSL for Iran. We find that this approach generates a value of approximately $45,000 (US). This value is actually very close to what one would generate with the more traditional (western) human capital approach, which of course also captures an ex ante valuation and is generally recognized as providing a lower bound for VSL in the developed nations.

In the second half of the paper, we investigate the Iranian VSL further. First, we conduct a contingent valuation (CV) survey on mortality valuation, and estimate a VSL of approximately $66,750, which is about 50 percent higher than the Diye (human capital) value. Next, we conduct a CV survey of morbidity valuation, and estimate monetary values for eight commonly occurring health symptoms. Using these morbidity values, in conjunction with some value indexes from the health literature, we calculate an Iranian WTP for averted mortality of nearly $100,000. Using this WTP figure, we also estimate an income elasticity for the value of a statistical life (α-WTP) of 2.44. Our VSL estimate, along with the calculated income elasticity, is consistent with values reported in other recent studies in the valuation literature. We offer the conclusion that in Iran people's attitudes towards the value of death may be strongly influenced by this long-held Diye tradition, and further, that its influence is weakened when people are surveyed about morbidity values, which are more within their common experience and therefore easier for them to value.

II.   The Diye.

Part of a society's culture, of course, is its attitudes toward dying and death. The Islamic religion long ago identified a straightforward method of compensation in cases of unintentional death and injuries. This form of compensation was named Diye, and is still being practiced today in the Islamic Republic of Iran (IRI), as well as in a number of other Moslem nations. According to the constitution of the IRI, Diye is used in order to bring about peace and stability to a society in cases of unintentional death and injuries.

The concept of Diye refers to a form of financial compensation to be paid by the perpetrator to the victim's family. It was designed to bring satisfactory resolution to a dispute between two parties. In Iran, Diye is looked upon as conforming to the will of God; as such, by following this method of compensation, one can please God. Diye has been defined as "blood

money," and was partially designed to serve as a form of punishment. It was also designed to provide some compensation to the victim or their families. Note that Diye did not attempt to place a monetary value on human life; instead, it was aimed at "softening the blow" and taking some of the pain away from the victims and their families.

Historically, many countries have used Diye, in a variety of ways. The concept does not even necessarily belong to Moslem nations--many non-Moslem nations have also utilized Diye in many forms to demonstrate the respect and value that one places on human life. For example, the prophet David practiced Diye long before the creation of Islam. At that time, the guilty party was required to make restitution to the victim's family for up to five generations. Thus, the enforcement of Diye occasionally resulted in long and complicated family feuds, where the payments forced families to terminate all of their associations.

Diye has always had comprehensive rules, conditions and regulations governing its application. It has quantified compensation for every part of the body, with the highest value, of course, being set aside for human life, which in pre-Islamic times was initially set equal to the value of 10 camels and eventually raised to 100 camels[2]. In later years, in order to provide a choice of payment, other forms of compensation were used in addition to camels. Specifically, one could use cows or sheep. After the Islamic religion was established, Islamic leaders offered even more payment options, including precious metals such as gold and silver, with which people could settle their disputes.

Today, the payment of Diye for an unintentional murder consists of <u>one</u> of the following six forms of payments:

➢ 100 healthy and strong camels
➢ 200 healthy and strong cows
➢ 1,000 healthy and strong sheep
➢ 200 sets of quality clothing
➢ 1,000 dinars, where each dinar is equivalent to 3.515 grams of gold, or
➢ 10,000 darham, where each darhamis equivalent to 2.46 grams of silver.

Since the monetary value of most of these items fluctuates a great deal (depending to a large degree on quality), we choose to focus on the one item whose value is easy to determine—the dinar, whose value is based on gold. With 2003 gold prices set at $363.38 per ounce, the value of 1,000 dinars thus becomes: (3,515 grams)(0.035274 oz/g)($363.38/oz) = $45,055. This represents our modern day value of the Diye. We note that this value coincides almost exactly

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[2] Abdoulmotalleb (the Prophet Mohammed's grandfather) had vowed to God to sacrifice one of his sons if God allowed him to have 10 sons. With the birth of Abdullah (his 10th son), it was time for him to act on his promise. Abdoulmotalleb gathered all of his children and explained to them his promise. They agreed to help their father and decided to select one child at random via lottery. The selected son happened to be Abdullah. He was taken away to be sacrificed, but the other sons, along with the rest of the village, attempted to stop the sacrifice by offering Abdoulmotalleb an alternative--a lottery between sacrificing Abdullah or Diye, which at the time was 10 camels. If the drawing happened to pick Abdullah, they would add 10 more camels and draw again. They would continue this process until the camels were drawn. The drawings actually continued until the number of camels reached 100. At that time the camels were drawn. Abdoulmotalleb thereby sacrificed the 100 camels and saved his son's life.

with the figure one obtains by calculating a worker's foregone earnings—the human capital approach. Considering a worker of average age in Tehran (37 years, which is based on our sample, described in the next section), a retirement age of 62, and a yearly real wage of $1800, an estimate of $45,000 results. We next turn to our procedure for estimating what economists believe to be a more comprehensive measure of the value of life.

III. Survey Instrument.

As part of a health valuation program initiated by the Ministry of Jihad in IRI, in the summer of 2002 the Contingent Valuation Method (CVM) was utilized to estimate monetary values for the avoidance of certain health symptoms (including the reduction in the probability of dying prematurely) in the Greater Tehran area. Of course, CVM plays a major role in economic research aimed at estimating the value of non-market goods. Basic to the survey technique is establishing a hypothetical market in which a commodity/service can be traded.

A survey instrument was thus developed to obtain Willingness to Pay (WTP) estimates for preventing future symptoms. Initially, pilot surveys were conducted to assess the effectiveness of the survey instrument and to identify any difficulties respondents might encounter in answering the questions posed. The results of the pilot surveys were used to assess whether changes were needed before full survey implementation was undertaken.

Eight health symptoms were identified for valuation: Cough, Shortness of breath, Chest pain, Irregular heartbeat, Vomiting, Headache, Sore throat, and Eye irritation. We also utilized the survey to obtain a monetary value of individual WTP to reduce the probability of dying prematurely (from which the VSL can be calculated). Three thousand random surveys were completed from the Tehran population. To collect the desired information, the following steps were taken.

First, the interviewers introduced themselves and presented the purpose of the study. After the introduction, a detailed description of good health and how it is negatively impacted by the symptoms was given. This section was designed to give all respondents homogenous information regarding good health and its value. A series of questions were then asked to determine respondents' overall health and lifestyle. For instance, respondents were asked about their smoking habits, whether they suffered from any air pollution health-related symptoms, and in general, to rate their overall health status. Finally, the respondents were specifically asked whether they had experienced any of the 8 symptoms during the last month.

Prior to bid elicitation the individual's monthly income and total expenditures were also asked and recorded. These questions were asked to force the respondent to consider their budget constraint during the valuation process. Following this introduction, respondents were then asked to state their willingness to pay to avoid having any of the symptoms. Respondents

were asked to place a dollar value on all symptoms independently and asked to be as accurate as possible. The willingness to pay question was stated as follows: *"If you were placed in a hypothetical market and were able to purchase avoidance of any of the listed symptoms, given your budget constraint, please identify your willingness to pay for avoiding one day of these symptoms."*

Next, the CVM utilized for health symptoms evaluation was enhanced by adding additional questions in an attempt to evaluate the VSL. Respondents were asked to place a dollar value on the possibility of reduction in the death rate. Specifically, the current death rate in Iran was given to the respondents. Following this information, they were asked their willingness to pay to have the death rate decrease by one in one thousand.

Finally, in the last part of the survey the respondents were asked a set of questions regarding the following socioeconomic variables: sex, age, marital status, education level, whether the respondent was the primary income earner, number of people in the household, employment status and how many hours per day were spent outdoors.

IV. Survey Data Analysis.

Overall, nearly 3000 surveys were completed from the residents of Tehran regarding their preferences related to preventing future symptom episodes. Table I summarizes the mean and median bids for each of the symptoms (including premature mortality), with the large disparity between the mean and median bids clearly indicating that responses varied tremendously from person to person (or at least that some people gave very high bids). Mean symptom bids range from 6,744 Rials for reducing one day of sore throat to 14,113 Rials for a day with irregular heartbeat, while the median bids are somewhat smaller, ranging from 3,000 Rials to 8,000 Rials for sore throat and heartbeat, respectively. The mean and median bids for a one in 1,000 reduction in the probability of dying prematurely are 35,000 and 15,000 Toman, respectively. To generate our VSL estimates, we focus on the median WTP numbers, which reduces the impact of some unusually high bids given by a number of the respondents.

Next, we consider the currency convergence question. Some studies have based value transfers on official exchange rates (here, 8,000 Rials = $1 US; also 10 Rials = 1 Toman), but this does not capture the relative domestic purchasing power of different currencies. Instead, many researchers prefer to compare relative incomes by using purchasing power parities (PPPs) as conversion factors. For Iran, the 2003 GNP per capita is only 5% of that of the United States using exchange rate conversion; however, this figure increases to over 18% when using PPP (as reported by the World Bank, 2003). In converting from the Iranian-based morbidity and mortality survey estimates, we thus use the PPP-based national output ratio between the U.S. and Iran. The resulting daily economic values for avoiding various health symptoms also appear in Table 1. These range from $1.78 to avoid a day of sore throat to $3.56 to avoid a day

experiencing irregular heartbeat. Finally, we note that the median survey responses directly imply a VSL of $66,750. In the following section, we attempt to indirectly infer the VSL using our survey's morbidity values.

V.   Deriving an Iranian Value of Statistical Life.

In this section, we use the willingness-to-pay (WTP) symptom numbers derived from our survey to derive an estimate of the value of a statistical life (VSL) for Iran. Drawing on work by French and Mauskopf (1992) and by Johnson et al. (1997), we make use of a health-status index to link morbidity WTP values to mortality WTP numbers--the VSL. Specifically, we perform the following steps to arrive at our VSL estimates:

1. Use our WTP survey results, measured in PPP-adjusted US dollars.
2. Determine, for each health effect, the number of Quality-Adjusted Life-Days lost, using health index numbers developed by Johnson et al.
3. Calculate a range of estimates for the Value of a Quality-Adjusted Life-Year (QALY), using the information from (1) and (2).
4. Combine the value of a QALY with life-years remaining to derive the VSL.

We discuss our methodology in more detail in the sections below.

a. Calculating WTP values for specific symptoms.

First, we use the WTPs, as expressed in US dollars, which were converted using the current market exchange rate, and making a purchasing power parity (PPP) adjustment based on the 2003 ratio of Iran's GDP per capita to the corresponding US figure. Again, these numbers appear in Table 1.

b. Determining the number of Quality-Adjusted Life-Days lost.

French and Mauskopf (1992) developed an approach for using health-status indexes to derive WTPs for specific symptoms (such as cough, headache, and asthma) from the value of a statistical life. Here, we "reverse the process" to derive an estimate of the VSL from our reported WTP values for specific symptoms. To provide the crucial link, we turn to a recent valuation study by Johnson et al. (1997). Their study pooled almost all of the existing morbidity WTP estimates in the economic valuation literature and linked them to the health-state index literature through a quality of well-being (QWB) index. This index has been extensively evaluated and used by health researchers, and provides a quantitative measure of the perceived severity of specific health conditions, on a scale ranging from 0 (death) to 1 (perfect health). By subtracting a symptom's QWB from one, the portion of the "day lost" due to the symptom is inferred. For each of the specific health outcomes we studied, our estimate for Days Lost is shown in Table 2.

c. Calculating the value of a life-year.

Combining the WTP for avoiding a day with a particular symptom with its QWB index number, it becomes a simple matter to infer the value of a Quality-Adjusted Life-Year (QALY). Again, we use the reverse of the process developed by French and Mauskopf. The equation generating the value of a QALY is as follows:

Value of 1 Life-Year = (WTP for Avoiding 1 day with symptom * 365)/ (Days Lost)

Thus, using mild cough (as one representative example), we estimate the value of a QALY to be [($1.78)*365 / 0.257] = $2,528. Using each of the symptoms from our WTP survey, we calculate a possible range for the value of a QALY. These values range from $1,820 (using the Nausea symptom) to $4,424 (derived from Shortness of Breath), and appear in Table 2.

d. Calculating the value of a statistical life.

In the final step, we calculate the VSL by simply multiplying our estimate of the value of one Quality-Adjusted Life-Year (QALY) by the number of life-years left. Remaining life-years can be computed by comparing the age of a particular individual to life expectancy. For example, the expected loss of life years from death at age 40, for a person with a life expectancy of 75 years, is 35 years. If we assume that the marginal value of a life-year is constant[3], the dollar value of avoiding premature death (the VSL) is thus related to the QALY by the following equation:

Dollar Value of VSL = (Dollar Value of QALY) x (Total Life-Years Remaining)

Here, we combine the average age of our survey respondents (37), and the Iranian life expectancy of 69 years, and predict 32 years of life remaining for an "average" survey respondent. With this approach, we find the VSL to range from $58,236 to $141,569, with an average value of $99,333. It should be noted that these values are not being ascribed to the life of any individual but to reducing the annual probability of death for Tehran residents by a small amount. This figure is substantially higher than the human capital and Diye values estimated earlier.

e. Calculating Income Elasticity of WTP for avoiding premature death.

As we have noted, there are few estimates of the VSL for developing nations in the economics literature. With this in mind, Bowland and Beghin (2001) conducted a meta-analysis of VSL studies from the industrialized nations to derive a VSL prediction equation that could be used for developing countries. This equation accounts for differences in risk, human capital levels, and perhaps most importantly, income between more and less developed nations. Their work also led to the estimation of an income elasticity of WTP for reductions in the probability of premature mortality--that is, an income elasticity of the value of a statistical life.

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[3] We realize that this is a heroic assumption. There is an emerging literature on this topic, with no clear theoretical resolution regarding the behavior of WTP to avoid premature death as one gets older. See, for example, Bowland and Beghin (2001), Johansson (2001), Viscusi and Aldy (2003), and Mount et al. (2001).

This elasticity, which Bowland and Beghin estimate to range from 1.52 to 2.269, can be expressed as part of the following formula:

$$WTP_A = WTP_B \, (INC_A / INC_B)^\alpha$$

where the A and B subscripts denote two different countries, WTP represents the willingness to pay for a particular health effect (here, the value of avoiding premature death), and INC denotes the per capita income in each nation. The α term is the income elasticity of WTP.

To provide a check on the validity of our previous VSL estimates, we use this Bowland-Beghin equation, along with our Iranian VSL numbers, to infer the value of α for Iran. Assuming a US value of statistical life of $6 million, PPP-adjusted per capita income figures for the 2 countries (as reported earlier), and the median-based VSL estimate derived from our survey work, we obtain a value for α of 2.44. This values falls only slightly outside of Bowland and Beghin's predicted range for α, lending some support to the validity of our morbidity-based VSL estimation procedure.

VI.   Summary and Conclusion.

In this paper, we examine the effect that a long-held cultural tradition (the Diye) can have on peoples' preferences and willingness-to-pay (WTP) regarding the value of avoiding premature death—the theoretical basis for the value of a statistical life (VSL). Our findings show that the Diye compensation is very close to the value obtained using the human capital approach, which measures foregone lifetime earnings and is generally regarded as a lower bound for the VSL. Then, we conduct a Tehran-based contingent valuation (CV) survey on mortality valuation, and estimate a VSL of approximately $66,750, which is about 50 percent higher than our Diye/human capital number.

Finally, we conduct a CV survey of morbidity valuation. By estimating monetary values for eight commonly occurring health conditions, and combining these values with value indexes from the health literature, we calculate an Iranian VSL of nearly $100,000, and an income elasticity for VSL of 2.44. These estimates are both consistent with values reported in other recent valuation studies for developing countries.

We speculate that peoples' attitudes toward the value of avoiding premature death, as captured by our WTP mortality survey, are strongly influenced by the long-held Diye tradition. Our health index-derived morbidity values, on the other hand, are not so closely tied to the Diye. People can more easily render independent values on minor health outcomes (such as sore throat and headache), which are well within their common, everyday experience. Overall, these findings clearly demonstrate the influence that a cultural factor can exert on peoples' preferences and values regarding health benefits.

Table 1: Mean and Median Bids for Symptom Avoidance (in Rials)

Symptom	Mean	Median	Median (in US $)
Cough	8,999.87	4,000	$ 1.78
Shortness of breath	13,413.77	7,000	$ 3.115
Chest pain	10,327.50	5,000	$ 2.225
Irregular heartbeat	14,113.21	8,000	$ 3.56
Vomiting	7,236.17	4,000	$ 1.78
Headache	12,085.66	5,000	$ 2.225
Sore throat	6,743.83	3,000	$ 1.335
Eye irritation	9,124.38	5,000	$ 2.225
Premature mortality (1 in 1,000 reduction)	35,072*	15,000*	$ 66.75

* Measured in Toman

Table 2: Life Days Lost and Value of Life (in US $)

Symptom	Days Lost	Value of 1 Year	VSL
Cough	0.257	$ 2,528	$ 80,896
Shortness of breath	0.257	$ 4,424	$ 141,569
Chest pain	0.299	$ 2,716	$ 86,916
Irregular heartbeat	0.359	$ 3,620	$ 115,824
Vomiting	0.357	$ 1,820	$ 58,236
Headache	0.244	$ 3,328	$ 106,508
Sore throat	0.170	$ 2,866	$ 91,722
Eye irritation	0.230	$ 3,531	$ 112,991

References.

Alberini A and A Krupnick. 1998. "Air quality and episodes of acute respiratory illness in Taiwan Cities: Evidence from survey data." Journal of Urban Economics 44: 68-92.

_____. 2000. "Cost-of-illness and willingness-to-pay estimates of the benefits of improved air quality: Evidence from Taiwan." Land Economics 76: 37-53.

Bowland BJ and JC Beghin. 2001. "Robust estimates of value of a statistical life for developing economies." Journal of Policy Modeling 23: 385-396.

Chestnut LG, BD Ostro, and N Vichit-Vadakan. 1997. "Transferability of air pollution control health benefits estimates from the United States to developing countries: Evidence from the Bangkok study." American Journal of Agricultural Economics 79: 1630-1635.

French MT and JA Mauskopf. 1992. "A quality-of-life method for estimating the value of avoided morbidity." American Journal of Public Health 82: 1553-1555.

Johannson P-O. 2001. "On the definition and age-dependency of the value of a statistical life," Stockholm School of Economics Working Paper.

Johnson FR, EE Fries, and HS Banzhaf. 1997. "Valuing morbidity: an integration of the willingness-to-pay and health-status index literatures." Journal of Health Economics 16: 641-665.

Mount T, W Weng, W Schulze, and L Chestnut. 2001. "Automobile safety and the value of statistical life in the family; valuing reduced risk for children, adults and the elderly," Report, U.S. Environmental Protection Agency, Washington, D.C.

Viscusi K and JE Aldy. 2003. "Age variations in workers' value of statistical life," NBER Working Paper Series, National Bureau of Economic Research, Cambridge, Mass.

World Bank. (2003). 2003 World Bank Indicators. Washington, DC.

World Development Report 2003, Sustainable Development in a Dynamic World, Oxford, 2003