A Tool to Assess Pedestrian Safety: Risk Curves by Injury Severity and their Confidence Intervals for Car-to-Pedestrian Front Collision.

Sophie Cuny, Henri Chajmowicz, Konthéa Yong, Thierry Hermitte, Erwan Lecuyer, Nicolas Bertholon

Abstract

In order to estimate the global effectiveness of Advanced Driver Assistance Systems, injury mitigation has to be taken into account. This is achieved through the use of injury risk curves that allow to convert speeds from accident scenario simulations into injury level probabilities. The present paper presents a new set of pedestrian injury risk curves (for fatal, severe and slight injuries), based on a French accident analysis database, and highlights the methodology used to build the curves and their confidence intervals.

The following analysis is based on car-to-pedestrian real-world collisions obtained from police reports in France. The cases selected were those relevant for an Autonomous Emergency Braking pedestrian system, i.e., car to pedestrian frontal collision. Injury probabilities were modelled using a polytomous CLOGLOG regression model, depending on the squared impact speed. Confidence intervals were computed by bootstrap methods, based on a 20,000 samples simulation.

The model shows a sharp increase of the risk of fatal injury above 70 kph impact speed. At 73 kph impact speed, the risk of fatal injury reaches 50%. The maximal risk of severe injury is reached at 60 kph impact speed.

The use of these curves can provide a better estimation of the safety benefits as they take into account the potential gain for every injury severity level.

Keywords bootstrap, car-to-pedestrian, frontal collision, injury risk curve

I. INTRODUCTION

In 2015, according to the World Health Organization [1], pedestrians accounted for 22% of fatalities in road accidents worldwide, representing approximatively 275,000 deaths. In 2015 in EU countries [2], pedestrians represented 21% of the road accident fatalities, namely 5,435 persons. In France in 2016, pedestrian road fatalities accounted for 16% of the overall road fatalities and represented 559 pedestrians **Error! Reference source not found.**.

To increase pedestrian safety, one of the solutions is to fit cars with active safety systems in order to assist the driver in avoiding crashes. Autonomous Emergency Braking for Pedestrian (AEB-pedestrian) is increasingly available on the high income countries car market and has been part of the European New Car Assessment Programme (Euro-NCAP) active safety package since 2016 [4]. AEB-pedestrian systems are designed to activate when a pedestrian is detected in front of the vehicle at a close range. Depending on a variety of parameters (e.g. vehicle speed, system reaction time, maximal braking effort etc.), AEB-

S. Cuny is Data Analyst in Accidentology at European center of studies on safety and risk analysis (CEESAR), Nanterre, France (email: sophie.cuny@ceesar.fr, Tel: + 33 1 76 87 35 71). H. Chajmowicz is Active safety and autonomous vehicle researcher, K. Yong is Data Analyst, E. Lecuyer is Data Scientist and N. Bertholon is Deputy Director at LAB Laboratory of Accidentology, Biomechanics and human behaviour / PSA – Renault (LAB), Nanterre, France. T. Hermitte is Active and passive safety/accident science Specialist at Renault, 1 av. du Golf, F – 78084 Guyancourt, France.

pedestrian can either avoid the collision altogether or mitigate its consequences by reducing impact speed. To improve AEB-pedestrian effectiveness assessment, relationships between impact speed and injury level probability has to be taken into account, regardless of injury level (fatal, severe and slight). These relationships are synthesized in injury risk curves, based on AEB-pedestrian-relevant accident data

The goal of the work is to build injury risk curves (along with their confidence intervals) to be used for AEB-pedestrian effectiveness assessment. Relevant accident data selected in a French accident database [5] were used for this purpose. We selected a statistical model (out of four possible models) using Akaike Information Criteria (AIC) and Bayesian information criterion (BIC) and built the related confidence intervals using bootstrap percentile methodology. Results were compared to existing literature on pedestrian risk curves for fatal [6] [7] and severe/slight injury (ASPECSS project [8] basing on UK and German data)

II. METHODS

Data

We used accident data, from real cases that occurred in France in 2011. These were aggregated in the context of the VOIESUR project that was set up in 2012 and involved four major actors of road safety research in France (LAB, CEREMA, IFSTTAR and CEESAR) [5]. The data base created in the project gathered all the fatal accidents that had occurred in France in 2011 and 5% of all accidents resulting in an injury, selected at random. About 8,500 accidents (involving pedestrians or not) were coded and recorded with information related to the infrastructure, the vehicle, the occupants and the injury. Experts in accidentology have added information related to vehicle impact speed, human functional failure, responsibility level, etc. The database is weighted to be representative of the accidental situation of France for year 2011, as described in the national census BAAC [9].

In the context of the present study, the case selection was done according to the standard specification of the AEB-pedestrian functionality: only cases possibly addressed by an AEB-pedestrian technology were taken into account. The selection criteria were as follows: pedestrian (regardless of age) is first hit by the front part of a passenger car (regardless of weather or light conditions), exclusion of collisions resulting from a loss of control of the car driver, exclusion of pedestrians lying on the road before the impact and exclusion of collisions occurring on the pavement. All type of road surface and light condition accidents were included in the sample, in order to be able to match with a wide variety of AEB specification. Nevertheless, side swipe have been excluded, as the injury mechanism is different to what it is observed when the pedestrian is hit by the frontal part of the vehicle. Vehicle impact speeds were calculated whenever the data contained in the accident report (e.g. interview of the driver, photos of the vehicle, sketch of the accident scene) allowed it. A common bias is that this kind of information is more often available for fatal accidents or accidents resulting in severe injuries, so a correction factor was applied to make up for the underrepresentation of slight injury accidents in the final sample containing cases with available impact speeds.

Three injury severity levels are analysed here: fatally injured pedestrian (fatality occurred within 30 days after the accident), severely injured (SI) pedestrian (pedestrian stayed at hospital at least 24h), slightly injured (SLI) pedestrian (injured pedestrian detained in hospital less than 24h). The VOIESUR data does not include uninjured pedestrians, and pedestrians for whom injury level was unknown have been excluded from the analysis. The final total weighted sample consists of 5,163 accident cases, involving a pedestrian in a frontal impact against a car. In detail, 195 cases result in a fatality, 1,871 in a severe injury and 3,097 in a slight injury. The mean impact speed was 28 kph (with 95% CI [25 -31] kph), with a minimum of 4 kph and a maximum of 110 kph.

Injury Risk Curves

As we need to take various injury *levels* into account, we must depart from the approach used for e.g. assessing fatal injury risks, which consists in modelling severity as a *binary* variable (e.g. fatal/not fatal). We modelled injury severity P(y) using a polytomous regression instead of a binary model. As injury severity is an ordered variable, proportional odds model was used [13]. In ordered variable modelling, cumulative probabilities are estimated instead of individual probabilities. This means that, the probability of sustaining a fatal injury will be modelled, versus the severe and slight injury probabilities. The probability of severe injury is not directly estimated, instead, the probability of sustaining a fatal or severe injury is fitted versus the slight injury. The assumption of the model is that the slope would be equivalent for all the level of the response variable (probability of fatal injury and probability of fatal or severe injury). Thus, probabilities of severe injuries are derived by subtracting probabilities of fatal injuries from the probabilities of fatal or severe injuries. Probabilities of slight injuries are obtained by subtracting the probabilities of fatal and severe injuries from 1.

As opposed to using two different regressions to assess fatal and slight injuries, as in e.g. [8], we chose to use a polytomous regression, which estimates all the injury probabilities within the same process. In this way, the sum of all injury probabilities equals 1, regardless of the value of the independent variable. The logistic regression (equation 1) is usually used to assess injury probability with regard to an independent variable. The Gompit model (also called Cloglog) (equation 2) is also worth taking into account as it is an asymmetrical model, approaching the 100% of probability faster than the logistic model and well adapted to events with small probabilities of occurrence.

$$P(y) = \frac{e^{\alpha+\beta x}}{1+ e^{\alpha+\beta x}} \quad (1)$$

$$P(y) = 1 - exp(-exp^{(\alpha+\beta x)}) \quad (2)$$

These two link functions were tested using two different independent variables: impact speed and squared impact speed. The 4 models were compared and the best model - according to Akaike information criteria (AIC) and Bayesian information criterion (BIC) - was eventually chosen.

SAS Entreprise Guide v5.1 and R were used for the analysis.

Bootstrap Percentile Confidence Intervals

Whereas the distribution and the dispersion parameters are known for the fatal injury risk curve, the theoretical statistical distribution of the severe injury risk curve is not well-defined. The dispersion parameters that allow the construction of the interval confidence around the risk curves are not identified. Bootstrap methodology, a simulation method, based on the random selection of samples from the initial sample [10], was used to overcome this issue. We generated N bootstrap samples by randomly (with replacement so that each sample has the same size than the initial sample) selecting elements from the initial sample. Injury curves at each level of severity were then computed for the N bootstrap samples. For each impact speed, N probabilities of injury could be estimated and the bootstrap percentile method for confidence intervals was applied [11]. The percentiles are used to assess bootstrap confidence interval, a 5% confidence intervals is estimated as the 2.5% and 97.5% percentile of the probability distribution at each impact speed

One thousand bootstrap samples are suggested as a minimum to achieve an appropriate estimation of the parameters [10] [11]. This issue was investigated, and several simulations using various numbers of bootstrap samples - 500, 1,000, 5,000 and 20,000 - were performed (five iterations for each number of bootstrap samples). It was anticipated that increasing the number of bootstrap samples would result in reducing differences between the predicted probabilities of the different simulation iterations. To assess whether the number of bootstrap samples was sufficient for our purpose, we calculated, for a given set of reference impact speeds (20 kph, 40, kph, 60 kph and 80 kph), the difference between the maximum and the minimum predicted probabilities for the lower and upper confidence interval limits of the three injury severities. The latter were analysed separately, as dispersion might depend on injury severity level. The number of bootstrap samples was considered as appropriate to estimate the confidence intervals when all the values of the maximum differences between predicted probabilities remained below a 0.5% threshold. This threshold was chosen as an acceptable difference between probabilities given by different simulation iterations.

Bootstrap confidence intervals were built for the best model according to AIC and BIC analyses.

In order to assess the robustness of the model, the expected number of casualties were calculated, given the impact speed distribution and given the injury risk curves, and compared to the initial figures.

III. RESULTS

Model Selection

Four regression models were run, with the logistic regression and the Cloglog regression, the injury probabilities being modelled with impact speed then with squared impact speed. In Table I summarizes the AIC and BIC values obtained for each of the models we tested.

TABLE I
MODEL FITTING STATISTICS ACCORDING TO THE MODEL CHARACTERISTICS

	Logistic - Impact speed	Logistic – Squared Impact speed	Cloglog – Impact speed	Cloglog – Squared Impact speed
AIC	6980	6932	6943	6896
BIC	6990	6943	6954	6907

Based on the lowest AIC and BIC values, the model that best fits the data is the Cloglog model using the squared impact speed. The coefficients of the regression provide the following probabilities:

$$P(K) = 1 - exp(-exp^{(-4.6451+0.00079*\mathrm{iS}^2)}) \quad (3)$$

$$P(KSI) = 1 - exp(-exp^{(-1.5174+0.00079*\mathrm{iS}^2)}) \quad (4)$$

Where:

- iS stands for impact speed
- *P(K)* stands for the probability to be killed (i.e. receive a fatal injury)
- *P(KSI)* stands for the probability to be killed or seriously injured

The Identical slope hypothesis is appropriate for this data, as we failed to reject the null hypothesis of identical parameter (Test for equal slopes assumption, p=0.46)

The seriously injured (*P(SI)*) and slightly injured (*P(SLI)*) probabilities are derived from (3) and (4).

$$P(SI) = (4) - (3)$$

$$P(SLI) = 1 - (4)$$

Number of Bootstrap Samples

Bootstrap methodology was applied on the data, and injury probabilities were calculated with a Cloglog model using squared impact speed. To assess the consistency of the results, five simulations were performed for four different numbers of bootstrap samples (500, 1 000, 5 000, 20 000). The following table II provides the values of the differences, for each reference impact speed and each reference number of bootstrap samples, between maximal and minimal predictions for the lowest and highest values of the confidence interval limits.

TABLE II
DIFFERENCES BETWEEN THE MAXIMAL AND THE MINIMAL PROBABILITY FOR THE LOW AND HIGH LIMITS OF THE CONFIDENCE INTERVAL, BY NUMBER OF BOOTSTRAP SAMPLES AND INJURY SEVERITY.

		LOW LIMIT OF CONFIDENCE INTERVAL				HIGH LIMIT OF CONFIDENCE INTERVAL			
Number of Bootstrap samples	*Injury severity*	20 kph	40 pkh	60 kph	80 kph	20 kph	40 pkh	60 kph	80 kph
500	*Fatal*	0.1%	0.2%	0.4%	3.2%	0.1%	0.1%	2.0%	0.2%
	Serious injury	0.8%	2.2%	1.1%	0.2%	1.1%	2.7%	0.8%	3.3%
	Slight injury	1.1%	2.3%	0.0%	0.0%	0.8%	2.0%	2.4%	0.0%
1000	*Fatal*	0.0%	0.1%	0.7%	3.2%	0.1%	0.1%	0.9%	0.1%
	Serious injury	1.1%	0.8%	0.5%	0.1%	1.4%	2.3%	0.4%	3.1%
	Slight injury	1.4%	1.7%	0.0%	0.0%	1.1%	0.8%	0.9%	0.0%
5000	*Fatal*	0.0%	0.0%	0.1%	0.5%	0.0%	0.1%	0.7%	0.1%
	Serious injury	0.2%	0.4%	0.2%	0.1%	0.4%	0.7%	0.2%	0.5%
	Slight injury	0.4%	0.9%	0.0%	0.0%	0.3%	0.3%	0.6%	0.0%
20000	*Fatal*	0.0%	0.0%	0.1%	0.2%	0.0%	0.0%	0.2%	0.0%
	Serious injury	0.2%	0.3%	0.2%	0.0%	0.2%	0.4%	0.1%	0.2%
	Slight injury	0.1%	0.4%	0.0%	0.0%	0.1%	0.3%	0.2%	0.0%

The variability of the predicted values decreased rapidly between bootstrap sample numbers 500 to 5,000. Then, with 20,000 bootstrap samples, the differences between all the predicted values were always below 0.5% for all reference impact speeds. We have considered that the benefit of further increasing the number of bootstrap samples would be insignificant.

Bootstrap Percentile Confidence Interval and Injury Risk Curves

Injury risk curves addressing the three levels of severity were calculated and the confidence intervals were obtained using 20,000 bootstrap samples. The results of the bootstrap percentile confidence intervals calculations are given by severity level for each of the impact speed required.

As there is no uninjured pedestrian in the data, the risk of slight injury is very high for low impact speed and is never zero. It was a deliberate choice not to give probabilities for impact speeds under 5 kph.

The curves are as follows (Fig. 1):

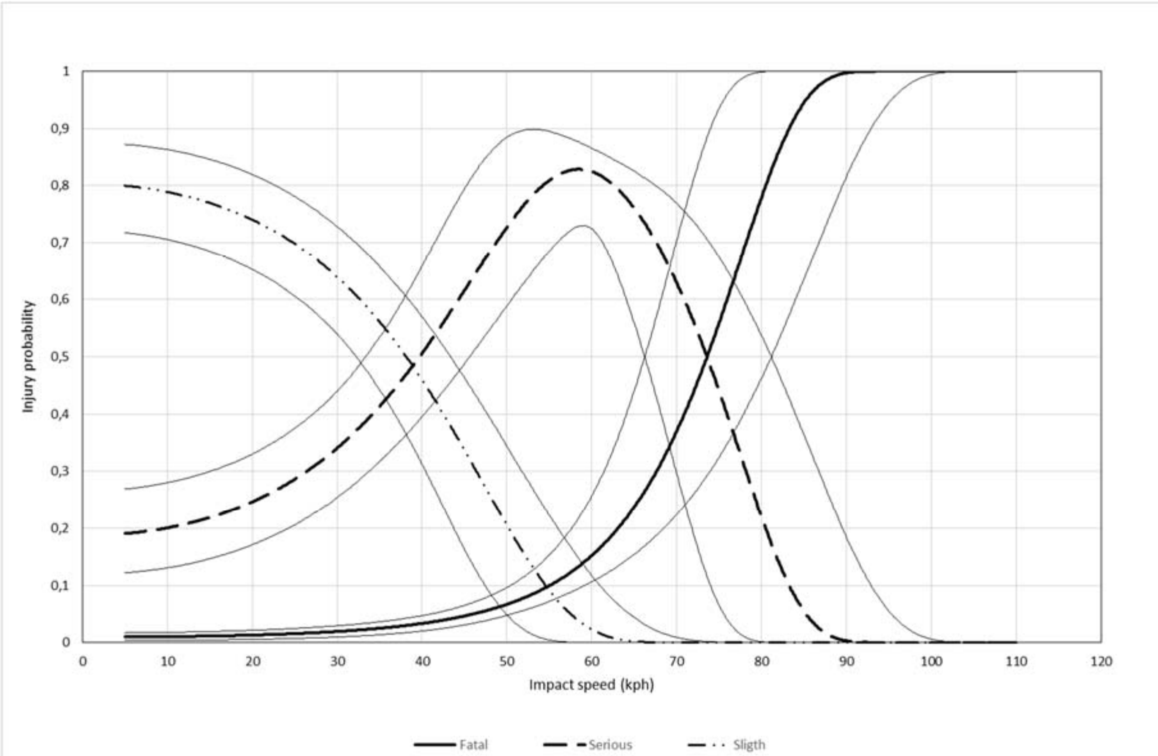

Fig. 1. Injury risk curves as a function of impact speed for injured pedestrian in a car-to-pedestrian frontal collision.

Confidence intervals were built for the three severity levels, they are roughly symmetric around the predicted probabilities. Confidence intervals are only identified with their values for each impact speed, as no equations are available. Exact values of the three confidence intervals are provided in the Appendix (Table A1).

From impact speed 70 kph onward, fatal injury risk shows a sharp increase. At impact speed 73 kph, the risk of fatality reaches 50%. If we look at speeds of 30 or 50 kph, corresponding to the main urban area speeds limits in France, the risk of fatal injury is respectively of 2% and 7%, those of severe injury of 34% and 73% respectively, and those related to slight injury of 64% and 20%.

In order to assess the robustness of the model, the expected number of casualties were calculated, given the impact speed distribution and given the injury risk curves, and compared to the original figures (Table III).

TABLE III
COMPARISON OF INITIAL AND EXPECTED CASUALTIES

	Fatal injury	Severe injury	Slight injury	Total
Initial casualties	195	1 871	3 097	5 163
Expected casualties	197	1 864	3 102	5 163

The injury risk curves do not return exactly the initial number of casualties. Nevertheless, depending on the severity level, the difference between the observed accident casualties and expected numbers do not exceed 1%. Therefore, the injury risk curves are assumed to be robust.

In the a-priori evaluation of the effectiveness of AEB-pedestrian systems, injury mitigation can be assessed thanks to the different injury curves, the reduction of impact speed due to AEB-pedestrian allows assignment of a set of three probabilities at the pedestrian level.

IV. DISCUSSION

Injury risks curves presented in this paper were elaborated from French data gathered by the VOIESUR project and made representative of France. They rely on a specific car-to-pedestrian accident selection criterion, directly resulting from an AEB-pedestrian system specification. Throughout Europe, injury risk curves for pedestrians in frontal impact have also been built based on data coming from Germany and UK [8]. In France, a partner of the VOIESUR project has also calculated injury risk curves for pedestrians [6].

The table below gives a summary of the characteristics of the curves and the risks computed at five specific impact speeds.

TABLE IV

RISK OF FATAL INJURY FOR VARIOUS IMPACT SPEEDS

	10 kph	30 kph	50 kph	70 kph	90 kph	Speed and Model
Present study	1%	2%	7%	37%	100%	iS² CLOGLOG
IFSTTAR [6]	0%	1%	5%	56%	100%	iS² CLOGLOG
Rosén [7]	0%	1%	8%	35%	77%	iS LOGISTIC
ASPECSS GIDAS [8]	0%	1%	4%	17%	50%	iS LOGISTIC
ASPECSS UK [8]	0%	1%	9%	45%	86%	iS LOGISTIC

The curve related to fatal injury from IFSTTAR [6] is shifted to the left compared to our curves, when considering impact speed above 60pkh. As it is based on the same database and as the probabilities are estimated in the same way, the difference is likely caused by a discrepancy in the selection criteria. In the present paper, a focus was made on cases relevant to AEB-pedestrian system as we aimed at providing a tool to assess the effectiveness of AEB-pedestrian systems. Car-to-Pedestrian accidents not addressable by AEB were excluded in the present curves, whereas IFSTTAR included all frontal car to pedestrian impacts. For example, pedestrians lying on the road and being run over by a car were not considered as AEB relevant and not taken into account in the present paper. They were included in the IFSTTAR curves, as their authors' purpose was to find a global injury risk in frontal impact containing all the accidental situations. That may have led to a shift toward higher injury risk at lower speed, as this kind of situations is likely to be fatal even at low impact speeds. IFSTTAR also developed an imputation methodology to include missing data on impact speed, whereas we only focused on known cases. That also could lead to modification of the selected case characteristics.

Injury risk curves from logistic regression [7] [8] present a very low slope, and give lower risk at high speed than the present curves. CLOGLOG function is asymmetric and then departs slowly from 0 and increases rapidly when approaching 1. Its inherent characteristic allows taking into account the sharp increase of fatality rate between 70 and 80 kph, observed on our original data.

Serious injury risk is at its maximum at 60 kph, which is completely consistent with the result from UK in the ASPECSS report. Data from GIDAS exhibit a peak at 70 kph.

Our slight injury risk curves show high risk estimation at very low speeds (about 80% at 5 kph). This is also observed in the curves from the ASPECSS report. This issue relates to the absence of non-injury collision in the database we used. The VOIESUR database gathered only accidents resulting in injury, and does not contain any collision resulting in an uninjured pedestrian. The probability of slight injury was derived from the severe and fatal injury probabilities, and it is the probability of being slightly injured, given that the pedestrian has been injured in the accident. It is expected that the real injury risk of slight injury would start from zero and increase with a less pronounced slope than the one observed. The same observation may also stand for serious injuries probabilities. No measure or method is available to overcome this issue to the best of our knowledge.

Our curves consider all pedestrians together but [12] highlighted that age is a crucial factor for explaining pedestrian injury severity. [6], [7] proposed curves which adjusted the age of the pedestrian.

Injury risk curves for to the three injury severity levels can also be calculated through two binomial regressions, one related to the fatal injuries versus the serious and slight injuries, the other one related to the slight injuries versus the fatal and serious injuries, as done in [8]. Severe injury probability are estimated again as the complementary value, given that the total probability for each of the speed would be 1. As the probabilities are estimated through different regressions, there is a possibility that the sum of the probabilities, especially for high values of the independent variable, does not reach exactly 1. The use of a polytomous regression model circumvents that issue and forces the sum of the probabilities of the three injury levels to equal 1, regardless of the value of the independent variable. That has a consequence that the three risk curves are totally dependent from each other and especially that the curve related to serious injury is relevant only if used with the two other curves. They are dedicated to injury mitigation evaluation and the serious injury risk curve has to be used in that purpose only. It is clear that the serious injury risk curve would have a typical injury risk curve shape if we had considered the risk of serious injury versus the slight injury.

Bootstrap percentile confidence intervals are symmetric around the injury curve. [7] calculated the confidence intervals curves for his fatal injury risk curve, and showed that they were not centred around the probability curves, whereas the confidence intervals proposed by IFSTTAR [6] is centred around the curve. This should be investigated to adjust the construction of bootstrap methodology in providing confidence intervals.

V. CONCLUSIONS

The injury risk curves presented here are based on real, recent and representative pedestrian accidents in France. As compared to the existing literature, our figures are more severe at high speeds and the slope is steeper from 70km/h. We also have built in confidence intervals for all injury levels. The bootstrap methodology appears appropriate for that purpose.

Risk curves can be used to provide insight into the potential benefits of driver assistance systems, especially AEB-pedestrian, as the selection criteria are based on these cases. The use of these curves can provide a better estimation of the safety benefits taking into account the potential improvement for every severity class. The construction of the three injury risk curves could be applied to other vulnerable users such as cyclists and motorcyclists. Moreover, with the change in mobility and the introduction of electric devices used by pedestrians, as Segways or electric scooters, it would be interesting to update the data with these kind of cases.

VI. REFERENCES

[1] World Health Organization, "Global status report on road safety 2015" Internet: http://www.who.int/violence_injury_prevention/road_safety_status/2015/en/, March 2018.

[2] European Road Safety Observatory, «Traffic Safety Basic Facts 2017" Internet: https://ec.europa.eu/transport/road_safety/sites/roadsafety/files/pdf/statistics/dacota/bfs20xx_pedestrians.pdf, March 2018.

[3] Observatoire National Interministériel de la Sécurité Routière. "La sécurité routière en France, Bilan de l'accidentalité de l'année 2016" Internet www.securite-routiere.gouv.fr/content/download/37021/353698/version/1/file/Bilan+de+la+s%C3%A9curit%C3%A9+routi%C3%A8re+2016.pdf, March 2018.

[4] Euro NCAP AEB piéton. Internet: http://www.euroncap.com/fr/sécurité-des-véhicules/la-notation-en-détail/protection-des-piétons/aeb-piétons/ , March 2018.

[5] Lesire P et al. Implication of children in road accidents in France in 2011, *Proceedings of ESV Conference*, 2015, Gothenburg

[6] Martin JL, Wu D. Pedestrian fatality and impact speed squared: Cloglog modeling from French national data. *Traffic Injury Prevention*, 2018, volume 19 (issue 1), 94-101

[7] Rosén E. Autonomous emergency braking for vulnerable road users. *Proceedings of IRCOBI Conference*, 2013, Gothenburg

[8] Mervin E, Nathanson A, Wisch M. ASPECSS D1.3 Benefit estimate and assessment methodologies for pre-crash braking part of forward-looking integrated pedestrian safety systems. Assessment methodologies for forward looking integrated pedestrian and further extension to cyclists safety. SST.2011.RTD-1 GA No. 285106. 2014

[9] Amoros E, Lardy A, Martin JL, Wu D, Viallon V. Méthodologie redressement et extrapolation. L3 Deliverable VOIESUR Project. ANR-11-VPTT-0007

[10] Efron B, Tibshirani RJ. An Introduction to the Bootstrap. Chapman & Hall, New York. 1993

[11] Efron B, Tibshirani RJ. Bootstrap methods for standard errors, confidence intervals, and other measures of statistical accuracy. *Statistical Science*, 1986, volume 1, No.1, 54-77

[12] Niebuhr T, Junge M, Rosén E. Pedestrian Injury and the effect of age. *Accident Analysis and Prevention*, 2016, Volume 86, 121-128

[13] Stokes ME, Davis C, Koch GG. Categorical data analysis using the SAS System. Second edition. Cary, NC: SAS Institute Inc. 2000

VII. APPENDIX

TABLE A1
CONFIDENCE INTERVAL VALUES

	Probability of fatal injury		Probability of severe injury		Probability of slight injury	
Impact speed (kph)	low CI	high CI	low CI	high CI	low CI	high CI
5	0.004	0.017	0.122	0.269	0.717	0.872
10	0.004	0.018	0.131	0.280	0.706	0.863
15	0.005	0.019	0.147	0.300	0.685	0.846
20	0.006	0.021	0.171	0.330	0.653	0.819
25	0.007	0.025	0.206	0.375	0.607	0.781
30	0.010	0.029	0.254	0.440	0.540	0.728
35	0.014	0.036	0.317	0.534	0.442	0.658
40	0.020	0.047	0.396	0.658	0.313	0.570
45	0.031	0.065	0.488	0.794	0.163	0.464
50	0.048	0.096	0.589	0.884	0.048	0.344
55	0.072	0.154	0.685	0.895	0.005	0.223
60	0.106	0.257	0.725	0.865	0	0.117
65	0.154	0.441	0.559	0.825	0	0.044
70	0.224	0.703	0.297	0.769	0	0.009
75	0.325	0.935	0.065	0.675	0	0.001
80	0.463	0.999	0.001	0.537	0	0
85	0.636	1	0	0.364	0	0
90	0.816	1	0	0.184	0	0
95	0.945	1	0	0.055	0	0
100	0.994	1	0	0.006	0	0
105	0.999	1	0	0	0	0
110	1.000	1	0	0	0	0