COST OF ROAD ACCIDENTS INVOLVING CHILDREN IN THAILAND*

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1. INTRODUCTION

Accidents involving children have resulted in immeasurable losses for the economy and for the society as a whole, because accident-related disabilities take away the opportunity for the children affected to live a normal life and contribute fully to society. As for those children who are killed in such accidents, they can make no contributions at all. According to the Public Health Statistics of Thailand for 2012 (Table 1), the leading cause of death among children aged 0-4 years is water accidents and drowning, followed by road accidents. These two types of accidents are also the two leading causes of mortality in 5-14-year-olds. However, road accidents are the number one cause of death among adolescents aged 14-19. Traffic-related accidents are, therefore, one of the greatest dangers facing young children and teenagers in Thailand.

Thailand Development Research Institute (TDRI) received a grant from UNICEF Thailand to conduct this research. This paper provides a quantitative estimation of the losses incurred from traffic accidents affecting children, and contains a number of policy implications drawn from the findings.

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Table 1: Number of fatalities caused by accidents, by age group, according to death certificates issued in Thailand in 2012

Cause of death		Total number of deaths among children	Traffic accidents	Water accidents and drowning
Total		415,141	14,059	4,017
Age	<1	5,420	33	11
	1-4	1,827	157	363
	5-14	3,423	595	677
	0-14	10,670	785	1,051
	15-19	5,211	1,702	N/A

Source: Public Health Statistics of Thailand for 2012, Bureau of Policy and Strategy, Ministry of Public Health.

Although the monetary damage caused by road accidents involving children is important for designing effective prevention policies, the amount of such losses caused by accidents among children and teenagers aged 0-14 and 0-19 has not been estimated systematically.

2. COST OF ACCIDENTS AMONG CHILDREN

Traffic-related accidents among children lead to untold costs for the various parties concerned–the children involved in the accidents, the families of those children, insurers, and society as a whole. In that context, Miller et al. (2000) categorized the costs resulting from unintentional injury and death into two types: "injury costs" and "quality of life losses."

Injury costs can be further subdivided into "resource costs" and "productivity costs." Resource costs involve medical fees and other indirect costs, such as police costs, while productivity costs are work-loss costs, which include the victims' lost wages and the value of lost household work, as well as the administrative cost of processing compensation for lost earnings, and so on.

Resource and productivity costs do not encompass all the victims' losses. Road accidents also worsen the surviving victims' quality of life. Permanently disabled children may suffer from motor or cognitive impairment. The victims' families may also experience mental anguish. Moreover, pain and suffering could comprise another consequential effect. Such costs can be estimated in non-monetary terms, such as the so-called quality-adjusted life years or the disability-adjusted life years.

3. VALUATION OF LOSSES CAUSED BY ROAD ACCIDENTS

Losses incurred as a result of traffic accidents comprise the losses of victims involved in non-fatal accidents, such as medical costs and opportunity costs from illness, and the losses caused by death. In economics, there are three methods for assessing the valuation of these losses. The first method is the **human capital approach (HCA)**, in which a monetary value of life is calculated based on the premise that the value of human capital equates to market productivity. The other two methods are the **quality-adjusted life years (QALYs)** approach and the **value of statistical life (VSL)** approach, the use of which is based on individual preference. Nevertheless, these two approaches rely on different assumptions. The details of the three valuation methods are described below.

(a) Human capital approach

HCA was the very first method that economists used to evaluate the value of life. With this approach, one's life is valued in terms of his or her market productivity. In this method, it is assumed that market productivity reflects a person's income. Death and disability are conceptualized as a loss in terms of human productivity (Faculty of Engineer-

ing, Prince of Songkla University, 2007). Hence, the value of life is calculated by discounting all expected future earnings (Andersson and Triech, 2011). Nonetheless, in this approach, neither the difference in how each person estimates his or her risk of fatality nor any other aspects of loss besides the material part is considered (Zhang, 2002).

The advantage of this approach is the simplicity of the concept and calculation for non-economists since it does not rely on the utility concept in economics; however, it has several major drawbacks. First, HCA assigns a zero value to non-market production. Consequently, in this approach, the life of an unemployed or retired person does not have any value. Second, HCA does not reflect an individual preference for personal safety as it evaluates only the value of lives based on the society as a whole. Accordingly, this technique ignores the theory of welfare economics, which values the effect of the utility of the individuals concerned. Third, this valuation approach reflects only the material point of view but disregards non-productivity loss. As a result, it tends to underestimate the health consequences of accidents.

(b) Quality-adjusted life years approach

QALYs measure the value of life loss by a person's reduction in utility as a result of illness, injury or death. This method quantifies health in terms of an increase in a lifespan of better health as health risk declines. The quantification of life value is not expressed in monetary terms, but rather in the form of duration of life. QALYs are commonly used in cost-effectiveness analysis (CEA), especially in the field of medicine and public health (Wang and He, 2010; Neamsri and Chancharoenchai, 2011).

The number of QALYs can be calculated from a lifespan weighted by health-related quality of life (HRQL), the formula for which is shown in equation (1) below (Hammit, 2002).

$$\text{QALYs} = \sum_{i=1}^{M} q_i T_i \qquad (1)$$

From this equation, a lifespan is divided into M periods, indexed with i. The duration of the period i is T_i and the state of HRQL in the period is characterized by the weight q_i. The weight q_i, which represents a health-related utility score, is in a scale ranging from 0 to 1, where 0 corresponds to death and 1 corresponds to perfect health. To sum up, QALYs are determined simply by a lifespan multiplied by health-related utility scores.

According to Pliskin et al. (1980), a QALYs model demonstrates a valid individual utility function if a person's preferences meet the following conditions:

- **Mutually utility independence:** This condition has two parts: (a) preferences between lotteries on a health state, holding the duration of life constant, do not depend on the remaining lifespan; and (b) preferences between lotteries on lifespan, holding the health state constant, do not depend on the health state.
- **Constant proportional trade-off of longevity and health:** A fraction of the remaining lifespan an individual is willing to sacrifice for an improvement in health state does not depend on his/her remaining lifespan.
- **Risk neutrality over lifespan:** Holding the health state constant, an individual prefers any lottery on longevity that yields the greatest life expectancy. For instance, an individual would prefer to live 41 years to having a 50-50 chance of living 50 and 30 years (the latter expected life span being 40 years).
- **Preferences for trade-offs between health and longevity independent of income.**

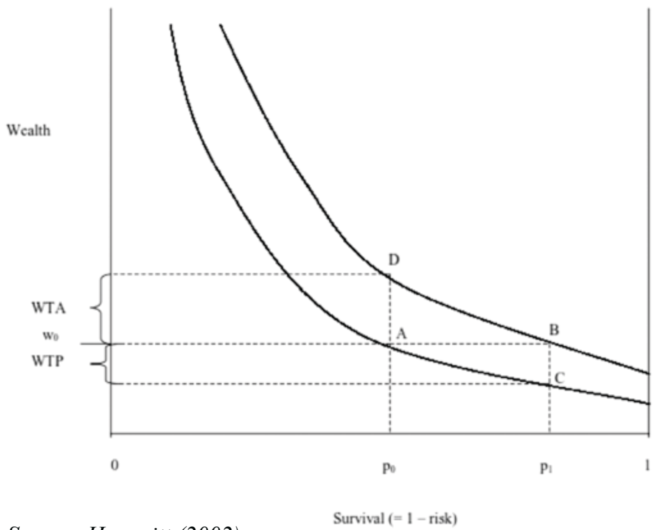
To determine QALYs, the numeric value of HRQL can be obtained by direct elicitation or a generic health utility scale. There are a variety of methods for direct elicitation. One of the methods, standard gamble (SG), requires that the respondents indicate the smallest chance of survival they could accept, when the only other alternative is death. Another method, time tradeoff (TTO), demands that the respondents indicate the number of years in perfect health (q=1) that they think is equivalent to a specified chronic health profile. The visual analog scale (VAS) method asks each respondent to give a score on a scale of 0 to 100 for their health state, where 0 means fatality and 100 means a perfect health state. For the person tradeoff (PTO) method, the respondents consider the relative value of improving health in different health states (Hammitt, 2002).

A very close alternative calculation method to QALYs, the disability-adjusted life year or DALYs, will be used in this study, and described in detail in a subsequent section.

(c) Value of statistical life approach

The VSL method is based on the concept of willingness to pay (WTP). Anything an individual has preferences for, including health profiles, are "economic goods." In this method, the value of an individual's health risk is represented by willingness to pay for a certain health gain. Alternatively, it can also be represented by willingness to accept (WTA) compensation for a certain health loss. Indifferent curves for survival probability and wealth (according to the utility theory) in Figure 1 illustrate the aforementioned idea (Hammitt, 2002).

Figure 1: Indifferent curves for survival probability and wealth



Source: Hammitt (2002).

The value of mortality risk reduction can be measured as VSL, an individual-specific value for the marginal rate of substitution (MRS) between wealth and mortality risk (Wang and He, 2010). In other words, VSL is equivalent to an individual's WTP to diminish his or her mortality rate divided by risk reduction, as depicted in equation (2) below (Neamsri and Chancharoenchai, 2011).

$$VSL = \frac{\Delta WTP}{\Delta R} \quad (2)$$

ΔWTP = A change in WTP as health or mortality risk declines

ΔR = A magnitude of risk reduction

From the society point-of-view, VSL is an economic value at the break-even point where the whole society is willing to pay in order to decrease its overall mortality risk (Kenkel, 2006; Andersson et al., 2011).

VSL depends on wealth, current mortality risk, and future health state probability. Correspondingly, an individual's expected utility is as follows:

$$EU(p, w) = (1 - p)u_a(w) + pu_d(w) \quad (3)$$

where p is the individual's chance of dying during the current period; $u_a(w)$ and $u_d(w)$ represent the individual's utility as a function of wealth conditional on surviving and not surviving this period, respectively. This model assumes that a person will maximize his or her own utility. Therefore, VSL can be obtained by differentiating equation (3), holding utility constant.

$$VSL = \left.\frac{dw}{dp}\right|_{EU=k} = \frac{u_a(w) - u_d(w)}{(1-p)u'_a(w) + pu'_d(w)} = \frac{\Delta U}{EU'} \quad (4)$$

The numerator in equation (4) is the difference in utility between surviving and dying in the current period. On the other hand, the denominator is the expected marginal utility of wealth. In this model, it is assumed that survival is preferred to death ($u_a(w)>u_d(w)$), and more wealth is preferred to less wealth ($u'_a(w)>0$, $u'_d(w)>0$). The individual is also assumed to be weakly risk-averse ($u''(w) \leqslant 0$). Under the aforementioned assumptions, both the numerator and denominator are positive; thus, VSL is positive and increases with wealth and mortality risk.

There are two ways to determine WTP, i.e., the stated preference and the revealed preference methods. The stated preference method uses a survey that requires respondents to indicate their hypothetical willingness to pay. The most common approach for stated preferences is the contingent valuation method (CVM), a method which creates a hypothetical situation about the related policy or incident in order to value an individual's willingness to pay. On the contrary, the revealed preference method measures the value of life by observing an individual's behavior to indicate how much the person is willing to pay, as revealed by that behavior.

Since VSL values an individual's life based on the amount he or she is willing to pay to enhance his or her chance of surviving, this method quantifies the value in monetary terms. Therefore, it is commonly used for cost-benefit analysis (CBA), especially of environmental and transport-related issues (Hammitt, 2002).

Although most studies do not conclude that VSL also includes human productivity in the value of life that it estimates, Jones-Lee (1990) stated that VSL incorporates "direct economic impact," such as net productivity loss following an accident. On that account, human capital is a part of the value of life calculated in this approach.

4. CALCULATION METHODS FOR DETERMINING LOSS AS A RESULT OF ROAD ACCIDENTS INVOLVING CHILDREN

This study employs the methods based on individual preference – QALYs and VSL – to estimate the value of children's lives lost as a result of traffic accidents. To estimate the amount of loss incurred by the surviving accident victims, the choice was made in this study to use total medical expenses as a benchmark; then the two values are added up to form the total value of loss from traffic accidents involving children in Thailand.

(a) Quality-adjusted life years

In some cases, it is quite difficult to transform utility values into the values of quality-adjusted life years; therefore, the disability-adjusted life years (DALYs) approach has been proposed as an alternative method (Australian Safety and Compensation Council, 2008).

DALYs calculate the value of health burdens from road accidents in terms of the number of years lost to illness, disability, or death (WHO, 2014a). In other words, DALYs are the sum of the present value of future years of a lifetime lost through premature mortality, and the present value of years of a future lifetime adjusted for physical disability caused by a disease or injury. Consequently, a DALY is the invert of a QALY, or equivalent to QALY loss (Fox-Rushby and Hanson, 2001).

DALYs are the grand total of years of life loss (YLLs) for the victims who are dead and years of life lived with disability (YLDs) for the victims who survive, as shown in equation 5 below (Fox-Rushby and Hanson, 2001).

$$\text{DALYs} = \text{YLLs} + \text{YLDs} \tag{5}$$

The calculation formula for YLLs proposed by Murray (1996) is as follows:

$$\text{YLLs}[r, K, \beta] = \frac{KCe^{ra}}{(r+\beta)^2}\{e^{-(r+\beta)(L+a)}[-(r+\beta)(L+a)-1] - e^{-(r+\beta)a}[-(r+\beta)a-1]\} + \frac{1-K}{r}(1-e^{-rL}) \tag{6}$$

where
- K = age weighting modulation;
- C = constant;
- r = discount rate;
- a = age at death;
- β = parameter from the age-weighting function;
- L = standard life expectancy at age a;

and r = 0.03, K = 1, β = 0.04, C = 0.1658 (WHO, 2014b).

This method entails each year's discount factor calculation. Additionally, the utility function for life years in this approach yields the highest utility when an individual is 25 years old and less utility later in life. In this study, we used the values of standard life expectancy as of the age at death (L) provided by the World Health Organization (WHO), as tabulated in Appendix Table A.

Then the value of life is obtained by multiplying YLLs by a ratio specified by a threshold indicated in the National Drug Accounts (NDA) B.E. 2551 (2008), which assigns 1 unit of QALY to be equal to 100,000 baht, according to Thailand's GDP per capita.

The formula for YLDs differs only slightly from that for YLLs, as it includes disability weight (D) in the formula:

$$\mathrm{YLDs}[r, K, \beta] = D\left\{\frac{KCe^{ra}}{(r+\beta)^2}\left\{e^{-(r+\beta)(L+a)}[-(r+\beta)(L+a)-1] - e^{-(r+\beta)a}[-(r+\beta)a-1]\right\} + \frac{1-K}{r}(1-e^{-rL})\right\} \tag{7}$$

where L is duration of disability.

Owing to a limitation of data on inpatients and outpatients, this study omits YLDs in the calculation. The estimation for surviving victims' value of lives lost will be described in the next section.

(b) Value of statistical life

One of the concepts related to VSL is the value of statistical life year (VSLY), which is used to determine the social value of premature fatality risk reduction in a unit of a statistical life year saved.

VSL is the sum of the present value of VSLYs, so VSLYs can be calculated by using VSL in the following formula (TDRI, 2010):

$$\mathrm{VSLY} = \frac{r \times \mathrm{VSL}}{(1-(1+r)^{-L})} \tag{8}$$

where r = discount rate, equal to 0.03;
L = life expectancy.

This study employs the value of total life loss from a Thai study on accidental value, which is worth 3.96 million baht, for VSL. The value is adjusted by each year's consumer price index (CPI) inflation rate. Nevertheless, the VSL used in this study covers only the human capital part but excludes the other aspects.

Posner and Sunstien (2005) suggested that VSLY should be adjusted to reflect the victims' characteristics. In this case, we adjusted VSL by determining the number of years expected to be left in the normal expectation of life for each age group. First, the age at premature death is calculated by subtracting the life expectancy for each age group (Appendix Table A) by the year in which the victims died. The calculation results are shown in Appendix Table B. The total of YLLs at premature death for 0-14-year-olds is roughly 53,000 years, while the total of YLLs for 0-19-year-olds is about 156,000 years. Following that, we multiplied the calculated VSLY by the total age at premature death for each age group.

(c) Calculation for the loss incurred by the surviving victims

Since the data on accident victims are limited, YLDs cannot be estimated in this study, as mentioned previously. This study calculates the total medical expenses of children and teenagers aged 0-19 years who were involved in road accidents but survived. To do this, we multiplied the number of children inpatients and outpatients by the average medical expense per person for each type of patient.

The data source for the number of inpatients was the "12 Files of Hospital Standard Database" provided by the National Health Security Office, and analyzed in 2008 by the Bureau of Policy and Strategy, Ministry of Public Health. Nonetheless, because the number of outpatients could not be obtained, it was estimated in this study. The estimation required an assumption that the number of outpatients in each age group is proportional to the number of inpatients within the same group. This assumption is based on the premise that outpatients and inpatients are usually in the same proportion.

The average medical expenses for inpatients and outpatients used in this calculation are from TDRI (2014), and are equal to 20,000 baht and 5,000 baht, respectively.

(d) Total life-related loss from road accidents involving children

The total life-related loss from traffic accidents is the sum of the fatality loss and the loss from injuries and illness (medical expenses). As mentioned previously, the calculation methods for loss from death are the finding YLLs in QALYs and VSLY, which generate different results.

5. CALCULATION RESULTS

(a) Value of fatality loss

The QALYs and VSLY methods involve different assumptions. Specifically, in the QALYs approach, it is assumed that each QALY has the same value. On the other hand, the VSLY approach adjusts VSL estimates to reflect differences in the remaining life expectancy or age of the affected children, resulting in a different estimated value for each statistical life year. Accordingly, the latter approach yields higher estimates.

Table 2 shows the calculation results for fatality loss by QALYs and VSLY in the period 2000-2012. The years studied can be divided into two periods: 2000-2009 when the Ministry of Public Health collected only data from death certificates; and 2010-2012 when the data from medical certificates of death were added to the database.

According to Table 2, during the period 2003-2009, the fatality losses in the 0-14 age group calculated by QALYs and VSLY were about 1-2 billion baht and 7-8 billion baht, respectively. From 2010 to 2012, the losses increased to about 3-4 billion baht using the QALYs method and 11 billion baht using the VSLY method.

For the 0-19 age group (Table 2), the values of loss in the period 2000-2009 were between 4 billion and 6 billion baht for QALYs and about 20 billion baht for VSLY. In the period 2010-2012, the costs of children's death as a result of traffic accidents were about 10 billion baht and 30 billion baht when measured by QALYs and VSLY, respectively.

Table 2: Values of children's fatality loss, by age group, calculation method and year

(Billions of baht)

Year	0-14-year-olds		0-19-year-olds	
	QALYs	VSLY	QALYs	VSLY
2000	1.49	7.83	4.25	20.66
2001	1.24	7.06	3.77	19.81
2002	1.44	7.83	4.62	23.18
2003	1.40	7.24	4.87	23.25
2004	1.66	7.99	5.51	24.70
2005	1.57	7.30	5.11	22.00
2006	1.82	7.50	5.62	21.61
2007	1.95	7.07	6.35	21.46
2008	2.29	7.78	6.64	20.94
2009	2.06	7.03	5.97	19.02
2010	3.49	10.64	10.80	30.56
2011	4.04	11.65	11.44	30.79
2012	3.79	11.04	11.90	32.16

Source: Authors' calculation (2014).

(b) Value of loss incurred by survivors of accidents

The calculation results are illustrated in Table 3 based on the calculation in the previous section. The values of loss for 0-14-year-old and 0-19-year-old inpatients were 400 million baht and 935 million baht, respectively. The costs for the outpatients, on the other hand, were 330 million baht for the 0-14-year-olds and 770 million baht for the 0-19-year-olds. The total values of loss for the inpatients and outpatients in 2008 were 730 million baht for the 0-14-year-olds and 1.705 billion baht for the 0-19-year-olds. The total values adjusted for 2012 were 800 million baht and 1.86 billion baht for 0-14 and 0-19-year-olds, respectively.

(c) Total life-related loss as a result of road accidents involving children

Using all the previous steps, we can find the total losses from road accident involving children for those in the 0-14 and 0-19-year-old age groups, by combining the fatality loss and the injury loss (medical expenses) in 2008, yielding the results shown in Table 4. The values of loss for 0-14-year-old children calculated by QALYs and VSLY were 4.59 billion and 11.847 billion baht, respectively. The loss for the 0-19-year-old age group was 13.767 billion baht when calculated by QALYs, and 34.023 billion baht when calculated by VSLY.

Table 5 shows the values of total loss as percentages of some macroeconomic indicators, namely gross domestic product (GDP), government expenditure and national health expenditure. Injuries and death caused by traffic accidents account for a large proportion of Thailand's health budget. For the 0-14-year-olds, the loss from traffic accidents accounts for 20.13 percent (QALYs) and 51.95 percent (VSLY) of the total national health expenditure in 2012. The percentages are as high as

Table 3: Value of loss for accident survivors

Type of patients	0-14-year-olds		0-19-year-olds	
	Number	Value (Billions of baht)	Number	Value (Billions of baht)
Inpatients	22,504	0.40	52,334	0.935
Outpatients	74,032	0.33	172,164	0.770
Total (2008)	96,536	0.73	224,498	1.705
Total (adjusted to 2012 value)		0.80		1.860

Source: Authors' calculation (2014).

Table 4: Value of total loss

Year	Total loss (Millions of baht)			
	0-14-year-olds		0-19-year-olds	
	QALYs	VSLY	QALYs	VSLY
2012	4,590	11,847	13,767	34,023

Source: Authors' calculation (2014).

Table 5: Value of total loss in 2012 as a percentage of GDP, government expenditure and national health expenditure

Value of loss, 2012	0-14-year-olds		0-19-year-olds	
	QALYs	VSLY	QALYs	VSLY
Percentage of GDP (฿ 9,232.2 billion)	0.05	0.13	0.15	0.37
Percentage of government expenditure (฿ 1,660 billion)	0.28	0.71	0.83	2.05
Percentage of national health expenditure (฿22.8041 billion)	20.13	51.95	60.37	149.20

Note: GDP and national health expenditure are at current prices.
Sources: Fiscal Policy Office (2014), National Health Account (2011), and authors' calculation (2014).

Table 6: Proportion of 0-4-year-old children killed by vehicles in 2008 and 2012, and proportion of 0-4-year-old children injured by vehicles in 2008

Vehicle type	Percentage		
	Death		Injuries
	2008	2012	2008
Motorcycles	32	31	45
Bicycles	-	-	24
Pedestrians	30	31	17
Cars	32	29	4
Trucks/vans	5	7	4

Source: Public Health Statistics of Thailand, 2012, Bureau of Policy and Strategy, Ministry of Public Health.

60.37 percent (QALYs) and 149.20 percent (VSLY) for the 0-19-year-olds. When comparing the values of loss to GDP, that of 0-14-year-old children was 0.05 percent (QALYs) and 0.13 percent (VSLY) of GDP as a result of traffic accidents in 2012. For the 0-19-year-olds, the values were 0.15 percent (QALYs) and 0.37 percent (VSLY) of GDP. The values of loss for the 0-14-year-olds were 0.28 percent (QALYs) and 0.71 percent (VSLY) of government expenditure. For the 0-19-year-olds, the percentages were 0.83 percent (QALYs) and 2.05 percent (VSLY) of government expenditure.

6. TRAFFIC ACCIDENTS BY TYPE OF VEHICLE, AND POLICY RECOMMENDATIONS

Since traffic accidents cause an almost immeasurable amount of loss, it is necessary to invest in prevention measures to increase road safety. However, owing to budget constraints, road safety measures must directly target problems. Accordingly, this section will present related facts and data–the number of deaths and the number of inpatients by type of vehicle–in order to specify target groups and measures related to each group.

According to Table 6, the vehicles engaged in fatal accidents involving children aged 0-4 years are cars, motorcycles, and pedestrians, with about the same proportions (about 30%). On the other hand, the main reasons for accidents among children are motorcycles, bicycles, and pedestrians (in arranged order). According to these facts, children this age should be prohibited from riding motorcycles. The use of child safety seats should also be promoted. In addition, parents or guardians should be more careful when their children ride bicycles or cross roads.

For children aged 5-9, the proportions of children who were killed and who were injured are fairly similar to that of the 0-4 year-olds, except for the higher proportion for those killed riding bicycles (Table 7). Therefore, road safety measures for this age group would resemble the measures for the 0-4-year-olds, with the exception of banning the riding of motorcycles. There should also be more safeguards for children riding bicycles.

In 10-14-year-olds, the proportions of dead and injured victims are different to those in the prior groups. As shown in Table 8, 65 percent and 76 percent of the total deaths in 2008 and 2012, respectively, and 79 percent of total injured victims in 2008 involved motorcycles. As a result, road safety measures to address this problem should be focused on motorcycles. Since the children were still underage for riding motorcycles, the law should be strictly enforced with appropriate penalties. In addition, children should be educated about the danger of reckless driving.

Lastly, motorcycles are also the main reason for death and injuries among the 15-19-year-olds, as shown in Table 9. Therefore, every aspect of road safety measures related to motorcycles should be strictly enforced.

Table 7: Proportion of 5-9-year-old children killed by vehicles in 2008 and 2012, and proportion of 5-9-year-old children injured by vehicles in 2008

Vehicle type	Percentage		
	Death		Injuries
	2008	2012	2008
Motorcycles	29	35	35
Bicycles	-	-	34
Pedestrians	30	28	18
Cars	35	29	4
Trucks/vans	0	3	4

Source: Public Health Statistics of Thailand, 2012, Bureau of Policy and Strategy, Ministry of Public Health.

Table 8: Proportion of 10-14-year-old children killed by vehicles in 2008 and 2012, and proportion of 10-14-year-old children injured by vehicles in 2008

Vehicle type	Percentage		
	Death		Injuries
	2008	2012	2008
Motorcycles	65	76	79
Bicycles	-	-	11
Pedestrians	14	8	3
Cars	16	13	2
Trucks/vans	2	2	2

Source: Public Health Statistics of Thailand, 2012, Bureau of Policy and Strategy, Ministry of Public Health.

Table 9: Proportion of 15-19-year-old children killed by vehicles in 2008 and 2012, and proportion of 15-19-year-old children injured by vehicles in 2008

Vehicle type	Percentage		
	Death		Injuries
	2008	2012	2008
Motorcycles	70	84	92
Bicycles	-	-	1
Pedestrians	10	4	1
Cars	18	9	2
Trucks/Vans	1	2	2

Source: Public Health Statistics of Thailand, 2012, Bureau of Policy and Strategy, Ministry of Public Health.

7. POLICY IMPLICATIONS

(a) Motorcycle accidents involving children

According to Tables 6-9, motorcycles are the leading cause of accidents among children and teenagers, since they are the main type of vehicles used by Thai middle-income households. However, there have not yet been any policies to reduce the number of child passengers using motorcycles, such as passenger age restrictions. The lack or inappropriate use of safety helmets also aggravates the situation. Moreover, a larger number of teenagers, including those under legal age, are motorcycle riders (Palitpolkarnpim, 2004). Hence, the Child Safety Promotion and Injury Prevention Research Center of Ramathibodi Hospital has proposed some recommendations to solve the problem. One of the recommendations is to prohibit the riding of motorcycles by children younger than 2 years of age.

As can be seen from Table 10, effective policies for preventing motorcycle accidents involving children could reduce a significant amount of such losses. If such policies could reduce by 10 percent the death and injuries among children as a result of motorcycle accidents, the losses for 0-14-year-old children would fall by 238 million baht (QALYs) and 601 million baht (VSLY), while the loss for the 0-19-year-olds would be reduced by 620 million baht (QALYs) and 1.424 billion baht (VSLY). If such policies could reduce by 25 percent death and injuries from motorcycle accidents involving children, the values of loss would decline by 596 million baht (QALYs) and 1.501 billion baht (VSLY) for 0-14-year-olds, and 2.036 billion baht (QALYs) and 4.048 billion baht (VSLY) for 0-19-year-olds.

(b) Car accidents and child restraint systems

The lack of a child restraint system in cars is also a serious threat to young occupants of cars. Standard car seats and safety belts might exacerbate injuries from road accidents involving children since they do not fit children's bodies properly. Child safety seats in Thailand are still very expensive due to import taxes. There is also only one local producer whose products are just for babies. Thus, the promotion of the use of child safety seats cannot be strictly enforced. According to Zaza et al. (2001), the United States has provided some measures to increase the use of child safety seats, which include the following:

- Child safety seat laws;
- Community-wide information and enhanced enforcement campaigns;
- Child safety seat distribution and education campaigns;
- Incentive and education programs.

Evidence shows that the first two measures are the most effective, although the last two are somewhat effective as well.

If the aforementioned policies could decrease by 10 percent death and injuries from car accidents involving children, this would result in reductions in losses of 89 million baht (QALYs) and 255 million baht (VSLY) among children aged 0-14, as well as reductions in losses of 164 million baht (QALYs) and 435 million baht (VSLY) among children aged 0-19. If the policies were even more effective, which would result in a 25 percent decrease in death and injuries from car accidents involving children, the reduction in losses would be as large

Table 10: Value of loss reduction when policies regarding motorcycle accidents involving children are implemented

Reduction in motorcycle accidents involving children (%)	Value of loss reduction (Millions of baht)			
	0-14-year-olds		0-19–year-olds	
	QALYs	VSLY	QALYs	VSLY
10	238	601	620	1,424
25	596	1,501	2,036	4,048

Source: Authors' calculation.

Table 11: Value of loss reduction when policies regarding child restraint system are implemented

Percentage reduction in death and injuries from car accidents involving children	Value of loss reduction (Millions of baht)			
	0-14-year–olds		0-19-year-olds	
	QALYs	VSLY	QALYs	VSLY
10	89	255	164	435
25	176	501	424	1,102

Source: Authors' calculation.

Table 12: Value of loss reduction as a result of implementing policies regarding the safety of child pedestrians

Reduction in accidents involving child pedestrians (%)	Value of loss reduction (Millions of baht)			
	0-14-year-olds		0-19-year-olds	
	QALYs	VSLY	QALYs	VSLY
10	88	240	121	311
25	219	601	331	807

Source: Authors' calculation.

as 176 million baht (QALYs) and 501 million baht (VSLY) for the 0-14 age group, and 424 million baht (QALYs) and 1.102 billion baht (VSLY) for the 0-19 age group (Table 11).

The safety of child pedestrians and cyclists is another important issue to be considered. According to Tables 7-10, children younger than 10 years of age are at higher risk of being injured and killed while walking and cycling than are older children. Apart from relying on family-based prevention, community intervention is needed in order to lower the speed and volume of vehicular traffic. Improving facilities for walking and cycling, such as zebra crosswalks and crossing signals as well as traffic calming, are some of the community interventions that should be considered.

Reduction of the loss from accidents involving child cyclists as a result of implementing prevention policies cannot be calculated due to the lack of related data. However, the estimated loss reduction for child pedestrians is fairly large, as shown in Table 12. If the death and injuries to pedestrians drop by 10 percent, the reduction in losses would be 88 million baht (QALYs) and 240 million baht (VSLY) for 0-14-year-old children, and 121 million baht (QALYs) and 311 million baht (VSLY) for the 0-19-year-olds. If such policies could decrease the death and injury of child pedestrians by 25 percent, the reduction of losses would be 219 million baht (QALYs) and 601 million baht (VSLY) for children aged 0-14. The loss of children aged 0-19 would also drop by 331 million baht (QALYs) and 807 million baht (VSLY).

In conclusion, road accidents account for a significant proportion of death and injuries among children, resulting in a great loss for the whole society. Nonetheless, because the value of such losses had not previously been determined systematically, in this study, therefore, some calculations were conducted to determine the value of loss from road accidents involving children in Thailand. According to the results obtained, road accidents involving children result in a huge amount of economic loss. The lack or inappropriate use of safety devices and underage driving are one of the main causes of traffic accidents involving children. To prevent such road accidents in the future, the government should enforce strict regulations as well as educate children and their parents about road safety.

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APPENDIX

Table A: Standard life expectancy, by age group and year of calculation

Standard life expectancy (years)							
Age group (years)	Year			Age group (years)	Year		
	1990	2000	2011		1990	2000	2011
0-4	67.5	69.4	73.9	55-59	20.4	23.2	24.6
5-9	64.4	65.7	69.9	60-64	16.8	19.4	20.7
10-14	59.7	60.9	65.1	65-69	13.4	15.9	17.1
15-19	54.8	56.1	60.2	70-74	10.4	12.8	13.8
20-24	50.3	51.5	55.6	75-79	7.8	10	11.1
25-29	45.8	47.1	50.9	80-84	5.6	7.7	8.7
30-34	41.3	43.2	46.3	85-89	4	5.8	6.6
35-39	36.9	39.4	41.8	90-94	2.8	4.1	4.8
40-44	32.5	35.3	37.4	95-99	2	2.9	3.3
45-49	28.2	31.1	33	100	1.6	2.1	2.3
50-54	24.2	27.1	28.7				

Source: World Health Organization (WHO).

Table B: Total age at premature death, by age group

Total age at premature death (years)					
Year	0-14-year-olds	0-19-year-olds	Year	0-14-year-olds	0-19-year-olds
2000	55,887	147,513	2007	37,803	114,681
2001	49,921	140,032	2008	40,631	109,378
2002	53,158	157,345	2009	37,659	101,864
2003	46,360	148,921	2010	52,954	152,093
2004	48,590	150,141	2011	60,059	158,721
2005	42,745	128,764	2012	53,632	156,149
2006	41,993	120,946			

Source: Authors' calculation (2014).