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The odds of accident-type casualties in a Peruvian jungle road

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CHRONICLE

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ABSTRACT

The current analysis analyzed the odds of casualties by road accidents. Hence, data were classified into tertiles for better research, and accident types were classified into five following the authority methodology: rollovers, crash, roadway departure, special accident, and car capsizing. Multi-logistic regression was employed for the data analysis. This research found that rollover was the most deadly accident, and the crash was the most probable to cause injuries.

1. Introduction

Road traffic accidents are the eighth leading cause of death globally (Cuenca et al., 2018). Even more deadly than many cancer or viruses (Mincă et al., 2013). It is anticipated that this pattern will intensify in the upcoming years and rank as the fifth leading cause of mortality (Cuenca et al., 2018). Drunk driving, distracted driving, pedestrian negligence, driver imprudence, and technical failure are the leading causes of fatal automobile accidents (Villalobos & Hernándes, 2013).

Developed nations have prioritized driver education while properly maintaining their high-quality road networks. In emerging nations, this scenario does not occur again. Because of this, it was discovered that industrialized countries should expect a considerable rise in traffic accidents compared to underdeveloped nations (Shen et al., 2014). Indeed, middle- and low-income nations account for half of all fatal automobile accidents (Peden & Di Pietro, 2017). As a result, initiatives have been made to decrease the number of fatal vehicle accidents by emphasizing safe driving instructions. Additionally, penalties for drivers were more severe to deter reckless driving (Goldenbeld, 2018). However, it does not appear enough (Silvano, 2016).

For instance, Peru's traffic accidents have increased every year (Superintendencia de Transporte Terrestre de Personas, 2021a). Adding punishments, vial education, automobile surveillance, and driver's education is intended to lower the accident number (Superintendencia de Transporte Terrestre de Personas, 2021).

Nevertheless, these measures were insufficient to avoid car accidents in a nation where the number of automobiles rises by 10% per year (Posada, 2018). Additionally, in the following decades, this tendency appears to double or even treble (Dirección de Seguridad Vial, 2021). It indicates a substantial need for the country's road system, which, according to Bonifaz et al. (2020), has an offer-to-demand imbalance of more than 72 billion dollars. There is a massive demand from jungle cities to build and improve their roadway net.

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A possible solution for the road traffic in the Peruvian jungle area is the road called PE-5 or "Longitudinal de la Selva". This route plans to join Junin, Pasco, Huanuco, San Martín, Amazonas, and Cajamarca jungle areas. Moreover, connecting the jungle parts of Cusco and Madre de Dios is over. It is a compound of almost 1 600 kilometers, partially asphalted two-way, and it is intended to be built more than 1 200 kilometers.

The natural conditions of the jungle make the route dangerous, especially in rainy months, due to rock slides that can interrupt the way for many days and even cause deaths. Indeed, the driver's visibility is affected by natural phenomena, which can be dangerous. Therefore, it is necessary to analyze the injured and dead pattern to provide essential information to make arrangements required for security purposes.

2. Literature review

The pattern of injuries in traffic accidents was the subject of several literary works. According to specific reports, victims of motorized two-wheeler accidents occur more often (Chaudhary et al., 2005). Some people claimed that pedestrians were the most frequent victims of auto accidents. Gupta et al. (2007) examined the road accident characteristics at an Indian hospital, finding that crashes caused most deaths. According to the research by Lilhare & Swarnkar (2016) and Jakhar et al. (2019), the categories of road accident victims vary by location, based on the vehicles being utilized, traffic regulations and congestion, public knowledge, and the state of the roads.

In a study, Vipul et al. (2021) carried out to know the injured pattern in heterogeneous road accident victims in India found that front collision was the most common type of accident. Such an accident type was especially severe in the brains of the victims, which caused the majority of deaths. Moreover, Singh (2004) found that 86.4% of deadly car accidents are between vehicles. It seems that the main affected area in a road accident is the head, leading to deaths. Hence, Pathak & Gupta (2008) found that linear skull fracture due to crashes was the deadliest death cause among car accidents.

3. Methodology

Sutran's database served as the primary information source for the current study. This database contained statistics on the frequency of accidents and their categorization. Hence, the casualties were classified as follows: 1 for rollovers, 2 for a crash, 3 for roadway departure, 4 for special [which is a combination of the others] accidents, and 5 for car capsizing. The information is from 2021 and 2022. It was divided into tertiles for a better analysis. The use of a multi-logit model and the Stata program was required because the data were categorical.

3.1 Multiple logistic regression

Multiple logistic regression is a progression from binary logistic regression. Its main feature is that it allows for more than two categories for the dependent variable (Schafer, 2006). Similar to binary logistic regression, this regression evaluates the probability of categorical membership (Starkweather & Kay, 2002). Even though this regression does not require normal distribution, linearity, or homoscedasticity requirements, it is still crucial to confirm the independence of the variables (Rodriguez, 2007). In other words, it bans any association between judgments about membership for one group and decisions about membership for another. There are ways to evaluate this condition. The Hausman technique is one way, although other tests, such as the Small-Hsiao or McFadden test, may also be utilized (Rodriguez, 2007).

Furthermore, this kind of regression requires a large sample. As a result, a necessary sample size must be used to produce valid results. The logistic regression makes numerous logistic regressions (Rodriguez, 2007). The model is, therefore $Logit[P(Y=1)] = \alpha + \beta_1 x_1 + \cdots + \beta_k x_k$ if we let K to choose specific predictors for a binary outcome, Y, by *x1, x2,…,xk*,. In the event that we provide a value for x, then $\pi(x) = \frac{\exp(\alpha+\beta_1 x_1+\cdots+\beta_k x_k}{1+\exp(\alpha+\beta_1 x_1+\cdots+\beta_k x_k}$.

In this instance, β_i displays the effect of x_i on the logs of Y=1 while simultaneously managing other x_j. The multiplicative impact of a unit increase in x_i while regulating other x_j leads to the emergence of exp (β_i). One logit must be added to a base level, and the other must be built around it if the research includes n observations, p-regressors, and numerous qualitative answer categories (Starkweather & Kay, 2002). Including that will make any type the base level in the model. The k category will be the basic theoretical motive level (El-Habil, 2012). Additionally, π_j is the *j^th^* category unusual observation. The multiple logistic regression will be as follows to determine the association between this odd and a group of explanatory factors $x_1, x_2 \ldots$,: $\log\left[\frac{\pi_j(x_i)}{\pi_k(x_i)}\right] = \alpha_{0i} + \beta_{1j}x_{1i} + \cdots + \beta_{pj}x_{pi}$. It becomes: $\log\left(\pi_j(x_i)\right) = \frac{\exp(\alpha_{01}+\beta_{1j}x_{1i}+\cdots+\beta_{pj}x_{pi})}{1+\sum_{j=1}^{k-1}\exp(\alpha_{01}+\beta_{1j}x_{1i}+\cdots+\beta_{pj}x_{pi})}$ when is added to the unity π. As a consequence, the multiple logistic regression yields the appropriate findings for j =1, 2, …, (k-1).

4. Results

Table 1 presents the dead quantities by accident type. Table 1 shows the number of dead people by accident type. The column dead is classified in tertiles only relevant to the numbers 1 and 3. On the other hand, the accidents are classified as follows: number one for rollovers, two for a crash, three for roadway departure, four for special [which is a combination of the others] accidents, and five for car capsizing. Therefore, for the first tertile, most casualties were multiple; for the third tertile, it was car capsize.

Table 1
Dear quantities by accident type

	Accident					
Dead	1	2	3	4	5	**Total**
0	15	227	197	11	1	451
	65.22%	83.76%	91.63%	84.62%	50.00%	86.07%
4	8	44	18	2	1	73
	34.78%	16.24%	8.37%	15.38%	50.00%	13.93%
Total	23	271	215	13	2	524
	100%	100%	100%	100%	100%	100%

Table 2 portrays the case of injured people. Many accidents were due to rollover for the first tertile, and for the third one, car capsize.

Table 2
Injured quantities by accident type

	Accident					
Injured	1	2	3	4	5	Total
1	20	182	155	10	1	368
	86.96%	67.16%	72.09%	76.92%	50.00%	70.23%
2	3	89	60	3	1	156
	13.04%	32.84%	27.91%	23.08%	50.00%	29.77%
Total	23	271	215	13	2	524
	100%	100%	100%	100%	100%	100%

Table 3 reveals that the first tertile is more likely to be injured when the accident is a rollover. Nonetheless, the least potent accident to cause injured people was a crash. Additionally, special and roadway departure were the second and third accident types, by the probability of occurrence, to force injured people.

Table 3
Quantile 1 injured people by accident type

Accident type	Margin	Standard Error	z	P>z	95% confidence interval	
1	0.87	0.07	12.38	0.00	0.73	1.01
2	0.67	0.03	23.54	0.00	0.62	0.73
3	0.72	0.03	23.57	0.00	0.66	0.78
4	0.77	0.12	6.58	0.00	0.54	1.00
5	0.50	0.35	1.41	0.16	-0.19	1.19

Table 4 depicts that for the third tertile, the two most relevant accident types were crash and roadway departure, respectively, while the least was a rollover. In this tertile, car capsizing was irrelevant due to its lack of statistical significance.

Table 4
Quantile 3 injured people by accident type

Accident type	Margin	Standard Error	z	P>z	95% confidence interval	
1	0.13	0.07	1.86	0.06	-0.01	0.27
2	0.33	0.03	11.51	0.00	0.27	0.38
3	0.28	0.03	9.12	0.00	0.22	0.34
4	0.23	0.12	1.97	0.05	0.00	0.46
5	0.50	0.35	1.41	0.16	-0.19	1.19

Furthermore, for the deadliest accidents, Table 5 shows that in the first tertile, it was found that roadway departure was the fatal accident type, while rollover was the least relevant. Besides, roadway departure and special accidents were also appropriate, in that order.

Table 5
Quantile 1 dead people by accident type

Accident type	Margin	Standard Error	z	P>z	95% confidence interval	
1	0.65	0.10	6.57	0.00	0.46	0.85
2	0.84	0.02	37.39	0.00	0.79	0.88
3	0.92	0.02	48.51	0.00	0.88	0.95
4	0.85	0.10	8.46	0.00	0.65	1.04
5	0.50	0.35	1.41	0.16	-0.19	1.19

However, Table 6 shows that for the third tertile, the most relevant accident was a rollover, followed by a crash and roadway departure.

Table 6
Quantile 3 dead people by accident type

Accident type	Margin	Standard Error	z	P>z	95% confidence interval	
1	0.35	0.10	3.50	0.00	0.15	0.54
2	0.16	0.02	7.25	0.00	0.12	0.21
3	0.08	0.02	4.43	0.00	0.05	0.12
4	0.15	0.10	1.54	0.12	-0.04	0.35
5	0.50	0.35	1.41	0.16	-0.19	1.19

5. Discussion

The current research aimed to analyze the probability of injured and dead people by accident on the main Peruvian jungle road. By employing Multiple Logistic Regression, it was possible to find relevant information about the odds of becoming dead or injured by a specific accident. Hence, the analysis showed that a crash is more likely to leave injured people than other accidents. Moreover, in the case of deadly accidents, having a rollover was found to cause more than any different kind of accident. As data was classified in tertiles, it was taken as more relevant than those that showed the most cases, i.e., the third tertile.

The results, in a certain way, match with the claim of Chaudhary et al. (2005) and Singh (2004) since it was pointed out that most accidents do not involve pedestrians but cars. Interestingly, statistical analysis showed that rollovers were the principal cause of many deaths on this jungle route since this road is characterized to be challenging to drive due to its geographical conditions as the specific characteristics in the research of Lilhare & Swarnkar (2016) and Jakhar et al. (2019. Hence, it appears that the road condition make rollover a significant cause to cause death, as determined by Jakhar et al. (2019) and Gupta et al. (2007)

The descriptive analysis also showed that most accidents are due to crashes, as stated by Vipul et al. (2021). Moreover, this kind of accident seems to be the most powerful to cause injuries and is the second most probable cause of deadly accidents.

As the current study did not analyze the physiological mechanics to determine the real cause of death, it is impossible to compare these results with Pathak & Gupta (2008).

6. Conclusions and recommendations

The current analysis found that rollover is the most deadly accident, while a crash is a severe accident that is more likely to leave injured people dead after rollover. Then, authorities need to improve this jungle road's infrastructure conditions to avoid these kinds of accidents. Actions like preventing rockslides and rain effects could make jungle roads safer.

Additionally, educating pedestrians and drivers about safe driving is necessary to stop increasing the number of affected people because of accidents on this road. Moreover, the implementation and maintenance of signalization and other safety infrastructure could be necessary to make this and other geographically difficult roads safer for everyone.

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