Statistical model used to estimate road traffic fatalities

Kacem Iaych

World Health Organization

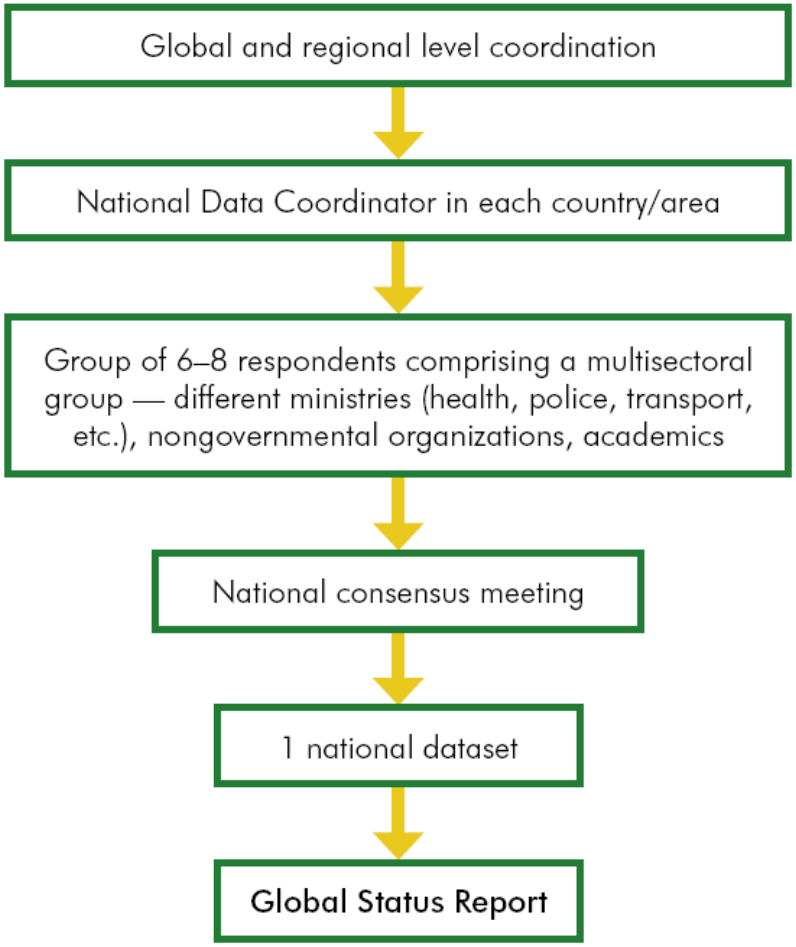
July 2011

World Health Organization

Outline

- The methodology used to collect data
- Negative binomial regression
- Outputs
- Next steps

Methodology used for data collection



World Health Organization

What is the research problem?

- Estimation of road traffic fatalities in view of underreporting of fatalities in data collected
  - Present reported data or improve on underreporting and derive estimates?
- If estimating
  - which statistical model to use?
  - which variables to use?

We decided to estimate: how did we do it?

- Started with 30-day definition adjustment

Table 1. ECMT standardized 30-day road crash fatality adjustment factors

	30-DAY TOTAL	ADJUSTMENT FACTOR
ON THE SCENE/1 DAY	77%	1.30
3 DAYS	87%	1.15
6 DAYS	92%	1.09
7 DAYS	93%	1.08
30 DAYS	100%	1.00
365 DAYS	103%	0.97

- Countries group based on VR completeness

- Group 1 : VR completeness >= 85% (37HICs,36MICs,24LICs)

- Group 2: VR completeness <85% (3HICs, 48MICs, 43 LICs)

Selected appropriate statistical model: negative binomial distribution

- The model can be expressed in mathematical form as follows:

$$RTF = FUNCT(X_{j1}, \ldots, X_{j10})$$

$$P(Y_j = y_j \mid x_j) = \frac{\Gamma(y_j + (1/\alpha))}{y_j!\,\Gamma(1/\alpha)} \left(\frac{1}{1+\alpha\mu_j}\right)^{1/\alpha} \left(\frac{\mu_j}{(1/\alpha)+\mu_j}\right)^{y_j}$$

Likelihood ratio test

Let $\Theta \subseteq \boldsymbol{R}^k$ and let $(Y_1, Y_2, \cdots, Y_n)$ be a random vector with probability or density function $\mathcal{F} = \{P(y;\alpha) : \alpha \in \Theta\}$, $\alpha \in \Theta$. Consider the problem of testing

$$\begin{cases} H_0 & : \quad \alpha \in \Theta_0 \\ H_1 & : \quad \alpha \in \Theta_1 \end{cases}$$

where $\Theta_0 \subset \Theta$, $\Theta_1 \subset \Theta$ and $\Theta_0 \cap \Theta_1 = \emptyset$.

The test statistic $T = \dfrac{\sup\limits_{\alpha \in H_0} L(\alpha; \boldsymbol{Y})}{\sup\limits_{\alpha \in H_0 \cup H_1} L(\alpha; \boldsymbol{Y})} = \dfrac{L(\hat{\alpha}_0; \boldsymbol{X})}{L(\hat{\alpha}; \boldsymbol{Y})}$

$-2\log(T)$ has an asymptotic χ^2_q distribution under H_0 (if the regularity conditions are satisfied) .

Poisson distribution versus negative binomial distribution

$$\begin{cases} H_0 & : \quad \alpha = 0 \\ H_1 & : \quad \alpha > 0 \end{cases}$$

The test statistic:

```
Likelihood-ratio test of alpha=0:  chibar2(01) = 8078.00 Prob>=chibar2 = 0.000
```

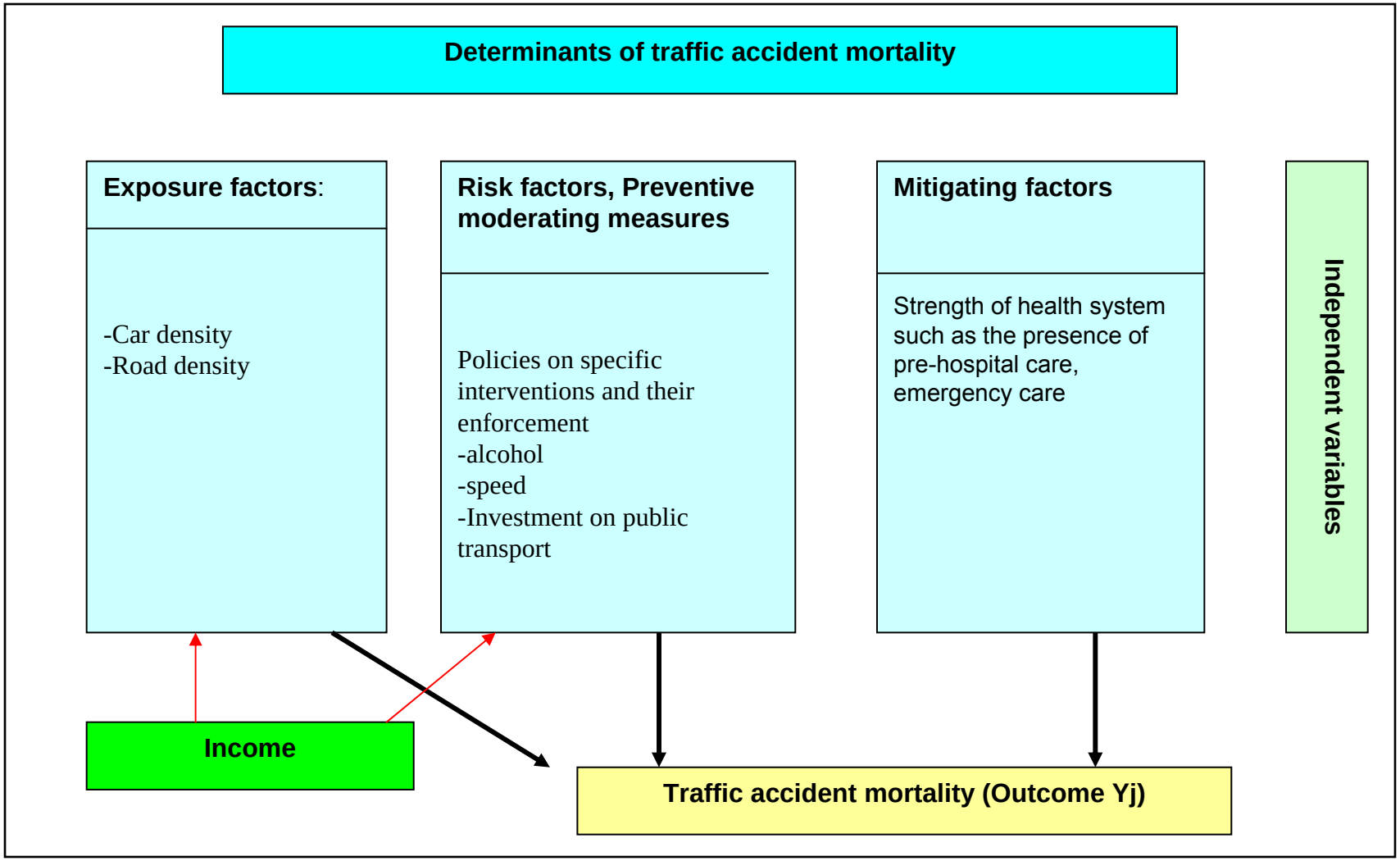

World Health Organization

- The mean in this case is represented as follows:

1. $\mu^*_j = \exp(\beta_0 + \beta_1 \times x_{j1} + \cdots + \beta_n \times x_{jn}) \times \text{population}$.

2. $\text{Log}(\mu^*_j) = \beta_0 + \beta_1 \times x_{j1} + \cdots + \beta_n \times x_{jn} + \log(\text{population})$.

Framework for determinants of traffic injury mortality



World Health Organization

- X_{j1} = Income
- X_{j2} = Car density
- X_{j3} = Road density
- X_{j4} = Helmet law
- X_{j5} = National policies that encourage walking and/or cycling
- X_{j6} = National policies that support investment in public transport
- X_{j7} = National speed limits on urban roads
- X_{j8} = National speed limits on rural roads
- X_{j9} = Alcohol consumption
- X_{j10} =Hospital beds (per 10 000 population)

Enforcement of laws

Law	Countries with enforcement >7/10
Speed	9%
Blood alcohol concentration	13%
Motorcycle helmet-use	25%
Seat-belt	19%
Child restraint	6%

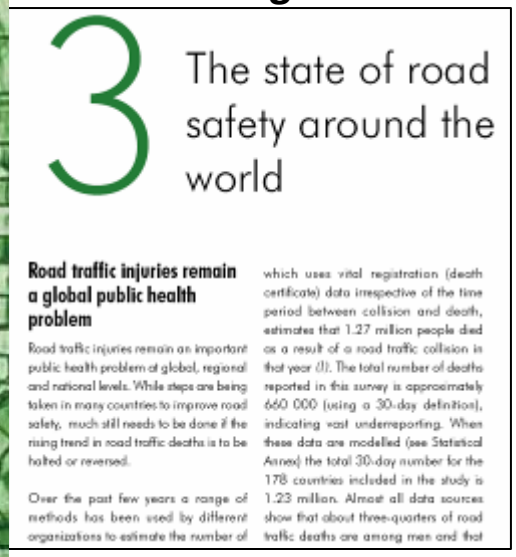
Results of model

WHO REGION	REPORTED DATA[a]		MODELLED DATA[a]	
	n	RATE PER 100 000 POPULATION	*n*	RATE PER 100 000 POPULATION
AFRICAN REGION	52 302	7.2	234 768	32.2
REGION OF THE AMERICAS	139 466	15.5	142 252	15.8
SOUTH-EAST ASIA REGION	143 977	8.4	285 020	16.6
EASTERN MEDITERRANEAN REGION	76 912	14.1	175 668	32.2
EUROPEAN REGION	113 346	12.8	117 997	13.4
WESTERN PACIFIC REGION	135 316	7.6	278 321	15.6
GLOBAL	**661 319**	**10.1**	**1 234 026**	**18.8**

World Health Organization

Outputs

Main messages



3 The state of road safety around the world

Road traffic injuries remain a global public health problem

Road traffic injuries remain an important public health problem at global, regional and national levels. While steps are being taken in many countries to improve road safety, much still needs to be done if the rising trend in road traffic deaths is to be halted or reversed.

Over the past few years a range of methods has been used by different organizations to estimate the number of which uses vital registration (death certificate) data irrespective of the time period between collision and death, estimates that 1.27 million people died as a result of a road traffic collision in that year (1). The total number of deaths reported in this survey is approximately 660 000 (using a 30-day definition), indicating vast underreporting. When these data are modelled (see Statistical Annex) the total 30-day number for the 178 countries included in the study is 1.23 million. Almost all data sources show that about three-quarters of road traffic deaths are among men and that

Statistical annexes

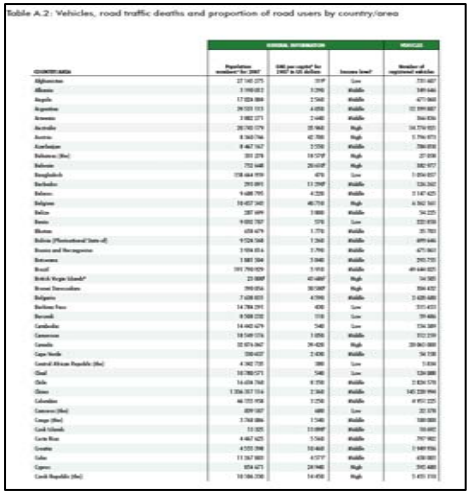
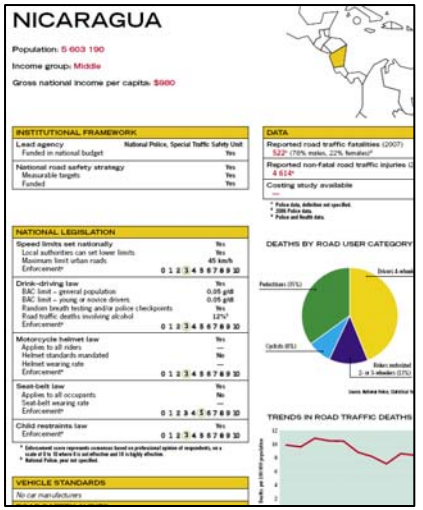


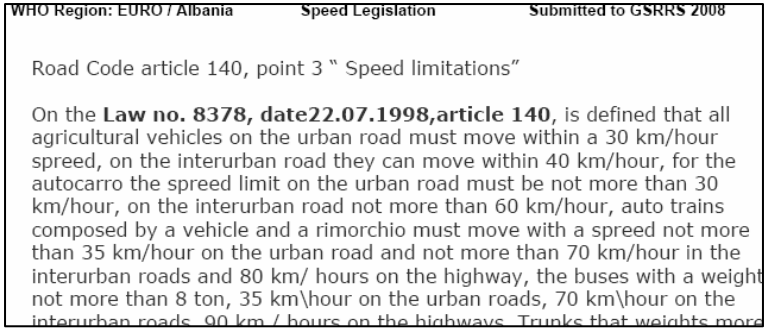
Table A.2: Vehicles, road traffic deaths and proportion of road users by country/area

Global health observatory

Country profiles



Supporting docs



WHO Region: EURO / Albania Speed Legislation Submitted to GSRRS 2008

Road Code article 140, point 3 " Speed limitations"

On the **Law no. 8378, date22.07.1998,article 140**, is defined that all agricultural vehicles on the urban road must move within a 30 km/hour spreed, on the interurban road they can move within 40 km/hour, for the autocarro the spreed limit on the urban road must be not more than 30 km/hour, on the interurban road not more than 60 km/hour, auto trains composed by a vehicle and a rimorchio must move with a spreed not more than 35 km/hour on the urban road and not more than 70 km/hour in the interurban roads and 80 km/ hours on the highway, the buses with a weight not more than 8 ton, 35 km\hour on the urban roads, 70 km\hour on the interurban roads, 90 km / hours on the highways. Trunks that weights more

World Health Organization

GSRRS2 follows

2ND GLOBAL STATUS REPORT ON ROAD SAFETY

DECADE OF ACTION FOR ROAD SAFETY 2011-2020

World Health Organization

Any refinement of the model?

- Include some additional variables
- Perhaps improve our model using elements of the GBD model

- **Takeuchi, H. (2001)**. *On the likelihood ratio test for a single model against the mixture of two known densities*. Communications in Statistics-Theory and Methods **30**, 931-942.
- **Cameron AC, Trivedi PK**. Regression analysis of count data. Econometric Society Monograph, No. 30. New York, Cambridge University Press, 1998.
- **Hilbe JM**. Negative Binomial Regression. Cambridge University Press, Cambridge, 2007.
- **Razzak JA, Luby SP**. "*Estimating deaths and injuries due to road traffic accidents in Karachi, Pakistan, through the capture-recapture method.*" International Journal of Epidemiology, 1998:27:866-870.
- **Greenwood M, Yule, GU**. An enquiry into the nature of frequency distributions representative of multiple happenings with particular reference to the occurrence of multiple attacks of disease or of repeated accidents. Journal of the Royal Statistical Society, 1920; Series A: 83: 255-279.
- *The Global Burden of Disease: 2004 update*. Geneva, World Health Organization, 2008 (http://www.who.int/healthinfo/global_burden_disease/GBD_report_2004_update_AnnexA.pdf, accessed 7 April 2009).

World Health Organization

Thank you for your attention

iaychk@who.int

World Health Organization