

CAUSES OF DEATH AND UNINTENTIONAL INJURY AMONG SCHOOLCHILDREN IN THAILAND

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Abstract. Few prospective studies of mortality among children in developing countries have been published. Here we quantify and describe mortality and injury morbidity among a cohort of schoolchildren in rural Southeast Asia. Deaths among a cohort of 40,119 schoolchildren in Thailand were prospectively monitored over a two year period from January 1991. Additionally, data were collected with a questionnaire from a subset of 6,378 children asking them to recall all injuries over a one-year period. There were 40 deaths for an annual incidence of 50/100,000. Fifty percent of all deaths were due to injury; 25% to infectious diseases. Sixty percent of the injury deaths were due to motor vehicles and 35% to drowning. Sixty-six percent of the children reported one or more accidents. The leading categories of non-fatal injuries, in decreasing order, were: animal bite, puncture wound, burn, near-drowning, fall from a height. Boys experienced more injuries than girls for almost every type of injury. Injuries are replacing infectious diseases as the most important cause of deaths in developing countries. Additional public health initiatives to reduce childhood accidents may be warranted.

INTRODUCTION

Few studies of unintentional injury and death have been carried out in developing countries such as Thailand. (Chooravech, *et al*, 1980; Chooravech and Chooravech, 1983; Tonmukayakul, 1984; Ruangkanhasetr *et al*, 1991; Junnanond *et al*, 1993) In Thailand and many other countries, control of infectious diseases may be perceived as a higher priority over reducing unintentional injury and death. On the other hand, increased immunization coverage and improved medical care may reduce infectious disease rates while the incidence rate for accidents may remain high. Obviously, unintentional injury can cause disability, death, and immeasurable anguish to families.

Injuries are a major cause of death among children in all countries of the world. (Ruangkanhasetr, 1989). Thailand is a country in Southeast Asia that is developing very quickly. In 1994 Bangkok registered 7,800 new motor-driven vehicles per day (including cars, motorcycles, tractors, buses, etc), while in the province of Kamphaeng Phet, where

the study reported here was conducted, 280 new vehicles were registered per day (statistics from Department of Transportation, Bangkok). In such circumstances, high rates of vehicular injury might be anticipated. Nevertheless, published studies of accidents in Thailand report only injuries serious enough to be seen at hospitals, with uncertain denominator data. While conducting a vaccine efficacy study in a large cohort of primary school children in rural Thailand, we prospectively enumerated deaths and were surprised to observe mortality rates greatly exceeding those anticipated or previously reported. Therefore we examined this phenomenon in greater detail. Herein we report prospectively enumerated deaths among 40,119 children and the self-reporting of accidents among a subset of those children in rural Thailand.

MATERIALS AND METHODS

Study population

The study population was comprised of 40,119 schoolchildren participating in an efficacy trial of an inactivated hepatitis A vaccine between January 1991 and June 1993. (Innis *et al*, 1994) The children ranged in age from 2 to 16 years at the time of enrollment and males and females were equally represented. The children attended the 148 largest community primary schools in Kamphaeng Phet

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Province in northern Thailand; children attending schools with enrollment of less than 150 pupils were omitted from the cohort. The enrolled children represented 31% of the 130,000 primary school age children in the province. For analysis, the children were divided into two age groups, less than 10 years ($n=2,270$) and 10 years or older (4,108).

The provincial economy is mostly agricultural, with many banana and sugar cane farms. Ninety-five percent of the population resides in rural areas. Eighty-five percent of the work force works in agriculture, animal husbandry, forestry, fishing, and hunting. Only 9% of the population receives schooling beyond primary school. (Anonymous, 1990). The provincial capital of Kamphaeng Phet is located on the banks of a major river, the Ping River. There are many streams in the province.

Notification of deaths

Deaths were identified in the course of administering vaccines or conducting a census of enrolled study participants on six occasions after January 1991. The timing of these activities was as follows: February 1991 (vaccination), May 1991 (census), January 1992 (vaccination), June 1992 (vaccination), July 1992 (vaccination), January 1993 (vaccination). When study enrollees failed to present for vaccination or enumeration in a census, an investigation was conducted to ascertain whether the child had died. When a death was reported by school or community authorities, the death certificate was obtained. If no death certificate was available, the death was confirmed by an interview of the community public health official and the family. If the death occurred in hospital, the hospital record was retrieved to review the hospital course and to confirm the cause of death.

Cross-sectional study of non-lethal accidents

Twenty percent of the cohort ($n=7,875$) had been randomly selected for sequential serologic studies as part of the inactivated hepatitis A vaccine trial. In June 1992 a questionnaire (see Appendix for an English translation of the Thai language questionnaire) was administered to this subset of children by trained interviewers. Children were asked if, during the past year (since the beginning of the previous school year in May 1991), they had experienced any of the following categories of injury: motor vehicle injuries while an occupant or pedestrian, a near-drowning, a burn, intoxication due to poison, or any other serious injury. Injuries were self-

ported by the children; questionnaires from study participants other than those in the 20% random sample were censored from the analysis.

Analysis

Statistical analyses (crosstabs, frequencies and confidence intervals) were performed using SPSS/PC+ (SPSS Inc, Chicago, Illinois).

RESULTS

Forty children died during the observation period, 20 due to unintentional injury (Table 1). One and a half times more boys than girls died ($p = 0.2$). The death rate due to injury was 25/100,000 per year (95% CI = 10, 41). The yearly death rate due to motor vehicle injuries was 15/100,000 (95% CI = 3, 27) and that due to drowning was 9/100,000 (95% CI = 0, 18). Sixty percent of the accidental deaths and 30% of all deaths were due to motor vehicle injuries. Insufficient information was available to differentiate between occupant and pedestrian motor vehicle deaths. Thirty-five percent of unintentional deaths were due to drowning.

There were 20 non-injury deaths; of these, 10 (50%) were due to infectious causes (Table 1) and five to heart disease, congenital ($n=3$) or cause unknown ($n=2$). Of the 10 deaths due to infectious causes, three were vaccine preventable (two cases of Japanese encephalitis, one case of rabies). On the other hand, there are no vaccines for most of the causes of infectious disease mortality in this study: malaria, dengue hemorrhagic fever, tuberculosis, and bacterial sepsis.

Complete injury questionnaires were obtained from 6,378 schoolchildren (81% of children in the 20% random sample); those missing either were absent from school when the interviews were conducted or had improperly completed the questionnaire. The male:female ratio was 1:0.97. Of the 6,378 children who answered the questionnaire, 4,184 (66%) reported at least one injury (range zero to eight injuries) over the one year period (Table 2). One third of the children reported no injuries at all. The most common injury reported was due to an animal bite, followed by puncture wounds, and burns.

Motor vehicle injuries were divided into those that affected children as occupants of the vehicle and as pedestrians who were hit by vehicles (Table 3). Motor vehicle occupant injuries had a higher incidence (7%) than pedestrian injuries (4%). In

Table 1

Deaths among cohort schoolchildren in Kamphaeng Phet Province from January 1991 to January 1993.

Deaths due to:	No. of cases	Proportionate mortality ratio	Incidence/100,000/year	95% Conf interval
Injuries	20	50.0	25	10, 41
Motor vehicle	12	30.0	15	3, 27
Drowning	7	17.5	9	0, 18
Landslide	1	*	*	-
Other	20	50.0	25	10, 41
Heart disease	5	12.5	6	0, 14
Malaria	3	7.5	4	0, 10
Homicide	2	5.0	3	0, 8
Dengue hemorrhagic fever	2	5.0	3	0, 8
Japanese encephalitis	2	5.0	3	0, 8
Rabies	1	*	*	-
Renal failure	1	*	*	-
Tuberculosis	1	*	*	-
Suicide	1	*	*	-
Sepsis	1	*	*	-
Unknown	1	*	*	-
Total	40	-	50	28, 72

Table 2

Reported injuries for a subset of cohort schoolchildren in Kamphaeng Phet Province from May 1991 to May 1992.

No. of injuries reported	No. of children (n=6,378)			%
	Total	Male	Female	
0	2,194	943	1,251	34.4
1	2,104	1,064	1,040	33.0
2	1,239	694	545	19.4
3	527	317	210	8.3
4	223	150	73	3.5
5	64	41	23	1.0
6	21	17	4	0.3
7	5	4	1	0.08
8	1	1	0	0.02

the older age group (10 to 17 years) more boys than girls reported an injury while an occupant (Relative risk (RR) = 1.35, 95% CI = 1.09, 1.68), and as a pedestrian (RR = 1.54, 95% CI = 1.11, 2.13). The risk of having a motor vehicle injury of any kind was 1.4 times greater for boys than for girls of any age (RR = 1.4, 95% CI = 1.2, 1.6). Of the children who reported an injury while an occupant, only 0.5% reported being seriously hurt.

Of the pedestrians who reported having been

hit by motor vehicles, 77% (185/251) reported being hit by a motorcycle, 12% by a pickup truck, 9% by a larger truck, and 3% by an automobile. Forty-six percent of the pedestrian accidents occurred as the child walked beside the road, another 46% while crossing the road, 7% while at school, and 2% while walking in the rice fields.

For non-vehicular accidents overall, boys experienced significantly more injuries than girls in all age groups and all categories except for land-

Table 3

Reported injuries for a subset of cohort schoolchildren in Kamphaeng Phet Province from May 1991 to May 1992, Thailand.

Injury type	No. of cases			Percent incidence/year	Relative risk for male	95% conf interval
	Male	Female	Total			
1. Animal bite	841	685	1,526	24	1.19	1.09-1.30
2. Puncture wound	852	599	1,451	23	1.38	1.26-1.51
3. Burned	691	582	1,273	20	1.16	1.05-1.29
4. Near-drowning	503	368	871	14	1.34	1.18-1.52
5. Fall from a height	516	320	836	13	1.56	1.37-1.78
6. Motor vehicle - occ and ped	378	273	651	10	1.35	1.16-1.56
7. Motor vehicle - occupant	248	186	434	7	1.31	1.09-1.57
8. Hit by an object	236	123	359	6	1.86	1.50-2.30
9. Motor vehicle - pedestrian	152	99	251	4	1.50	1.17-1.92
10. Ingested poison	75	53	128	2	1.38	0.98-1.96
11. Landslide	9	6	15	0.2	1.45	0.52-4.08

Table 4

Comparison of published death rates for Thailand, 1993, ages 5 - 14 years, versus a cohort of Kamphaeng Phet schoolchildren, 1991 - 1992, ages 5 - 16 years.

Disease	Thailand, children 5-14 yrs (n = 11,331,000) in 1993*			Our study, Kamphaeng Phet, 5-16 yrs (n = 40,119) in 1991, 1992		
	No.	Rate/100,000/year	95% CI	No.	Rate/100,000/year	95% CI
DHF	155	1.4	1.2, 1.6	2	3	0, 8
Rabies	38	0.3	-	1	*	-
Malaria	33	0.3	0.2, 0.4	3	4	0, 10
Encephalitis	31	0.3	0.2, 0.4	2	3	0, 8
Suicide	9	0.1	-	1	*	-
Tuberculosis	2	0.0	-	1	*	-
Overall non-injury	380	3.4	3.1, 3.7	20	25	10, 41

* (Anonymous, 1993), (Anonymous, 1995)

slides, poison ingestion and burns. For poison ingestion, a significant difference was found between boys and girls only in the older age group, and for burns, only in the younger age group.

Children were asked if they knew how to swim. Forty-seven percent (2,876/6,181) answered yes. Boys were 1.7 times more likely to claim to know how to swim than girls (95% CI = 1.6, 1.8). Boys also experienced significantly more near-drowning accidents than girls in all age groups (RR=1.34, 95% CI = 1.18, 1.52).

A comparison of published death rates for

Thailand in 1993 of children aged 5-14 years versus a cohort of Kamphaeng Phet school children aged 5-16 years during 1991-1992 is shown in Table 4.

DISCUSSION

Half the deaths among schoolchildren in this rural province were due to injuries. Most of the unintentional deaths were due to motor vehicles followed by drowning.

Deaths from all unintentional injuries in Kamphaeng Phet Province, at 25/100,000, was 25%

higher than that of a study of children in the United States by Rivara in 1991, at 20/100,000. (Rivara and Grossman, 1996) The mortality rate from motor vehicle accidents in Kamphaeng Phet was 15/100,000 as compared to 9/100,000 in Rivara's United States study. Motor vehicles caused 60% of all accidental deaths in Kamphaeng Phet, compared to less than half in the United States in 1985. (Guyer and Ellers, 1990) The death rate from drowning in Kamphaeng Phet was 9/100,000, compared to 2/100,000 in Rivara's United States study.

The cohort's overall non-injury death rate was seven times higher than figures reported for all of Thailand (age-specific data for Kamphaeng Phet Province was not available) by the Ministry of Public Health for children under the age of 15 years (see Table 4 - although the Ministry reports deaths for 50 diseases, our table lists only those categories that had any deaths for that age group of children in our study). On the other hand, the Kamphaeng Phet rate of 25/100,000 included cardiac mortality, whereas the Ministry of Public Health did not publish figures for cardiac mortality. Yet when cardiac mortality is excluded, the Kamphaeng Phet rate remains six-fold higher than national statistics. One explanation for the difference in rates could be the inefficiency of passive reporting. However, we obtained 38 death certificates for the 40 children who died, suggesting most deaths are registered with the government.

As observed non-accident death rates in the cohort were higher than nationwide rates, we compared rates by cause of death. Among the nationwide rates for children aged 5 to 14 years pneumonia was the second leading cause of death, but we had no death due to pneumonia in our cohort. Childhood fatality rates in the Kamphaeng Phet cohort exceeded the national average in 1993 by 10-fold or more for three infectious diseases, JE, rabies and malaria, but, given the relatively small numbers of deaths in our cohort (sometimes only one per category), these differences were not significant.

In Kamphaeng Phet, the most common reported cause of unintentional injury was animal bite, but the type of animal was not elicited by the questionnaire. This high incidence reinforces the need to vaccinate dogs and cats against rabies, and to control the feral population. One death in this study was due to rabies. One hundred to 200 cases of rabies are reported each year in Thailand. (Junnanond *et al*, 1993).

Of the reported pedestrian injuries, 77% of the

children were hit by motorcycles, underscoring the importance of motorcycles as a major cause of vehicular injury in the province.

Sex differences in injury rates start from the first years of life, with boys experiencing more injuries than girls. (Rivara *et al*, 1982; Scheidt *et al*, 1995) In Thailand, boys also were injured more often than girls. Sex differences in behavior may explain at least some of these differences. Rivara *et al* (1982) concluded in their study that injuries which do not exhibit sex differences in rates do not require gross motor activities. They found no difference in rates for poisoning, burns and foreign body ingestion. In our study as well, boys did not experience significantly more burns or poison ingestion than girls.

One bias in this study was recall bias of injuries over the one year period. Studies show that over time, only the more severe injuries are recalled. (Harel *et al*, 1994) A one-year period is used most often in studies to include as many injuries as possible. We used the one year period from May because this was the start of the new school year and should have been easier for the child to recall. Another limitation of the study was the self-reporting of injuries by children less than 10 years of age.

Our results indicate that injuries are now replacing infectious diseases as the most important causes of childhood deaths in developing countries. Deaths can be prevented and childhood injuries can be reduced. Many opportunities for preventing injury already exist. (Rodriguez, 1990) Rivara and Grossman (1996) note that up to 31% of injury deaths can be prevented by using safety measures such as seat belts and motorcycle helmets. Motorcycle helmet and seatbelt laws exist in Thailand. (Ruangkanchanasetr, 1989) Government regulations concerning operation of motor vehicles are already in place and should be enforced. Parental supervision and government enforcement of laws are important. Some Thai authorities have recommended that teachers take a more active role in safety education in Thailand. Additional public health initiatives to reduce childhood injuries may be warranted.

APPENDIX

ENGLISH TRANSLATION OF THAI LANGUAGE QUESTIONNAIRE TO DETERMINE INJURY RATES (with percent for all volunteers, except #1.1 and #4.1)

1. Since May 1991 were you injured by a motor

- vehicle while a pedestrian?
- Never (96%)
 - Yes, by a pickup truck (0.5%)
 - Yes, by a big truck (0.3%)
 - Yes, by a farmer's truck (0.1%)
 - Yes, by a motorcycle (3%)
 - Yes, by a car (0.1%)
- 1.1. If you were injured by a vehicle, where did the accident occur?
 - While walking beside the road (44%)
 - While crossing the road (44%)
 - In the rice field (1.5%)
 - In school (7%)
 - Other: _____ (18%)
 2. Since May 1991 have you had a motor vehicle injury while being a passenger in the vehicle?
 - Never (93%)
 - Yes, but not hurt (3%)
 - Yes, slightly injured, but not admitted to hospital (3.5%)
 - Yes, seriously injured and admitted to hospital (0.5%)
 3. Since May 1991 have you fallen into water and almost drowned?
 - Never (86%)
 - Yes, but was saved (14%)
 - 3.1 Can you swim?
 - Yes, I can swim (47%)
 - No, I cannot swim (53%)
 4. Since May 1991 were you burned by fire or boiling water badly enough to cause blistering or scarring?
 - Yes, by a hot object ((16%)
 - Yes, by fire or boiling water (4%)
 - Never (80%)
 - 4.1 If you were burned, how were you burned?
 - By boiling water (49%)
 - By hot oil (12%)
 - By electricity (12%)
 - By fire (20%)
 - Other: _____ (8%)
 5. Since May 1991 have you ingested a toxic substance?
 - Never (98%)
 - Yes, by accident (1.5%)
 - Yes, on purpose (0.5%)
 6. Since May 1991 have you had any other serious injury?
 - No (49%)

- Yes, by falling from a height (13%)
- Yes, by being hit with an object (6%)
- Yes, covered by a landslide (0.2%)
- Yes, by an animal bite (24%)
- Yes, puncture by a sharp object (23%)
- Other: _____ (6%)

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REFERENCES

- Anonymous. 1990 Population and housing census. Kamphaeng Phet, Thailand: National Statistics Office, Office of the Prime Minister, Thailand, 1990.
- Anonymous. Annual epidemiological surveillance report 1993. Bangkok, Thailand: Division of Epidemiology, Ministry of Public Health, 1993; 12-44.
- Anonymous. Population projections for Thailand 1990 - 2020. Bangkok, Thailand: Human Resources Planning Division National Economic and Social Development Board, 1995.
- Choovoravech P, Choovoravech N. Accidents in school. *J Ped Soc Thai* 1983; 22: 7-17.
- Choovoravech P, Choovoravech N, Voravarn T, et al. Motor vehicle accident in childhood. *J Med Assoc Thai* 1980; 63: 304-9.
- Guyer B, Ellers B. Childhood injuries in the United States. *Am J Dis Child* 1990; 144: 649-52.

- Harel Y, Overpeck MD, Jones DH, *et al.* The effects of recall on estimating annual nonfatal injury rates for children and adolescents. *Am J Public Health* 1994;84: 599-605.
- Innis BL, Snitbhan R, Kunasol P, *et al.* Protection against hepatitis A by an inactivated vaccine. *JAMA* 1994; 271: 1328-34.
- Junnanond C, Ruangkanchanasetr S, Chunharas A. Childhood trauma, country report (Thailand). *J Med Assoc Thai* 1993; 76: 209-13.
- Rivara FP, Bergman AB, LoGerfo JP, *et al.* Epidemiology of childhood injuries. II. Sex differences in injury rates. *Am J Dis Child* 1982; 136: 502-6.
- Rivara FP, Grossman DC. Prevention of traumatic deaths to children in the United States: how far have we come and where do we need to go? *Pediatrics* 1996; 97: 791-7.
- Rodriguez JG. Childhood injuries in the United States. *Am J Dis Child* 1990; 144: 625-6.
- Ruangkanchanasetr S. Childhood accidents. *J Med Assoc Thai* 1989; 72: 144-50.
- Ruangkanchanasetr S, Sriwatanakul K, Luptawan S, *et al.* Epidemiology and risk factors of injury in Thai children. *Southeast Asian J Trop Med Public Health* 1991; 22: 127-32.
- Scheidt PC, Harel Y, Trumble AC, *et al.* The epidemiology of nonfatal injuries among US children and youth. *Am J Public Health* 1995; 85: 932-8.
- Tonmukayakul A. Accidents in primary school age children. *Siriraj Hos Gaz* 1984; 36: 67-75.