



**Statistical model used to  
estimate road traffic  
fatalities**

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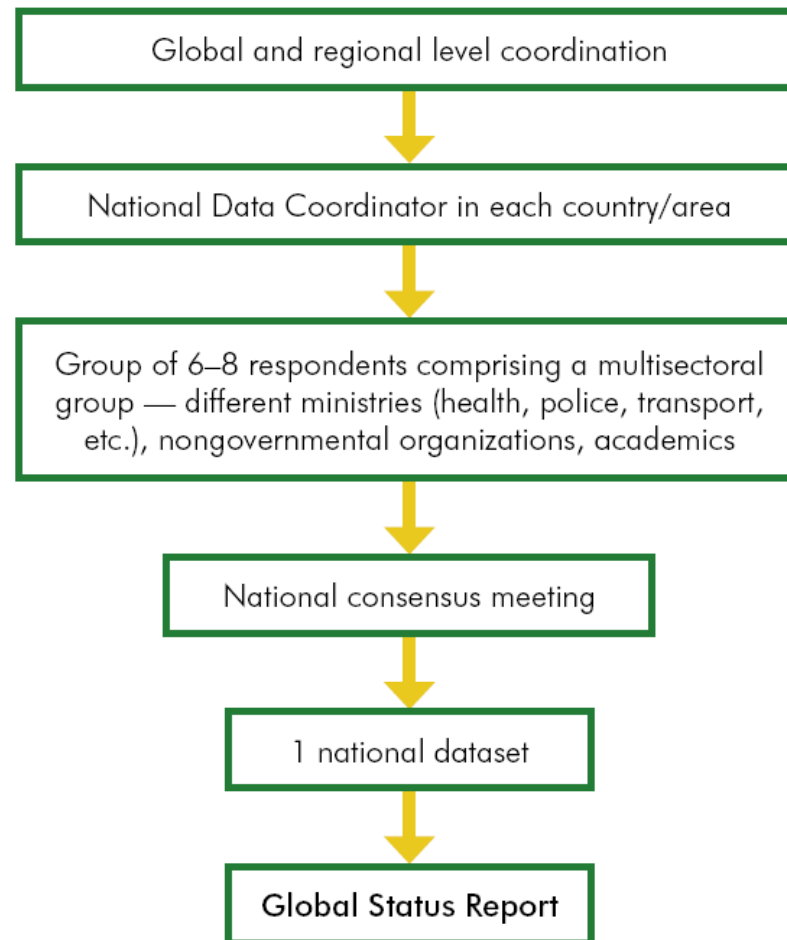




# Outline

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

# Methodology used for data collection



# 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  $\geq 85\%$   
(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:

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

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



## Likelihood ratio test

Let  $\Theta \subseteq \mathbb{R}^k$  and let  $(Y_1, Y_2, \dots, Y_n)$  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

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

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

$$\text{The test statistic } T = \frac{\sup_{\alpha \in H_0} L(\alpha; \mathbf{Y})}{\sup_{\alpha \in H_0 \cup H_1} L(\alpha; \mathbf{Y})} = \frac{L(\hat{\alpha}_0; \mathbf{X})}{L(\hat{\alpha}; \mathbf{Y})}$$

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





## Poisson distribution versus negative binomial distribution

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

The test statistic:

```
Likelihood-ratio test of alpha=0:  chibar2(01) = 8078.00 Prob>=chibar2 = 0.000
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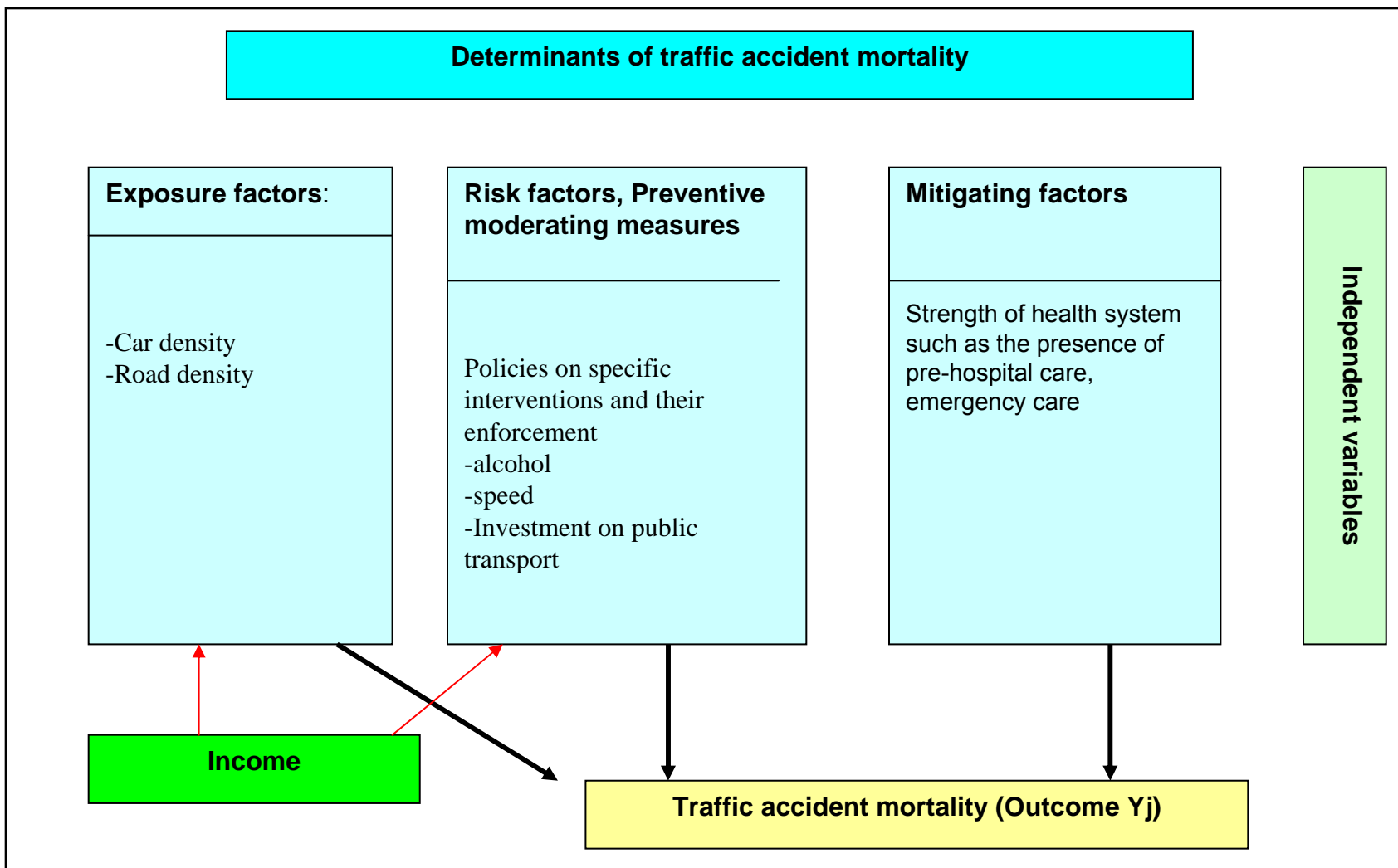
- The mean in this case is represented as follows:

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

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



## Framework for determinants of traffic injury mortality



- $X_{j1}$  = 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 <sup>a</sup>		MODELLED DATA <sup>a</sup>	
	<i>n</i>	RATE PER 100 000 POPULATION	<i>n</i>	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
<b>GLOBAL</b>	<b>661 319</b>	<b>10.1</b>	<b>1 234 026</b>	<b>18.8</b>



## 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

Country/Area	Vehicle registration		License type	Number of registered vehicles
	Population (millions)	2007 per 1000		
Algeria	27 120 276	121	Low	161 000
Algeria	3 198 037	7 296	Medium	349 246
Algeria	17 922 239	12 947	Medium	4 127 943
Argentina	39 581 313	4 495	Medium	10 189 007
Australia	21 927 273	1 046	Medium	364 874
Australia	26 742 174	35 368	High	16 774 000
Austria	8 542 764	42 789	High	17 764 971
Azerbaijan	8 447 742	1 706	Medium	766 818
Bahrain (incl.)	101 274	16 579	High	27 238
Bahrain	1 241 042	20 027	High	766 818
Bangladesh	158 244 934	475	Low	1 024 027
Belarus	10 091 011	11 289	Medium	126 242
Belarus	9 468 793	4 232	Medium	1 414 423
Bolivia	9 507 703	46 778	High	4 562 347
Bolivia	1 27 499	1 268	Medium	1 268
Brazil	198 921 301	178	Low	320 039
Brazil	48 424 276	1 174	Medium	56 761 161
Brazil (Pernambuco State only)	9 524 548	1 248	Medium	409 446
Brazil and Portuguese	1 016 014	1 796	Medium	471 361
Bulgaria	1 041 042	1 546	Medium	295 767
Burkina Faso	191 716 074	1 013	Medium	49 444 021
Burkina Faso (Sikasso)	22 889	62 467	High	14 941
Burkina Faso (Sikasso)	29 034	50 087	High	56 427
Bulgaria	7 128 031	4 796	Medium	1 425 249
Burkina Faso	14 726 741	4 001	Low	1 014 431
Burkina Faso	9 569 232	118	Low	70 446
Cameroon	14 442 276	148	Low	126 869
Cameroon	14 549 174	1 008	Medium	1 021 239
Cameroon	22 061 627	34 425	High	286 260 389
Canada	336 042	1 246	Medium	34 718
Canada (Alberta Province only)	4 142 721	380	Low	1 000
Canada	32 022 272	1 548	Low	1 026 889
Chad	14 248 744	6 156	Medium	1 024 174
China	1 364 517 034	1 248	Medium	140 224 994
China	1 364 517 034	1 248	Medium	4 127 943
Cuba	11 261 011	480	Low	20 278
Cuba (incl.)	11 261 011	1 046	Medium	4 127 943
Czech Republic	10 225	10 087	Medium	10 087
Czech Republic	4 441 223	1 046	Medium	1 046
Czech Republic	4 551 248	10 440	Medium	1 046 769
Dominican Republic	11 542 249	4 077	Medium	459 261
Dominican Republic	10 474 111	24 440	High	244 440
Dominican Republic (incl.)	10 584 238	14 456	High	1 451 715

# Outputs

## Global health observatory

The screenshot shows the 'Global Health Observatory Database' interface. A search bar is at the top with 'Find indicator' and a search button. On the left, there is a navigation menu with categories like 'Health-related Millennium Development Goals', 'Mortality and Burden of Disease', 'World Health Statistics', 'Immunization', 'Nutrition', 'Epidemiology and infectious diseases', 'Tobacco Control', 'Violence and Injuries', 'Road safety', 'Demographic and socio-economic statistics', 'Registered vehicles', 'Mortality', 'Contributions of road traffic deaths by road user', 'National Legislation', 'Institutional Framework', 'Emergency care', and 'Global Information System on Alcohol and Road Traffic'. The main content area is titled 'Road traffic deaths' and displays a table with columns for Location, Year, Estimated number of road traffic deaths, and Estimated road traffic death rate (per 100 000 population).

Location	Year	Estimated number of road traffic deaths	Estimated road traffic death rate (per 100 000 population)
Afghanistan	2007	10593	
Albania	2007	445	
Algeria	2007	6425	
Argentina	2007	5427	
Armenia	2007	471	
Australia	2007	1919	
Austria	2007	691	
Azerbaijan	2007	1066	
Bahrain	2007	48	
Bahrain	2007	91	
Bangladesh	2007	20388	
Barbados	2007	35	
Belarus	2007	1517	
Belgium	2007	1967	
Belize	2006	69	
Benin	2007	2815	
Bhutan	2007	85	
Bolivia (Plurinational State of)	2007	1594	
Bosnia and Herzegovina	2007	428	
Brazil	2007	451	

## Country profiles

The screenshot shows the 'NICARAGUA' country profile. It includes basic information: Population 5 603 190, Income group Middle, and Gross national income per capita \$580. The profile is divided into several sections: 'INSTITUTIONAL FRAMEWORK', 'NATIONAL LEGISLATION', 'VEHICLE STANDARDS', and 'DEATHS BY ROAD USER CATEGORY'. The 'DEATHS BY ROAD USER CATEGORY' section features a pie chart showing the distribution of deaths among different road users.

## 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, date 22.07.1998, article 140, it is defined that all agricultural vehicles on the urban road must move within a 30 km/hour speed, on the interurban road they can move within 40 km/hour, for the autocarro the speed 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 speed 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. Trucks that weights more



## GSRRS2 follows



# 2<sup>ND</sup> GLOBAL STATUS REPORT ON ROAD SAFETY





# Any refinement of the model?

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



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- **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](http://www.who.int/healthinfo/global_burden_disease/GBD_report_2004_update_AnnexA.pdf), accessed 7 April 2009).



**Thank you for your attention**

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