RISK FACTORS FOR TRAFFIC ACCIDENTS IN BANGKOK METROPOLIS : A CASE-REFERENCE STUDY

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Abstract. It was aimed to study injures from road traffic accidents in Bangkok Metropolis and identify patients' characteristics as well as to search for risk factors for traffic accidents leading to hospitalization. The study included 346 in-patient cases suffering injuries from road traffic accidents in Bangkok Metropolis. The patients were recruited during a period of 4 months of the year 1992 from five hospitals in various areas of Bangkok which were judged to be representative for Bangkok Metropolis. Using the method of case-reference, relative risk could be estimated for various exposure factors. Most of the patients drove a motorcycle, had their license for only a short period, and drove more than 5 hours a day. About one third of the patients were under the influence of alcohol. The traffic accident characteristics were that they occurred mainly at night time with the peak between 21.00 and 24.00 hours. About 90% of all traffic accidents occurred during the rainy season and most of them occurred near to road junctions. Reference data was available for some variables and the following risk group could be identified : RR (male-age 20-24) = 17.06 (8.8-33.9), RR (single-marital status) = 2.25 (1.7-3.1), RR (primary-education) = 6.2 (2.9-12.6), RR (unskilled labourer-occupation) = 3.91 (2.7-5.9), RR (salesperson-occupation) = 3.34 (2.2-5.0).

INTRODUCTION

It is well-known that in developed countries, accidents are of high importance in public health spectrum. Robertson (1992) commented that "Injury is the leading cause of lost potential years of life in the United States". It is less well known, however, that in developing countries or countries being in a phase of transition such as Thailand the mortality and morbidity from road traffic accidents are high relative to other causes of disease with increasing tendency (Fig 1).

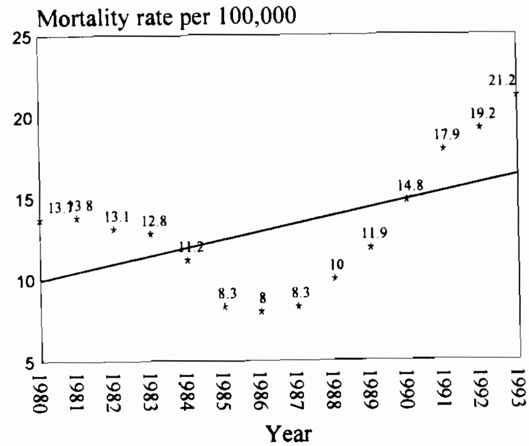
If the age distribution for various causes of death is considered, there is a rather different pattern for *traffic accidents* if compared with the other leading causes of death. Whereas the peak occurs at the age group 55-65 for other leading causes of death, it can be observed that the peak for traffic accidents is at age group 15-25. This leads to the indicator of *loss of potential life years,* which expresses the concept of measuring the loss of life years when dying at a specific cause. The individual's age at death is subtracted from the expected value of years this individual would have lived to if not killed by this cause. If this is done for all individuals dying of this c use one gets the overall loss of potential life years. one divides the total loss of potential life years by t e number of people who died from that specific c cause the *expected loss of potential life years* is gained. The expected loss of potential life years indicates how much longer an average person would have lived if he/she did not die on the specific cause of death. In 1992, the expected loss of potential life years for traffic accidents was 45.02 years, for intracerebral diseases 28.17 years, followed by malignant neoplasms with 26.87 years and heart failure with 25.55 years. This underlines the importance of traffic accidents as a cause of mortality and morbidity, in particular for Thailand.

The aim of this study was to identify patients' characteristics as well as to search for risk factors for traffic accidents.

MATERIALS AND METHODS

Study population and sample

The study sample case-group consisted of 346 in-patients who were admitted in a period of four months of 1992 from five hospitals in various areas of Bangkok Metropolis, namely Police, Nopparat-Rajathani, Bhumibol, Rajavithi and Siriraj hospitals. The hospitals were chosen from different areas of Bangkok Metropolis to cover potential spatial variation in traffic accident occurrence (Fig



*Public Health Statistics (1993)

Fig 1–Trends in mortality of traffic accidents in Thailand: deaths per 100,000* inhabitants.

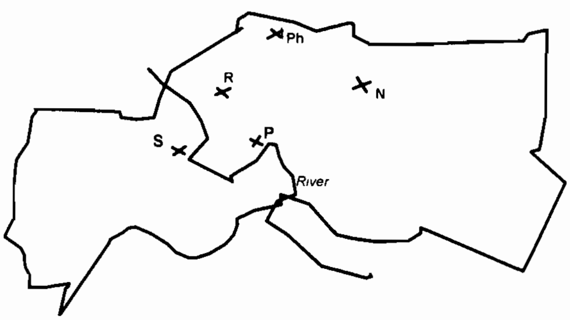


Fig 2–Selected hospitals in Bangkok Metropolis for case inclusion.

2). Cases were included if admitted to one of the above named hospitals as the result of an injury caused by a traffic accident. Patients who were not able to understand or answer the questions which were asked by trained nurses had to be excluded. The reference-group consisted of all the population in Bangkok Metropolis 1992, (National Statistical Office, 1993).

Statistical methodology for estimating relative risk

For studying the univariate distribution of potential risk factors, routine statistical procedures could be applied. However, for developing a concept of estimation of relative risk, a difference concept has to be developed because the non-case side is missing in the study data. This can be accomplished as follows. It is assumed that in a study population the number of exposed is n_1, the number of non-exposed n_0. In the exposed group we observe y_1 cases, in the non-exposed group y_0 cases. Both n_1 and n_0 are unknown, since it is not known, how large the population is from which the traffic accidents are arising. Usually, the relative risk is estimated by

$$\hat{p}_1/\hat{p}_2 = (Y_1/n_1)/(Y_0/n_0) \quad (1)$$

where p_1 and p_0 are the risks for developing disease in exposed and non-exposed group respectively. Since n_1 and n_0 are unknown, the relative risk cannot be estimated. However, for some exposure variables data are available from the Bangkok Metropolis population which is called here the *external reference population,* denoting the size by N_1 and N_0 for exposed and non-exposed group respectively (Table 1). If it can be assumed that the risk factor distribution in the study population follows the one in the reference population up to multiplicative constant, in other words, if $n_i = cN_i$ for i = O, 1 then an *estimate of relative risk* is available by the following:

$$\hat{p}_1/\hat{p}_0 = (Y_1/n_1)/(Y_0/n_0) = (Y_1/N_1)/(Y_0/N_0) = Y_1N_0/Y_0N_1 \quad (2)$$

where the multiplicative constant c has cancelled out. Note that the odds ratio which can be computed from Table 1 is in fact a relative risk (Pearce, 1993). One problem with getting the standard errors of the log-relative-risk is as follows: in the Taylor-series method one usually receives the following variance approximation:

$$[p_1(1-p_1)/p_1^2]/n_1 + [p_0(1-p_0)/p_0^2]/n_0 = [(1-p_1)/p_1]/n_1 + [(1-p_0)/p_0]/n_0 \quad (3)$$

Replacing parameter values by their estimates provides

$$(1-Y_1/n_1)/Y_1 + (1-Y_0/n_0)/Y_0 \quad (4)$$

The variance given in formula (4) can only be used if Y_1, Y_0 are small relative to n_1, n_0, in which case (4) becomes

$$1/Y_1 + 1/Y_0 \quad (5)$$

Formula (5) is also achieved if one considers Y_1, Y_0 as a Poisson count with mean p_1n_1, p_0n_0, respectively. It follows from the Poisson distribution that it's variance is also p_1n_1, p_0n_0, respectively, which is estimated by Y_1, Y_0 itself, and formula (5) follows. Note also that (5) is an upper bound for (4) with an error of order $1/n_0 + 1/n_1$. The latter fact implies that the use of (5) will lead to confidence limits which are more conservative than those based on (4).

Alternatively, one can view the relative risk estimate $\frac{Y_1 N_0}{N_1 Y_0}$ as an odds ratio coming from columns 4 and 5 of Table 1. Then, the application of the Taylor-series odds ratio variance, the so-called Woolfe-formula, is straightforward:

$$\hat{var} \log \hat{RR} \approx \frac{1}{Y_1} + \frac{1}{Y_0} + \frac{1}{N_1} + \frac{1}{N_0} \quad (6)$$

If N_1 and N_0 are *large*, the difference between (6) and (5) is neglible. Note that always

$$(4) \leq (5) \leq (6) \quad (7)$$

The preceding results imply that Relative Risks can be computed with standard software such as the statistical calculator of EPI-INFO, (Dean *et al*, 1990) when the cases are processed as cases and the reference data as controls, and statistical-inference-output related to odds ratios is used.

Table 1

Outline of the notations in the case-reference design.

Exposure	Cases	Study population	Reference
E	Y_1	n_1	N_1
NE	Y_0	n_0	N_0
Relative risk		p_1/p_0	p_1/p_0
Estimate or RR		Not estimable	Y_1N_0/Y_0N_1

RESULTS AND DISCUSSION

Univariate distribution of accident related factors

There were 346 in-patients in this study. They were admitted in five hospitals: Police Hospital 42.2%, Nopparat-Rajathani Hospital 28.0%, Bhumipol Hospital 18.8%, Rajavithi Hospital 8.7%, and Siriraj Hospital 2.3%.

The characteristics of study patients

Age (years) : Most of the patients were in the age group 20-29 years 44.5%, less than 20 years 27.2%, and 30-39 years 19.3%. **Sex** : Most of them were male 82.4%. **Education** : Most of the patients had a primary level of education 52.9%, secondary level 32.4%, diploma level 7.8%, bachelor and higher level 2.6%. **Marital status** : Most of the patients were single 60.1%. **Type of work** : Most of the patients were unskilled laborers 35.5%, salespersons and drivers 26.3%, house workers 12.7%, office workers 10.4%, skilled laborers 6.4%, business men and traders 5.5%. **Driving ability** : Most of patients were capable of driving and were driving when they got into the accident 61.0%; incapable 25.1%, capable of driving but were not driving when they got into the accident 11.3%.

The driving status of drivers at accident

Type of motor vehicle : Most of motor vehicles involved in the accident were motorcycles 53.5%, cars, trucks and buses 7.8%. **Driving hours per day** : Most of motor vehicles were driven one hour per day 25.6%, two hours per day 21.8%, ten and more hours per day 19.9%, three hours per day 12.8%. **Length of driving** (years) : Most of drivers had a driving range of 0-4 years 29.5%, more than 4 years 24.3%. **Type of driving license** : The proportion of drivers who had motorcycle licenses was 31.8%, didn't have license 28.9%, annual service cars 14.7%, personal car 6.2%, annual service motor trucks 3.8% and lifetime service cars 3.3%. **Accident history** : Most drivers had one accident 40.8%, 2-8 accidents 25.1%. **Time of accident** : The distribution of the cases with respect to day time of accident showed an almost symmetric distribution with the peak in the evening and night hours. **Police reported causes of accident.** The majority of the police reported causes of accident were motor vehicles which collided with motor vehicles 79.2%, motor vehicles which hit pedestrians 12.4%.

Estimation of relative risk

It is possible to provide reference population distributions for age, sex, marital status, education and occupation. With this methodology it is then possible to estimate the associated relative risks.

Age and sex : The reference population by age and sex is from the whole Bangkok Metropolis for 1992. The associated estimates of relative risk for the male study population appears to be a rising pattern of risk up to the age group of 20-24, and from then onwards a falling pattern. For the female study population this pattern is not as sharp, but

Table 2

Relative risk with 95% confidence interval by age and sex (females above 40 is the baseline data).

Age	Male		Female	
	RR	95% CI	RR	95% CI
< 15	0.73	0.71-1.89	0.25	0.06-0.98
15-19	14.54	7.43-29.18	4.13	1.85-9.31
20-24	17.06	8.81-33.88	1.15	0.35-3.58
25-29	16.20	8.27-32.62	2.22	0.85-5.76
30-34	10.31	5.06-21.47	1.91	0.67-5.30
35-39	5.92	2.63-13.48	2.32	0.81-6.44
>40	1.98	2.63-13.48	1.00	-

there seems to be an elevated risk for the teenage girls of 15-19 years (Table 2).

Marital status : Since there are more young people in the single group than in the ever-married group, and since young persons are at higher risk for a traffic accident, the potential for confounding the relationship of marital status and accident occurrence is present. Therefore, besides the crude risk estimator 2.93, the Mantel-Haenszel estimator adjusted for age was computed, giving a value of 2.25 (1.74-3.09), which though diminished is still significantly elevated.

Education: It appears that the secondary level of education shows an elevated risk. Note that the crude and age-adjusted risk estimates do not deviate much for secondary level of education, whereas the Mantel-Haenszel relative risk estimate for the primary level is higher than the crude estimate : crude RR (primary level) = 1.17, MH-RR = 2.19 (1.09-4.61); crude RR (secondary level) = 5.83, MH-RR = 6.19 (2.9-12.6) University is baseline.

Occupation: The reference population for the whole Bangkok Metropolis 1992 could not be matched with classification on occupation used in the cases. Nevertheless, the authors decided to use this reference population presenting the crude and sex-adjusted estimates of relative risk (MH-RR). The Mantel-Haenszel relative risk estimate did not deviate much for salespersons, whereas, the crude estimate for unskilled laborer was higher than the Mantel-Haenszel estimate: Crude RR (salesperson) = 3.28, MH-RR = 3.34 (2.24-5.02); Crude RR (unskilled laborer) = 4.56, MH-RR = 3.91 (2.71-5.89). Office worker is baseline (Table 3).

For age and sex one finds the result that the young males were at highest risk, as has been established in other studies for different populations (Robertson, 1992). Also, the single population showed a higher risk than the married one. The secondary level of education implies an elevated risk as well, since a large proportion of the mobile population is represented. Similarly, this holds true for the occupational categories salesperson and unskilled laborer. The reason for the high risk of house worker is unclear, but might be simply due to a differential misclassification in exposure, since in the reference population the category houseworker was not present, and the category workers not classifiable by occupation was used instead.

Note that this simple technic (of estimating relative risk) can be used in many applications in which reference exposure distributions are available, though it is often not done. An example of this

Table 3

Crude and Mantel-Haenszel sex-adjusted relative risk with 95% confidence interval by occupation (office worker is the base line).

Occupation	Male		Female		RR		
	Case	Reference	Case	Reference	Crude	MH	95%CI
Business	13	149,832	6	36,673	2.13	1.50	0.85-2.86
Office worker	31	350,200	5	401,832	1	-	-
Skilled labor	22	507,549	0	352,157	0.53	0.43	0.25-0.77
Unskilled labor	99	327,117	23	232,290	4.56	3.91	2.71-5.89
Sales person	83	263,363	8	316,160	3.28	3.34	2.24-5.02
House worker	30	16,548	14	13,071	31.03	27.12	17.80-45.03

Table 4

Cases, reference* population, relative risk with 95% confidence interval by age group.

Age	Cases	Reference	RR	95% CI
> 15	607	15,710,300	0.94	0.83-1.06
15-24	1,754	11,459,800	3.71	3.16-3.93
24-34	1,424	9,792,600	3.52	3.16-3.93
35-44	328	6,879,400	1.16	1.00-1.34
> 45	441	10,690,000	1.00	-

*Population of Thailand 1992

nature is given in Saksri (1986), in which the following age distribution of hospital cases of traffic accidents can be found (Table 4). This remains pointless unless a reference population is matched to it, which then allows estimation of relative risk accordingly. Note that the table is not separated for males and females, so that only an age specific relative risk could be computed, being in the range of the estimates available in this study (Table 1).

This approach also points out how important national and international standards are for exposure definitions as well as then the availability of their distributions in form of reference populations. Alternatively one can follow the case-control approach and compare the exposure distributions of the two samples leading to the concept of estimating exposure odds ratios. Clearly, there are also difficulties in finding appropriate exposure definitions in case and control groups, though this might not be hopeless in the situation where it is with the case-reference approach.

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REFERENCES

Dean J, Dean A, Burton A, *et al. EPI-INFO* 5.0. Centers for Disease Control, Atlanta 1990.

Health Statistics Division, Ministry of Public Health. Public Health Statistics 1993. Bangkok : Veterinary Remount Publisher, 1995.

National Statistical Office. Key statistics of Thailand. 1992. Bangkok 1993.

Pearce N. What does the odds ratio estimate in case-control study. *Int J Epidemiol* 1993 : 1189-92.

Robertson LS. Injury Epidemiology. New York : Oxford University Press. 1992 : 3.

Saksri P. Motor vehicle accident and cure in Lerdsin hospital. Medical Department report (unpublished) 1983.