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Threats on roads: myths or facts

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Research issue

Examining the influence of selected human factors on threat on roads expressed by:

- incorrect behaviour of an accident responsible road user
- accident type
- accident severity

The research carried out on separated and mutually independent data sets about found guilty:

- drivers in no pedestrian single-vehicle accidents; D-A1Vh
- drivers in no pedestrian multi-vehicle accidents; D-A2Vh
- drivers in pedestrian accidents; D-APds
- pedestrians involved in road accidents ; P-APds

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Data for the analysis

The data sets contain information about road users found guilty in non-urban accidents from the time period 1999-2004.

Observations for which variables used for model building have missing data are excluded from the analysis.

Data set description	Number of observations	
	road users	traffic offenders
Drivers in no pedestrian single-vehicle accidents	1834	1680
Drivers in no pedestrian multie-vehicle accidents	7472	3451
Drivers in pedestrian accidents	2152	669
Pedestrians in road accidents	1959	1095

- **VhTp – vehicle type**
- **DrSx, PdSx – sex of a driver and a pedestrian**
- **DrAlk, PdAlk – alcohol influence on a driver, on a pedestrian**
- **DrAGr, PdAGr – driver and pedestrian age group**
- **DrBh, PdBh – driver and pedestrian behaviour**
- **AcTp – accident type**
- **AcSv – accident severity**

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Research method

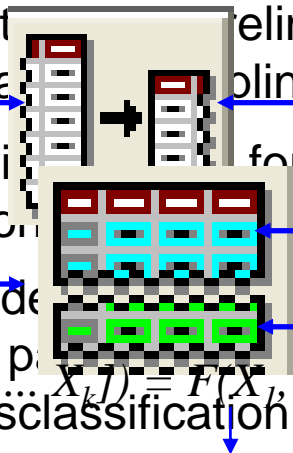
Logistic regression – estimation the probability that the dependent variable will have a given value (success) having known the values of a group of independent variables (continuous or discrete).

Sampling – the reduction of the disproportion of the target variable distribution, simple random sampling of a majority category.
 $P(Y = Success | X_1, X_2, \dots, X_k) = \frac{\exp(A + \sum_{j=1}^k B_j X_j)}{1 + \exp(A + \sum_{j=1}^k B_j X_j)}$

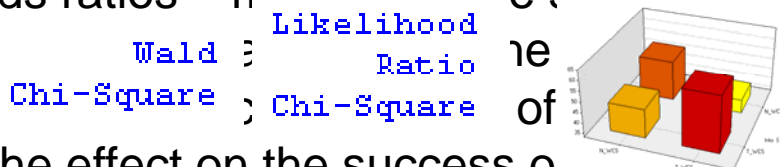
Train and validation data sets, preliminary model fitting and model fine-tuning respectively: stratified sampling by the target variable.

Model building – stepwise selection for choosing effects, validation misclassification criterion, aggregation voting.

Results testing and model evaluation: the significance of: the model, main effects, structural parameters.
Confusion matrix: CM(S), CM(F).
Train and validation misclassification rates: MR(T), MR(V).



Odds ratios – measuring the strength of association between an independent variable, i.e. assessing the influence of the effect on the success odds.



$$OR = \frac{P(Y = Success | X_j = x_2) / P(Y = Failure | X_j = x_2)}{P(Y = Success | X_j = x_1) / P(Y = Failure | X_j = x_1)} = \exp(B_j \cdot (x_2 - x_1))$$



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Description of data sets subject to analysis

D-A1Vh	DrBh	ExSp	74.0
		Ot	17.0
		Rm	9.0
	AcTp	HtPTr	44.8
	RI	37.6	
	Rm	17.6	
D-A2Vh	DrBh	NGwW	25.5
		ExSp	23.6
		InOvPR	15.5
		Ot	7.7
		DrWrRS	6.8
		FICI	5.5
		InTr	8.0
		Rm	7.4
	AcTp	HdCr	34.8
		Sdlm	31.8
		RrCr	27.0
	Rm	6.4	
D-APds	DrBh	Ot	27.1
		ExSp	27.2
		InPR	17.3
		Rm	28.4
P-APds	DrBh	ImEnBfMVh	48.6
		InCrss	10.1
		ImEnBhVhOb	10.0
		StFIIRd	12.1
		Ch7Rd	6.8
		Rm	12.4

Effects and their domain		D-A1Vh	D-A2Vh	D-APds	P-APds
AcSv	LA	55.0	59.4	42.9	45.1
	SA	33.8	28.8	36.0	34.5
	FA	11.3	11.9	21.1	20.4
VhTp	Bc	4.5	15.7	2.1	0.5
	M	5.8	4.4	3.3	1.1
	C	75.2	60.4	76.7	81.2
	Bs	0.5	0.6	2.2	1.6
	H	10.5	15.4	13.3	13.3
	O	3.5	3.4	2.4	2.2
DrSx	M	87.3	87.9	92.7	75.8
PdSx	F	12.7	12.1	7.3	24.2
DrAlk	N	74.6	85.5	79.2	72.4
PdAlk	Y	25.4	14.5	20.8	27.6
DrAGr	1 - till 7	0	0.5	0	10.0
PdAGr	2 - till 15	0.9	4.7	0.7	15.8
	3 - till 18	3.8	2.8	4.6	4.0
	4 - till 25	34.2	22.1	29.4	10.1
	5 - till 40	33.4	33.8	36.3	16.4
	6 - till 60	23.0	26.7	25.3	27.7
	7 - till 60	4.7	9.5	3.6	16.0

Note: ordered character of the accident severity

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Behaviour of accident responsible road user

Offender group	Success category (% offenders)	VhTp	Model significance	CM(S) [%]	CM(F) [%]	MR(T) [%]	MR(V) [%]	VhTp	DrAGr PdAGr	DrSx PdSx	DrAlk PdAlk
D-A1Vh	ExSp (74.0%)	yes	96.2; 5 (<0.0001)	92.4	38.7	34.4	39.3	47.92; 5 (<0.0001)			
		no	33.66; 5 (<0.0001)	71.4	47.8	40.3	47.8		21.92; 5 (0.0005)		
D-A2Vh	NGvW	yes	74.8; 6 (<0.0001)	55.7	62.5	41.1	45.7		54.84; 6 (<0.0001)		
		no	VhTp - effect statistically not significant; results as above								
	ExSp (23.6%)	yes	174.1; 11 (<0.0001)	67.3	54.2	40.2	40.3	47.95; 5 (<0.0001)	11.92; 6 (0.064)		
		no	71.2; 7 (<0.0001)	62.9	55.5	41.1	41.9		50.0; 6 (<0.0001)		8.4; 1 (0,004)
D-APds	ExSp (27.2%)	yes	22.9; 5 (0.0004)	88.0	34.1	40.7	45.5	8.73; 5 (0.12)			
		no	No effects								
	Ot (27.1%)	yes	5.1; 1 (0.024)	28.1	84.3	45.4	44.9				4.9; 1 (0.027)
		no	VhTp - effect statistically not significant; results as above								
P-APds	InEnBfMVh (48.6%)	yes	42.5; 6 (<0.0001)	56.5	64.4	39.4	45.3		34.5; 6 (<0.0001)		
		no	VhTp - effect statistically not significant; results as above								

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Road accident type

Offender group	Success category (% offenders)	VhTp	Model significance	CM(S) [%]	CM(F) [%]	MR(T) [%]	MR(V) [%]	VhTp	DrAGr	DrSx	DrAlk	DrBh
D-A1Vh	HtPTr (44.8%)	yes	97.2; 10 (<0.0001)	68.1	51.2	41.0	42.7	23.0; 5 (0.0003)	11.4; 5 (0.0442)			
		no	44.6; 7 (<0.0001)	64.2	52.4	41.7	47.7		23.5; 5 (0.0003)			14.4; 4 (0.0062)
D-A2Vh	HdCr (34.8%)	yes	378.0; 12 (<0.0001)	77.6	65.0	28.9	28.7	34.2; 5 (<0.0001)				217.0; 7 (<0.0001)
		no	324.3; 14 (<0.0001)	64.6	75.5	29.0	30.0		12.3; 6 (0.055)	0.6; 1 (0.43)	0.8; 1 (0.38)	249.6; 7 (<0.0001)

Hitting a pedestrian is a road accident type caused by pedestrians in 97% (P-APds) and by drivers (D-APds) in 92% .

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Road accident severity

Offender group	Success category (% offenders)	VhTp	Model significance	CM(S) [%]	CM(F) [%]	MR(T) [%]	MR(V) [%]	VhTp	DrAGr PdAGr	DrSx PdSx	DrAlk PdAlk	DrBh PdBh	
D-A1Vh	SFA (45.1%)	yes	20.5; 6 (0.0023)	39.4	73.5	43.2	43.2	12.9; 5 (0.0024)			5.1; 1 (0.025)		
		no	18.7; 3 (0.0003)	43.7	70.5	42.7	48.1				9.2; 1 (0.002)	9.1; 2 (0.01)	
	FA (11.3%)	yes	16.1; 5 (0.007)	51.8	70.3	38.7	48.4		13.5; 5 (0.02)				
		no	VhTp - effect statistically not significant; results as above										
D-A2Vh	SFA (40.6%)	yes	56.9; 18 (<0.0001)	61.9	53.5	42.2	43.5	16.2; 5 (0.006)	23.3; 6 (0.001)			22.6; 7 (0.002)	
		no	36.4; 13 (0.0005)	51.7	60.3	44.1	45.0		13.2; 6 (0.04)			23.0; 7 (0.002)	
	FA (11.9%)	yes	53.9; 18 (<0.0001)	63.3	63.1	36.8	40.7	13.9; 5 (0.02)	11.6; 6 (0.07)			22.5; 7 (0.002)	
		no	33.4; 13 (0.001)	62.7	55.9	40.7	43.4		14.3; 5 (0.01)			18.6; 7 (0.001)	
D-APds	SFA (57.1%)	yes	11.4; 3 (0.01)	60.2	52.9	43.4	46.8					11.0; 3 (0.01)	
		no	VhTp - effect statistically not significant; results as above										
	FA (21.1%)	yes	No effects										
		no	No effects										
P-APds	SFA (54.9%)	yes	27.0; 6 (<0.0001)	67.5	50.8	40.8	40.7		25.9; 6 (0.0002)				
		no	VhTp - effect statistically not significant; results as above										
	FA (20.4%)	yes	77.5; 15 (<0.0001)	76.9	69.2	27.0	35.1	12.4; 4 (0.01)	25.8; 6 (0.0002)			17.9; 5 (0.003)	
		no	57.7; 12 (<0.0001)	75.9	63.2	30.5	30.0		26.4; 6 (0.0002)		6.6; 1 (0.01)	13.7; 5 (0.02)	

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Odds ratios for the behaviour of accident responsible road user

D-A1Vh	ExSp	VhTp	C	H; O; M; Bc	0,9	0,04	0,4	0,1		
		DrAGr	>60	till 18; 25; 40; 60	2,9	6,2	5,7	3,3		
D-A2Vh	NGvW	VhTp		statistically not significant						
		DrAGr	>60	till: 15; 18; 25; 40; 60	1,4	1,2	0,3	0,3	0,4	
	ExSp	VhTp	C	Bs; H; O; M; Bc	0,5	0,9	0,1	0,8	0,04	
		DrAGr	>60	till: 15; 18; 25; 40; 60	0,4	1,6	3,6	5	3,9	
		DrAlk	Y	N	1,7					
D-APds	ExSp	VhTp		statistically not significant						
		No effects								
	Ot	VhTp		statistically not significant						
		DrAlk	Y	N	2,1					
P-APds	ImEnBf MVh	PdAGr	>60	till: 7; 15; 18; 25; 40; 60	0,1	0,3	0,3	0,5	0,4	0,6

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Odds ratios for road accident type

D-A1Vh	HtPTR	VhTp	C	H; O; M; Bc	0.9	0.7	0.5	0.1	
		DrAGr	>60	till: 15; 18; 25 ; 40; 60	0.5	2.2	3.9	2.7	1.9
		DrBh	ExSp	Rm; Ot	0.8	0.5			
D-A2Vh	HdCr	VhTp	C	Bs; H; O; M; Bc	0.4	0.8	0.4	0.4	0.4
		DrAGr	>60	till: 15; 18; 25; 40 ; 60	0.7	1.2	1.3	1.6	1.3
		DrBh	NGvW	Rm; InTr; DrWrRS ; FICl; Ot ; InOvPR; ExSp	3.9	0.4	23		
					0.1	2.6	1.7	4.6	

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Odds ratios for road accident severity

D-A1Vh	SFA	VhTp	C	Bs; H; O; M; Bc	1.9	2.5	2.5	2.3	0.9	
		DrAlk	T	N	0.6					
		DrBh	ExSp	Rm; Ot	0.9	1.7				
FA	VhTp		statistically not significant							
	DrAGr	>60	till: 15; 18; 25; 40 ; 60	0.7	1.2	1.3	1.6	1.3		
D-A2Vh	SFA	VhTp	C	Bs; H; O; M; Bc	0.5	1.2	0.8	2.4	1.3	
FA	VhTp	C	Bs; H; O; M; Bc	0.7	1.7	0.3	0.4	1.6		
	DrAGr	>60	till: 15; 18; 25; 40; 60	0.2	0.1	0.3	0.5	0.5		
	DrBh	NGvW	Rm; InTr; FICl; Ot; DrWrRS; InOvPR; ExSp	1.8	1	0.7	2.3			
P-APds	SFA	PdAGr	>60	till: 7; 15; 18; 25; 40; 60	0.6	0.4	0.5	0.9	1.2	1.4
FA	PdAGr	>60	till: 7; 15; 18; 25; 40; 60	0.06	0.1	0.2	0.3	0.4	0.3	
	PdAlk	T	N	2.3						
	PdBh	ImEnBf MVh	Rm; Ch7Rd; ImEnBhVhOb InCrss; StFlIRd	1.1	0.7	0.6				
				2.4	3.5					

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Conclusions

The greatest threat on roads expressed by:

- excessive speed accidents
- most dangerous accident types (hitting a pole or tree and head-on crash)
- are made by car and heavy vehicle drivers

The odds of killing or seriously injuring himself or other road user are for a bicyclist, a mototcyclist or a heavy vehicle driver even over two times higher than for a car driver

Traffic offenders that create especially high danger on roads belong to the following age groups:

- (18, 25] and over 60 years old – drivers in single-vehicle accidents
- (25, 40] and under 60 years old – drivers in multi-vehicle accidents
- over 60 years old – pedestrians

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Conclusions

Excessive speed is not such a risky behaviour of a traffic offender that leads to a fatality like:

- other behaviour (!) by Road Accident Card in no pedestrian accidents
- driving wrong side of a road in multi-vehicle accidents

Imprudent enter a roadway is not such a risky pedestrian behaviour that leads to a fatality like incorrect crossing a roadway or standing or falling down on a roadway

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Summing up

Logistic regression is a good tool to model threats on non-urban roads, described by qualitative features

Models obtained in the study have not shown statistically significant influence of the sex of a traffic offender on the road hazard expressed by: excessive speed as an accident cause, hitting a pole or a tree and head-on crash as an accident type and fatal or serious injury as an accident severity

There have been no satisfactory results in modelling road risks among drivers responsible for pedestrian accidents

Among no pedestrian accident responsible drivers and pedestrian offenders there are statistically significant relationships between threats on roads and the following features: vehicle type and offender's age and in some cases behaviour and blood alcohol concentration of the offender

If in the classification of accident severity the success category is fatal accident (as an opposition to joined light or severe accident) the classification results are better than if the success category is joined fatal or serious accident (as an opposition to light accident)

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