Drivers Behavior In Interchange Ramps Depending On Their Age, Vehicle Type And Vehicle Age

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Introduction & Main Targets

In Europe, about 26,000 people die each year and 1.1 million are injured. Most of them who were killed in road accidents were over 25 years old and 37% of them belong to 25-49 years old category. A determining factor seems to be the age of driver.

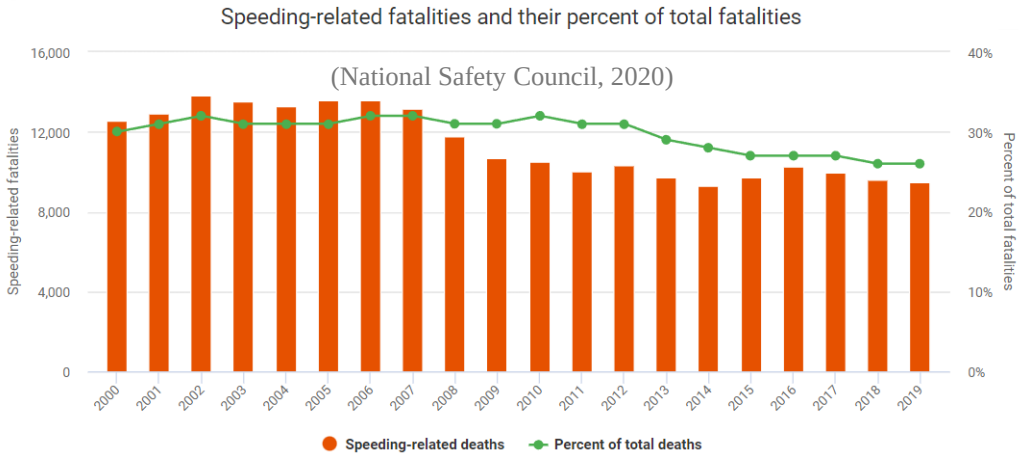
NHTSA's (2005) research has shown and clarified that every younger age group is increasingly involved in a fatal vehicle accident. In particular, drivers between 16 and 24 years old seem to be the most hazardous based on this research.

An other main factor -as mentioned by the research- is the vehicle type. It has been observed that the death toll is significantly lower in SUV types compared to smaller vehicle types. Also, the number of deaths in road accidents, where the vehicles rolled over, is overwhelmingly lower in SUV types.

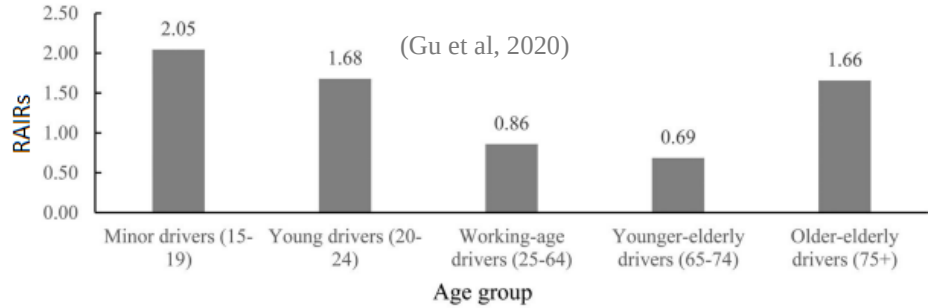
This research aims:

- to clarify the effect of vehicle type, vehicle age and drivers age to driving behavior, with direct application to the Greek reality
- to examine the potential differentiations of driving behavior between main road sections (tangents, curves etc.) and interchange ramps
- to clarify the range of velocities that can be applied in interchange ramps of different radii, by different age drivers, by different vehicle types and by different vehicle ages
- to investigate the criticality of the above factors in driving behavior
- to try to explain (based on high accuracy velocity recordings) the reason why younger drivers are more involved (than each other age group) in fatal accidents

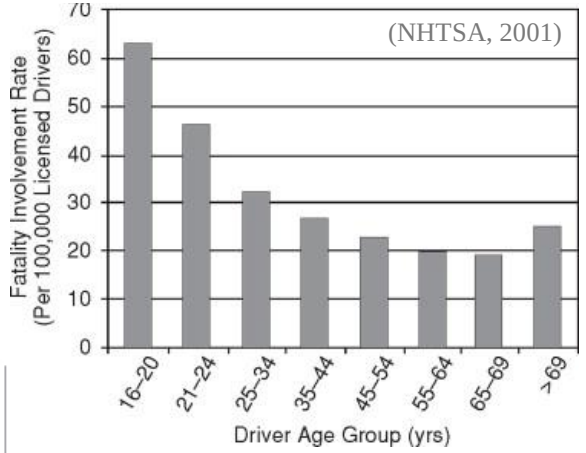
Past Studies (1/2): The Influence of Drivers Age



(National Safety Council, 2020)



(Gu et al, 2020)



(NHTSA, 2001)

(Horberry et al. 2006)

Age Group (years)	Minimum Speed (km/h)
Under 25	32.46
30-45	17.23
Over 60	11.76

Based on the Figures & the Table is observed that:

- between 2001 and 2019 the driving speed was a major fatal accident factor, as there were years when the death toll exceeded 12,000-13,000 and the fatality rate (caused by this factor) exceeded 30% (National Safety Council, 2020)
- based on RAIRs (Relative Accident Involvement Ratios) the teenage drivers (15 to 19 years old) are more often involved in a road fatal accident (Gu et al, 2020)
- in 2001, in United States the most fatal driver age was between 16 and 20 years old, followed by drivers between 21 and 24 years old and over than 69 years old (NHTSA, 2001)
- in hazardous conditions the age group of drivers up to 25 years old, maintained almost twice speed compared to the drivers between 30 and 45 years old and almost three times compared to the drivers over 60 years old (Horberry et al. 2006)

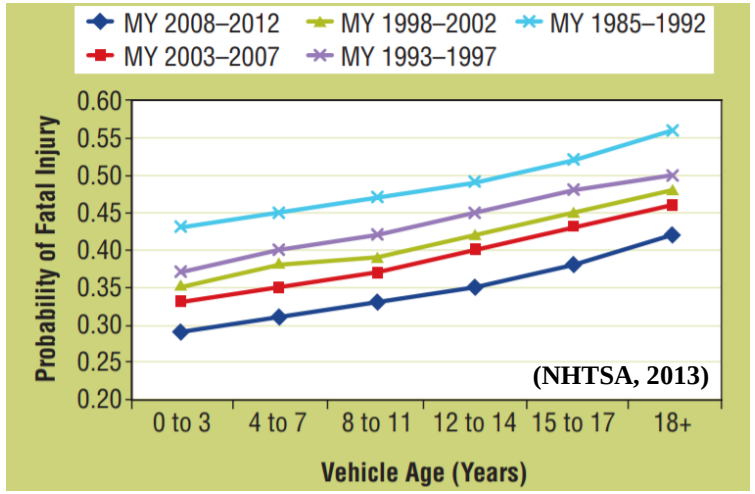
Past Studies (2/2): The Influence of Vehicle Type & Age

(NHTSA, 2006)

	Fatalities in all crashes		Fatalities in rolled over vehicle	
Year	Passenger Vehicles	SUV	Passenger Vehicles	SUV
1997	32,448	2,380	9,527	1,489
1998	31,899	2,713	9,773	1,705
1999	32,127	3,026	10,140	1,902
2000	32,225	3,358	9,959	2,064
2001	32,043	3,530	10,157	2,149
2002	32,843	4,031	10,729	2,471
2003	32,271	4,483	10,442	2,661
2004	31,693	4,735	10,553	2,920
Total	**257,549**	**28,256**	**81,280**	**17,361**

(Jayaratne & Kumarage, 2005)

	Fatal Accidents Involvement	
Year	Small/Medium Vehicles	SUV
2001-2002	267	111



Based on the Tables & the Figure is observed that:

- for the years between 1997 and 2004, fatalities in all crashes were 9 times more in passenger vehicles (of any size) than in SUV types (NHTSA, 2006)
- In 2001 and 2002, small or medium vehicles were involved in 267 fatal recorded accidents while SUV were involved in 111 additional fatal accidents. (Jayaratne & Kumarage, 2005)
- Every newer technology vehicle is safer than every older one, because the probabilities of any driver of newer technology vehicle being fatally injured are significantly lower (NHTSA, 2013)

Data Collection (1/2): Methodology & Measuring Equipment

Info about the methodology:

■ the data collection took place using followed observer method, i.e. the equipped (researcher's) vehicle was following the leading one with the same velocity (always trying to maintain a stable distance), the same braking (regarding the intensity and the position of the braking), etc., desiring each reaction to reflects -as much as possible- the motion of the leading vehicle

■ the measurements used in the research, are them the examined drivers consented to their use, while this experimental procedure was not made known to the drivers of leading vehicles before the end of their recording

■ after the recording procedure, the age group of the examined leading vehicle was accurately determined, identifying the characteristics of the model with the standards of the automotive industry from which was designed

■ the measurement procedure took place during morning hours of every weekend between 4th January and 1st March 2020. The prevalence of good weather conditions was essential for the success of the procedure, because the road was completely dry and the recorded velocities and the inherent driving behavior could not be affected by weather conditions

■ for each driver, according to the data of his recording, a characteristic velocity value was obtained corresponding to his passage through the curve of the ramp

■ the velocity recording of the leading vehicle started many meters before the curve (within the previous tangent) until the exit from the ramp, in order to be created a complete speed profile for each driver

Info about the measuring equipment:

■ VERICOM 4000RG is a 3D accelerometer that has a built-in coordinate recorder and offers the ability to export the elements of road horizontal and vertical alignment

■ utilizing the built-in GPS the recordings of position coordinates and velocity every 0.01 second were made

■ measurements were rejected when the motion of the leading vehicle was hindered by another vehicle or/and the driver of the leading vehicle decelerated unnecessarily, or/and the drivers of the leading vehicles did not approve the inclusion of their driving behavior in the experiment

Data Collection (2/2): Selected Interchange Ramps & Sample Size

The selection of the examined ramps was based on the following conditions. At least:

- one ramp with less than 40 meters radius
- one ramp with radius between 40 and 100 meters
- one ramp with more than 100 meters radius

and at the same time was preferred the selection of:

- ramps of similar radii for comparison of results
- different ramp types

Regarding the sample participated in this research:

- the initial sample size included the total participants in the measuring procedure
- the final one is much more lower, because of plenty of the recorded (or under recording) measurements were rejected and were not used in the final analysis, due to the aforementioned reasons

Kifisias Interchange, 28 meters radius horizontal curve (clover part)

Kimis Interchange, 34 and 50 meters radii horizontal curves (trumpet)

Kapodistriou Interchange, 33 meters radius horizontal curve (diamond part)

Alimou Interchange, 175 and 39 meters radii horizontal curves (trumpet)

Results (1/4): Velocity within the Curve and Driver Age Group

Table: Maximum, mean and minimum velocity for each age group in interchange ramps branches

Age Group (Years)	Max. Velocity (km/h)	Mean Velocity (km/h)	Min. Velocity (km/h)	Sample Size
20 to 30	93	48	28	69
30 to 40	86	46	30	58
40 to 50	72	46	30	38
50 to 60	65	41	27	43
Over 65	61	38	27	13

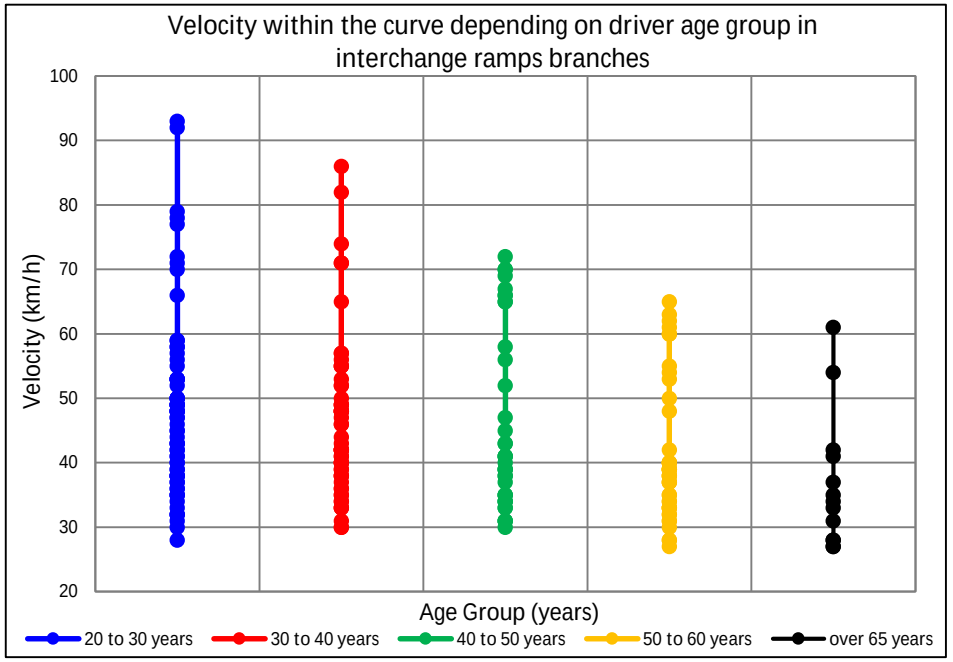


Figure: Velocity within the curve depending on driver age group in interchange ramps branches

Observations regarding the presented Table & Figure:

- every point of the figure may reflect for more than one recorded velocity value
- the youngest age group (drivers 20 to 30 years old) is the fastest one and drivers 30 to 40 and 40 to 50 years old are following
- however, the velocity values deviation between the drivers 20 to 30 years old and 40 to 50 years old is not significant, regarding the mean velocity
- on the contrary, regarding the maximum velocity, this deviation is much higher
- drivers 20 to 40 years old feel more comfortably than the older ones, because they apply higher maximum velocity values

Results (2/4): Velocity within the Curve and Vehicle Type

Table: Maximum, mean and minimum velocity for each vehicle type in interchange ramps branches

Vehicle Type	Max. Velocity (km/h)	Mean Velocity (km/h)	Min. Velocity (km/h)	Sample Size
Hatchback	71	40	27	102
Sedan	82	46	28	81
SUV	93	52	32	40

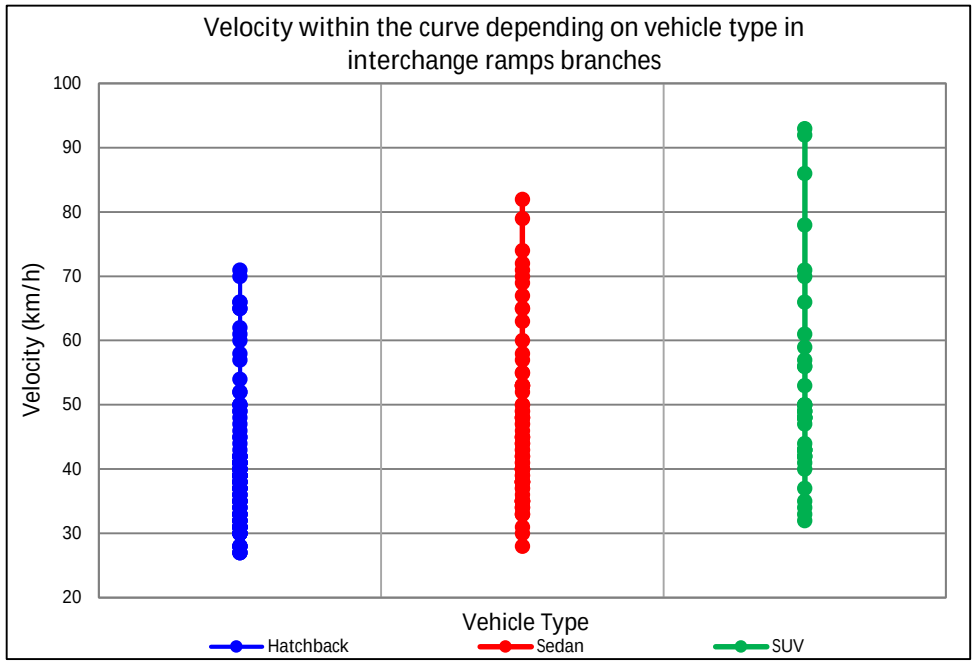


Figure: Velocity within the curve depending on vehicle type in interchange ramps branches

Observations regarding the presented Table & Figure:

- every point of the figure may act for more than one recorded velocity value
- drivers of larger vehicles move with higher velocity than the drivers of smaller ones
- specifically, drivers of SUV feel more comfortably than drivers of other vehicle types and this can be confirmed for all velocity values (minimum, maximum, mean), by checking the significant deviation, mainly, in the mean and the maximum velocity values.
- based on the total measurements, the larger vehicles offer higher sense of safety for the driver.
- taking into account that larger vehicles can usually reach higher velocity, are leading their drivers to apply significantly higher velocity values.

Results (3/4): Velocity within the Curve and Vehicle Age Group

Table: Maximum, mean and minimum velocity for each vehicle age group in interchange ramps branches

Vehicle Age Group (Decade)	Max. Velocity (km/h)	Mean Velocity (km/h)	Min. Velocity (km/h)	Sample Size
1990s	65	40	30	30
2000s	78	44	28	100
2010s	93	47	32	93

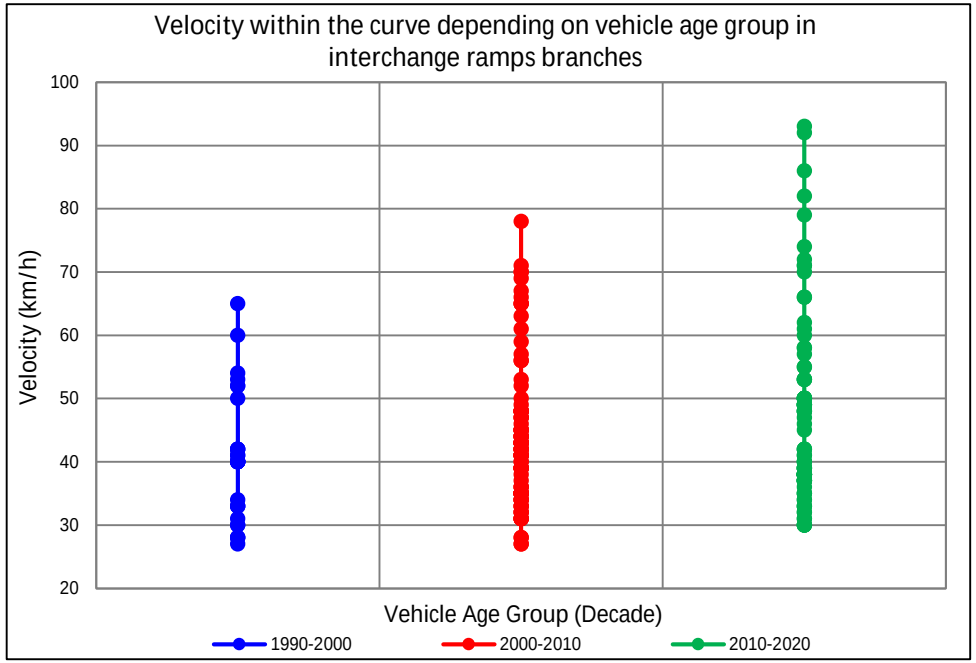


Figure: Velocity within the curve depending on vehicle age group in interchange ramps branches

Observations regarding the presented Table & Figure:

- every point of the figure may act for more than one recorded velocity value
- the newer vehicles enable drivers to apply higher velocity values and to feel safer in this application
- for newer vehicles, in addition to the significant deviation between the mean velocity values, there is an even greater deviation in the maximum velocity values
- every next decade the equipment of vehicles is enriched with more innovative systems, which offer real comfort and safety, but also a greater sense of the above and as vehicles manufacturing technology is evolved, drivers feel more comfortably applying higher velocity values.
- the sample size for 1990s vehicles is the smallest one, because the vehicles of this decade are no longer frequently circulated
- however, it must be mentioned that the 13% of the sample belongs to very old vehicles, something which automatically reduces the provided road safety level.

Results (4/4): Vtangent - Vramp and Driver Age Group

Table: Maximum, mean and minimum Vtangent - Vramp for each age group in interchange ramps branches

Age Group (Years)	Max. (km/h)	Mean (km/h)	Min. (km/h)	Sample Size
20 to 30	26	17	1	33
30 to 40	32	18	6	40
40 to 50	36	23	7	29
50 to 60	40	27	8	47
Over 65	45	29	12	15

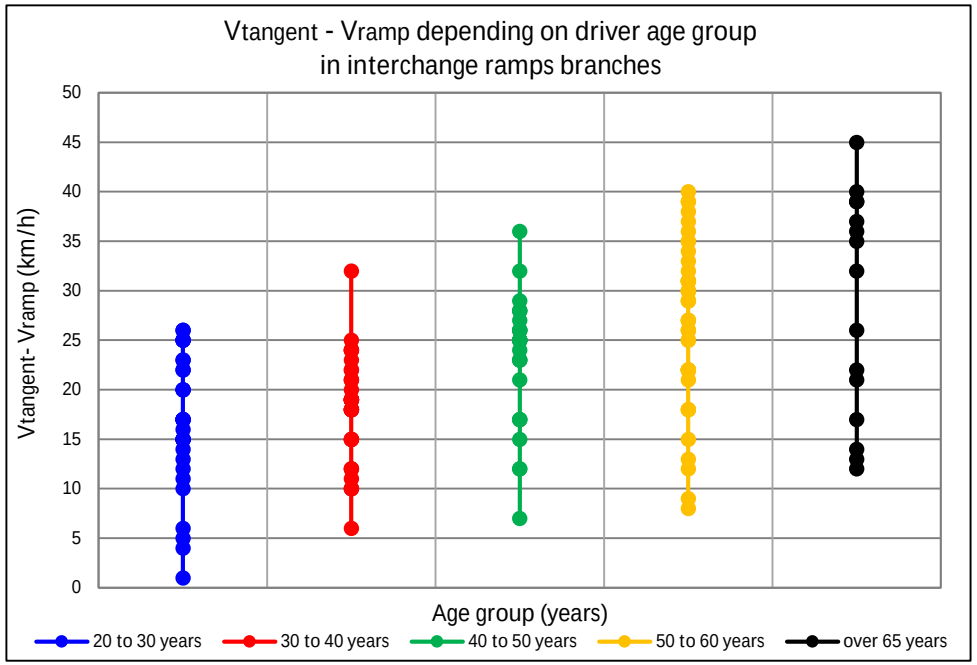


Figure: Vtangent - Vramp depending on driver age group in interchange ramps branches

Observations regarding the presented Table & Figure:

- every point of the figure may act for more than one recorded velocity value
- the deviation between the velocity in the tangent and the corresponding one within the ramp increases while drivers age increases, too
- this increase seems to be smooth, regarding the maximum and minimum differences in each age group, while the same trend is followed by the mean values
- the above finding is explained by the driver's sense of safety and the inherent driving behavior
- older drivers feel less comfortably during their transition from the tangent to the curve of ramp, reducing -with a faster rate- the applied velocity between these road sections
- on the contrary, younger drivers feel safer while transitioning from the tangent to the curve of ramp, as evidenced by the data for drivers between 20 and 40 years old
- the difference between Vtangent and Vramp (Vtangent - Vramp) seems to be a representative element of driving behavior, given that in previous analyzes it was found that the applied velocity of younger drivers is much higher than the corresponding one of older drivers

Conclusions

- Younger drivers apply higher velocity values than the older ones.
- Drivers between 20 and 40 years old feel more comfortably applying higher velocity values than the older drivers.
- Interchange ramps branches are treated more conservatively by older drivers as opposed to younger ones.
- Drivers between 40 and 50 years old keep stable velocity without applying higher or lower velocity values, probably because of their driving experience.
- Drivers of larger vehicles apply higher velocity values compared to drivers of smaller vehicles.
- Specifically, drivers of SUV feel more comfortable and safe applying high velocity values.
- The above conclusions confirm that vehicle type affects driving behavior.
- Drivers of newer vehicles apply higher velocity values than drivers of older vehicles.
- The vehicles of every next decade can reach higher velocity values (and at a faster rate) than vehicles created the decade before. This capability seems to significantly influence the driving behavior.
- It seems that vehicle type and age influence driving behavior more crucially than drivers age, because of the higher deviation values between the different categories in vehicle analysis in contrast to age analysis.
- That high percentage of 1990's vehicles still in circulation, has to be worrying.
- It is obvious that interchanges do not affect the driving behavior (based on human factor) more than other main road sections (tangents, curves, etc.).
- It is observed that younger drivers (20 to 40 years old) do not significantly reduce their velocity, while transitioning from the tangent to the curve of ramp, although they choose to apply significantly higher velocities. The above observation reinforces the conclusion that the drivers of this age group feel more comfort and safety applying high velocity values.
- Higher velocity values applied by younger drivers may be a causal factor regarding the high fatal rate of these age groups.

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THANK YOU VERY MUCH!!

QUESTIONS?