CHANGES IN EXPOSURE AND ACCIDENT RISK FOR CAR DRIVERS IN FRANCE

Hélène Fontaine
Institut National de Recherche sur les Transports et leur Sécurité
Arcueil, France
Paper Number 98-S6-W-38

ABSTRACT

This paper aims at analyzing changes in risk exposure as revealed by the last two travel surveys carried out in 1981-82 and 1993-94, and at assessing variations in accident risk by linkage with accident data for the corresponding periods. The findings show that car trips are on average longer and faster in 1994, but there is still a lot of very short journeys. The proportion of female and elderly people in the driver population is increasing. Trip purposes still differ according to driver sex. Linkage with accident data reveals a general decrease in the risk per kilometer traveled, tending to confirm the hypothesis of a general improvement in driving standards.

INTRODUCTION

The quantitative analysis of road safety issues is based on study of the distribution of accidents and victims. But in order to target prevention efforts more accurately in this field, one has to identify the high-risk groups. This means comparing accident data with reference populations, i.e. with risk exposure data. Risk exposure may be represented by different indicators, such as inhabitants, cars, driving licenses, kilometers traveled, journey times, etc. Reference indicators are generally selected with a specific objective in view, and the choice naturally affects the results of risk assessment, particularly the hierarchy of high-risk groups.

Data for injury accidents are taken from official statistics drawn up on the basis of Police reports. Exposure data are generally more difficult to obtain, hence the usefulness of transport surveys such as the French National Personal Transportation Survey. Through trip notebook attributed to each vehicle, it provides substantial information about vehicles and their drivers, distances traveled, time spent driving and trip purpose.

The aim of this paper is to present an analysis of these notebooks and to evaluate the changes in exposure characteristics and in accident involvement by comparing the data from the last two transport surveys carried out in 1881-82 and 1993-94 and police accident data for the same periods.

DATA AND METHODS

Data Source and Population Studied

The purpose of the French National Personal Transportation Survey is to produce a picture of the driving habits of households in France (Saglio et al, 1993). The results obtained may serve to measure structural changes insofar as this type of survey is conducted approximately once every decade (in 1959, 1966-67, 1973-74, 1981-82 and 1993-94).

The data collected from May 1993 to April 1994 concerned a sample population of 20 000 households. Each household was interviewed on two occasions, and between the two visits a car trip notebook was attributed at random to one vehicle in the household, to be completed by the driver(s) of the vehicle concerned over a 7-day period between the two visits. The driver had to note the characteristics of the trip at each stop, including the number of kilometers traveled and the time of day of the journey. All stops had to be mentioned, including those made to drop off or pick up passengers, but excluding stops at traffic lights, level crossings, etc.

The vehicles concerned by the notebook included private cars, small vehicles requiring no driving license, camping cars or light utility vehicles (vans). For the purposes of our analysis we concentrate on private cars only.

Allowing for households which were not main places of residence and consequently were not included in the survey, and for non-responses, 9 515 log books were properly completed and described 197 003 journeys (Armoogum and Madre 1995). 8 783 of these notebooks were for private cars and described 183 450 journeys. A comparison of the results produced by the car notebooks with other sources of information, including daily journey descriptions, shows that the weekly notebook method can be used to observe 83 % of annual mileage (Madre, 1996).

In the previous French National Personal Transportation Survey, conducted from March 1981 to February 1982, a sample of 2 677 exploitable car notebooks describing 55 334 journeys was available (Fontaine and Saint-Saens, 1988).

Accident data used for the risk evaluation were drawn from the Road Traffic Injury Accident Analysis Bulletins (BAAC) compiled by the French police for each injury accident. We took accident data from the BAACs corresponding to the two transport survey periods when cars where involved, i.e. 259 656 cars in 1981 and 167 854 cars in 1993-1994.

Method

Accident risk may be evaluated using various indicators which correspond to different objectives. The following are the most commonly used*.

- The number of accidents or victims per year represents the risk to the community.
- The number of accidents or victims related to the number of inhabitants is often used in international comparisons of road safety, since it is the most readily available criterion. It is also used to analyze the risk associated with different types of accident, such as domestic accidents, aggressions, suicides, disease, etc. It is mainly a public health criterion. But strictly in the road safety field, it does not reveal any differences in the mobility patterns of the different populations concerned.
- The number of accidents or victims related to the number of vehicles gives a clearer idea of the mobility pattern, and also allows for the degree of motorisation in international comparisons, but it does not allow for the different types of vehicle use. It is often used, nevertheless, in particular by insurance companies, to calculate their premiums.
- The number of accidents or victims related to fuel consumption takes mobility into account, but does not provide differential results.
- The number of accidents or victims related to distance traveled, or time spent driving are indicators currently used in road safety. The time factor introduces the notion of mean journey speed. The relative risk obtained using this indicator amplifies the gaps between groups who drive at very different speeds : "fast" drivers represent a greater relative risk per unit of time than per unit of distance.

Our aim was on the one hand to analyze the change in risk exposure as revealed by the vehicle note books from the last two transport surveys, and on the other to assess the change in the road accident risk by comparing these data with the accident data for the corresponding periods. We used an aggregated approach, comparing different driver groups defined according to their socio-demographic characteristics. The journeys were analyzed according to distance traveled, time taken and mean journey speed. The mean speed includes stops at red lights, road junctions, level crossings, etc. It corresponds to the mean speed for all the kilometers traveled by the group concerned. While less informative than spot speed, which is a particularly important criterion in accidentology, but difficult to measure in the event of a collision, mean journey speed does reflect the behavior of different groups of drivers. It must be remembered, however, that it is closely linked to the type of road network used. This geographical criterion was not revealed by the vehicle log books, since previous tests had demonstrated that the quality of this data collected over a one-week period was unsatisfactory.

The relationships with car characteristics are also examined but only for the last Transport survey insofar as these criteria were not registered in the previous survey.

EXPOSURE CHARACTERISTICS AND CHANGES

General Results

The average number of car journeys in the course of a week increased little between the two surveys (20.7 journeys per week in 1981-82 vs. 20.9 in 1993-94), i.e. three journeys per day. The average journey distance rose from 10.1 km to 11.8 km. Mean journey time also rose, but to a lesser degree, from 16.5 minutes in 1981-82 to 17.7 minutes in 1993-94. The distances traveled were covered at a higher speed, mean journey speed increasing by almost 10%, from 36.7 km/h to 40.1 km/h. While the proportion of short journeys was smaller in 1993-94 (Figure 1.), it was still high, with 52% of all car journeys no longer than 5 km, compared with 58% in 1981-82.

Average journey speed increases with the distance traveled. The reason for this is that the longer the journey, the smaller the part spent on urban roads, where the speed limit is lower. Note that for the same distance, the average speed increased between the two surveys. The greater increase in speed over longer journeys may be due to the development of the motorway network, particularly in periurban areas around major conurbations. This stagnation in the number of journeys, accompanied by an increase in the distances traveled and in speed, is found in the analysis of all types of transport (Orfeuil, 1996).

* We don't mentioned here exposure indicators based on non at fault drivers (induced exposure method)

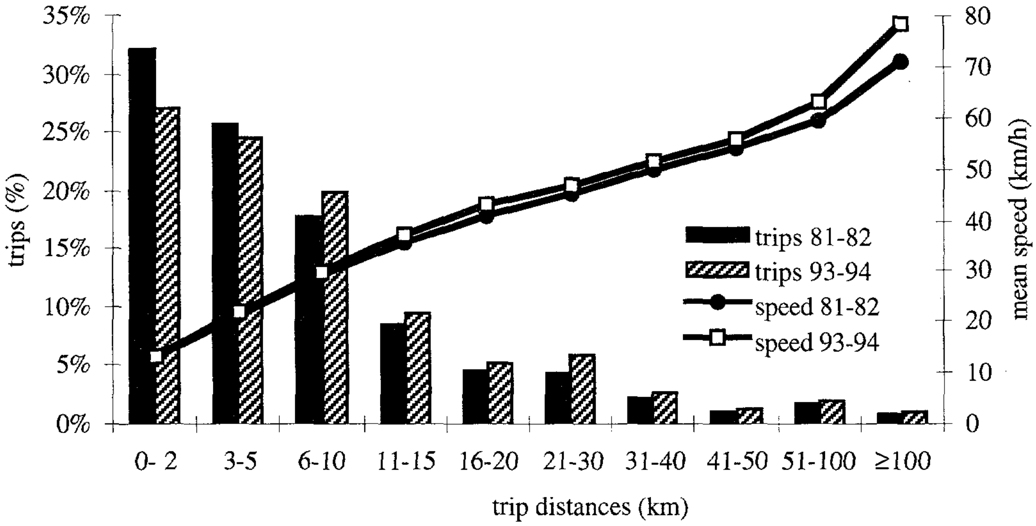

Figure 1. Car journeys and mean speed according to distance traveled.

Table 1.
Exposure Characteristics According to Sex and Age of Driver

	km traveled %		mean journey distance km		mean journey time mn		mean journey speed km/h	
Year	81-82	93-94	81-82	93-94	81-82	93-94	81-82	93-94
Sex								
men	74.2	66.4	11.6	13.8	18.0	19.5	38.6	42.5
women	25.8	33.6	7.3	9.0	13.6	15.2	32.4	35.8
Age								
< 20	1.9	1.4	10.9	12.1	16.8	19.2	39.1	37.7
20 à 24	11.4	8.6	10.3	12.5	16.4	17.7	37.5	42.3
25 à 34	31.5	25.8	9.5	11.3	15.5	16.7	36.7	40.6
35 à 49	33.0	37.9	10.1	11.5	16.5	17.2	36.7	40.1
50 à 64	18.1	18.8	10.9	12.7	17.9	19.2	36.5	39.6
≥65	4.0	7.6	10.9	11.6	18.2	18.9	36.2	36.8
Together	100	100	10.1	11.8	16.5	17.7	36.7	40.1

Exposure Characteristics According to Sex and Age of Driver

Female drivers accounted for 33.6% of the kilometers traveled in 1993-94 compared with 25.8% in 1981-82 (Table 1.). The share of journeys made by female drivers rose from 35% in 1981-82 to 44% in 1993-94. Women made up 43% of regular or occasional drivers in 1993-94, up from 38% in 1981-82. The distances they travel are shorter than those traveled by men (9 km on average, compared with 13.8 km for men in 1993-94), and the average speed slower (35.8 km/h for women and 42.5 km/h for men). This reflects the higher proportion of urban driving done by women. This is borne out by the SOFRES panel survey on car driving (Fontaine and Gourlet, 1996), which showed that in 1994, 37% of the distance driven by female drivers was on urban roads and 17% on motorways, compared with 30% and 22% respectively for men.

The aging of the population and the fact that the number of years during which people drive has increased, enabling them to participate more in social life (Chich, 1991), have contributed to the larger share of elderly people in the driving population. The share of kilometers driven by drivers age 65 or over increases from 4% in 1981-82 to 7.6% in 1993-94. Mean journey length varies little with driver age, but the highest mean speeds are observed in the under-20 age group in 1981-82 and in the 20-24 age group in 1993-94. The lowest speeds are observed in the 65-and-over age group in 1993-94. This is also the age group for whom the percentage of urban mileage is lowest, probably because at this age there are no daily journeys to and from work (which often involve more urban driving) and because elderly people more often live in rural area. The lower mean journey speeds may therefore indicate a more "careful" style of driving among senior citizens.

The analysis also reveals a decrease in the share of mileage traveled by young drivers and an increase in that of drivers in the 35-49 age group. This may correspond to the time of life when many households buy themselves a home and move out of the city into the suburbs and also to the demographic changes.

Trip Purposes

As in the previous survey, work-related travel (driving to work and back, and professional journeys) represents 30% of kilometers traveled (Fontaine and Saint-Saens, 1988). Distance traveled and mean journey speed are higher than average for leisure trips (18.4 km and 47.2 km/h in 1993-94). The smallest trips are for accompanying children (5.2 km in 1993-94).

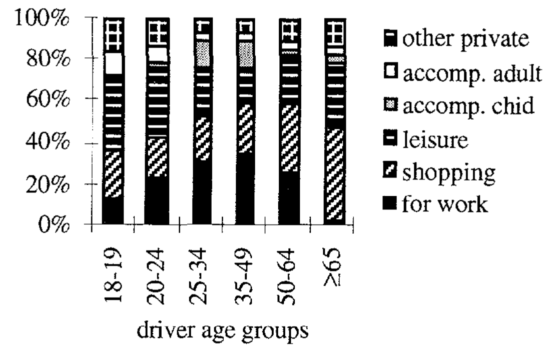

Figure 2. Breakdown of trips made in 1993-94 according to driver age.

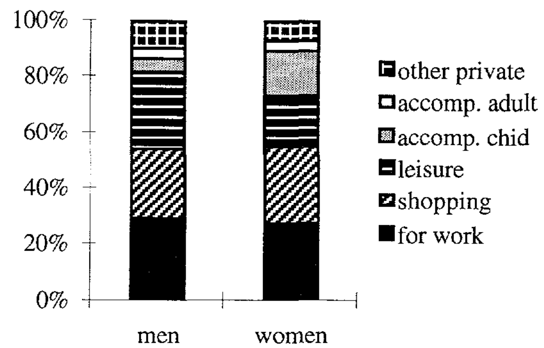

Figure 3. Breakdown of trips made in 1993-94 according to sex of driver.

Reasons for journeys made differ according to age and sex of driver. The breakdown of trip purpose according to driver age (Figure 2.) reflects the different stage of the life. Work related trips are less frequent for young drivers and also for those over 65. This corresponds to students and retired people. In the same way, leisure trips are more frequent for these age group.

Accompanying children is more frequent between 25 and 40 years old, when people have young children. Shopping represents nearly half of the trips made by the elderly age group.

We had already noticed in the 1981-82 survey that the type of vehicle use differed considerably with the sex of the driver : women generally used their vehicles for shopping or for driving people back and forth (Fontaine, 1988). This still applied in 1993-94 : 15% of the journeys made by women were made to take a child somewhere, compared with only 5% of journeys made by men for the same reason (Figure 3.).

The mean distance traveled by a woman accompanying a child is 4.8 km, compared with 6.4 km for a male driver accompanying a child. Work-related travel vary little in frequency between male and female drivers, but men drive longer distances on average than women (12.8 km and 9.2 km respectively to travel to a fixed place of work in 1993-94).

Taking all types of journey together, men are less frequently alone in their cars than women (61% of men and 64% of women make journeys alone in their cars). The difference is greater for shopping (58% of men alone vs. 64% of women alone) and for journeys for leisure (42% of men alone vs. 51% of women alone). This may be the consequence of a traditional attitude : when a couple go somewhere by car, it is usually the man who drives. The journeys most often made alone in the car are journeys to and from work (90% of women alone and 88% of men alone).

Table 2.
Exposure Characteristics According to Car Characteristics in 1993-94

	km traveled %	mean journey distance km	mean journey time mn	mean journey speed km/h
Age (years)				
<3	25	14.5	20.1	43.5
3-4	21	12.7	18.4	41.4
5-9	36	11.3	17.1	39.8
≥10	18	9.3	15.6	35.7
Mass (kg)				
< 800	22	9.3	15.6	35.6
800 - 1000	41	11.3	17.3	39.2
> 1000	37	14.5	19.4	44.7
Power (kw)				
< 40	20	9.2	15.7	35.3
40 - 49	31	11.8	17.5	40.3
50 - 69	36	12.6	18.2	41.4
≥70	13	14.5	19.2	45.2

Exposure According to Car Characteristics

The results concern only the period 1993-94 because the previous survey did not take into account car characteristics such as mass and power. Table 2. shows that mean trip distance increase with car mass and power and decrease with car age. New big vehicles make more kilometers than old small cars. In the same way, mean journey speed increase with car mass and power and decrease with car age, insofar as the longer the trip the longer the part spent outside urban area and motorways.

RISK EVALUATION AND CHANGES

We privileged the distance traveled as the exposure risk indicator since it is one of the most commonly used in road safety, but some results are also given for time spent driving as exposure.

General Results

Between the periods analyzed, mobility increased by 51%, with more cars on the road and drivers covering larger distances. At the same time, the number of injury accidents decreased. Consequently, the accident risk in terms of the number of accidents per kilometer traveled decreased. For the car driver population the risk decreased by 61%, from 1.5 injury accidents per million km traveled in 1981-82 to 0.6 injury accidents per million km traveled in 1993-94.

This decrease in risk, observed in numerous countries, confirms the classical hypothesis of a process of "collective learning" in motor vehicle driving (Brenac, 1989). Improvements to the inter-city motorway network may also have played a role in reducing the accident risk, insofar as motorways are among the safest roads, with a high traffic capacity. This could explain the increase in mobility in terms both of mean journey speed and of the number of vehicle-kilometers.

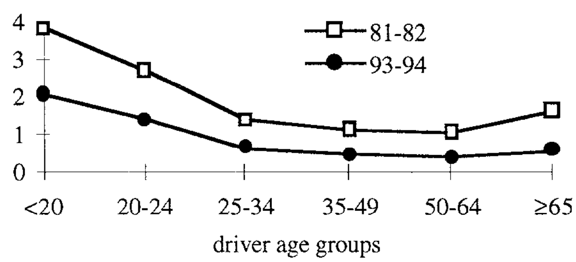

Figure 4. Injury accidents per million km according to driver age.

Risk by Age and Sex

The shape of the injury accident risk curve per km according to driver age groups is the same in 1981-82 and in 1993-94 (Figure 4.). The highest risk is observed among very young drivers, and is explained partly by their inexperience ; the risk then decreases to reach its lowest levels in the 35-64 age group, before increasing again for drivers age 65 and over, although this increase is more marked in 1981-82 than in 1993-94. The largest relative decrease in risk between the two surveys is observed in the elderly driver group (66% decrease in the accident rate of drivers age 65 and over), and the smallest relative decrease is that of young drivers (49% decrease between the two surveys).

Taking all age groups together, the injury accident risk related to distance traveled in 1993-94 was 1.2 times higher for men than for women. And the risk of a fatal accident was 1.9 times higher for men than for women. These ratios are comparable to those recorded in the earlier survey.

The analysis of the SOFRES survey on vehicle use (Fontaine and Gourlet, 1996) reveals that taking non-injury and injury accidents together, women have a higher accident rate per million kilometers (19.5) than men (14.8). This higher involvement in non-injury accidents (with material damage only) may be explained by the relatively greater share of urban driving. The APSAD (1994) also noted that although the frequency of (non-injury and injury) accidents was higher among female drivers, the average cost was lower.

When driver sex and age are taken into account, the traditional results appear again (Table 3.), but the differences are much less marked in the case of women. Young men are at much greater risk than young women. This excess risk exposure of young men is a finding commonly observed in road safety studies. Women age 65 and over, on the other hand, are at greater risk of injury accident involvement than men of the same age, probably because they are less accustomed to driving.

For some authors (Chipman et al, 1993) the accident risk related to journey time is more pertinent than the risk related to distance traveled, insofar as the time drivers take to cover a given distance is the reflection of their perception of risk. When comparing the two criteria, however, the environment criterion must be checked so as not to confuse congested urban traffic situations and difficult driving conditions on small country roads.

When time spent driving is considered as exposure measure (Table 4.), the highest risk groups are also drivers under 25 years old, particularly men. But whereas women age 65 and over are at greater risk over a given distance than men of their generation, when journey time is taken into account, women are at less risk than men for a given driving time whatever the age group. Similar results are found in Ontario (Chipman et al, 1993).This corresponds to their different journey speeds. The mean journey speed for women age 65 and over is 31.2 km/h, compared with 38.3 km/h for men in the same age group. This may be explained by the more urban nature of the journeys made by women, but also by the difference in their driving experience, elderly women often having started to drive later in life. This difference in the age at which men and women start to drive is tending to disappear (Fontaine and Hubert, 1997), so it is possible to assume that the excess accident risk per km driven to elderly women compared with elderly men will decrease further.

Table 3.
Injury Accidents per Million Kilometers in 1993-94

driver age	driver sex	
	men	women
<20	2.4	1.5
20-24	1.7	0.9
25-34	0.8	0.5
35-49	0.5	0.4
50-64	0.4	0.5
≥65	0.5	0.6

Table 4.
Injury Accidents per Million Driver Hours in 1993-94

driver age	driver sex	
	men	women
<20	90.9	54.0
20-24	74.1	35.7
25-34	33.3	18.8
35-49	21.8	15.3
50-64	17.7	16.7
≥65	20.8	18.6

The high-risk groups are the same in both cases : male drivers under 25 years of age. The behavior of young men at the wheel is often blamed for the excess risk. It is also suggested that they drive in more difficult conditions (Massie and Campbell, 1993). Young drivers, particularly young men, drive more frequently at night : 19% of their mileage is done between 8 p.m. and 5 a.m., whereas all drivers together travel 10% of their mileage during the same period of time (Fontaine and Hubert, 1997). For the same distance driven at night, they are more likely to be involved in accidents than any other driver category. Note that other factors, such as drinking, type of road and vehicle, number of vehicle occupants and type of journey, with peers or family, very certainly play a part.

Risk According to Car-Driver Characteristics in 1993-94

Among car characteristics, age is the most registered data : there is 3% of unknown data for this in the accident database and that of the Transportation Survey. The other criteria linked to power and mass are a lot less well known because the code which makes it possible to identify them is often wrongly coded especially in the accident database. It appears that the number of unknown classification numbers is higher for older vehicles so we firstly estimated the risk of involvement according to the age of vehicles and then we considered the other criteria, taking into account car age groups to limit biases.

Car Age - Table 5. gives the rates of injury accident involvement per million km traveled according to car age. The highest risk is observed for vehicles more than 10 years old. This has already been observed in previous study (Fontaine et Saint-Saens, 1988).

Table 5.
Risk of Accident per Million Kilometers

car age	accident per million km
less than 3 years	0.47
3 to 4 years	0.49
5 to 9 years	0.57
10 years and more	0.75
Together	0.56

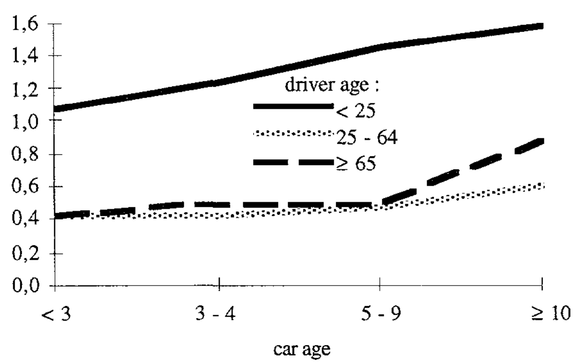

Figure 5. Accident involvement per million km traveled according to car and driver age.

Older vehicles are more frequently driven by young drivers. Thus, drivers under 25 do a quarter of their mileage in vehicles which are 10 years old or more whereas this only accounts for 17% of the mileage of drivers over 25 (Fontaine et al, 1997). It is therefore important to take the age of drivers into account as the under 25s show an over-risk compared to older drivers. Figure 5. shows that the age of drivers differentiates the risk more strongly than vehicle age. Thus the rate varies from 0.4 accident per million km for the 25 to 64 year group driving a vehicle less than 3 years old to 1.6 accident per million km for the under 25s at the wheel of a vehicle more than 10 years old. We can also observe a higher risk in the over 65 group driving a vehicle more than 10 years old. However, in terms of stakes, the latter group of users only accounts for 1.8% of accidents and 1.1% of kilometers driven.

Car Mass and Performance - We have seen that there is less available information about the criteria of car mass and performance in that the code is not known or is wrongly coded. Insofar as this missing data is more frequent for older vehicles, we estimated a risk of involvement in accidents according to mass and performance for vehicles less than 10 years old.

Firstly, the performance was estimated by the power of the vehicles which was crossed with the mass in order to identify the effect of small sports models (Fontaine and Gourlet, 1994) then we analyzed the ratio power/mass. Some groups, for whom we had little data, if any, were not selected.

Table 6.
Accident Involvement per Million Km for Vehicles Less Than 10 Years Old.

mass	power	driver age (years)		
kg	kw	< 25	25 - 64	≥ 65
<800	< 39	1.2	0.7	0.6
<800	40-49	0.8	0.4	0.5
<800	50-69	0.7	0.5	0.6
<800	≥70	3.4	0.3	-
800-1000	< 39	0.5	0.3	0.3
800-1000	40-49	0.7	0.3	0.3
800-1000	50-69	1.0	0.3	0.4
800-1000	≥70	2.0	0.7	0.4
> 1000	40-49	1.5	0.2	0.2
> 1000	50-69	0.7	0.2	0.2
> 1000	≥70	2.3	0.2	0.2

Table 6. shows that the effect of the driver age is still very important but it is amplified by the vehicle power, especially for lighter vehicles. Thus, although globally the risk for the under 25s is nearly 1 accident per million km, this rate goes up to 3.4 when a young person drives a light sports vehicle weighing less than 800 kg with a power of 70 kw. It is to be noted that this category of small, light, fast vehicles is relatively old in that the more recent sports vehicles are also heavier. The percentage of cars bought second-hand is

probably high in this group (Girard and Michel, 1991).

If we consider the ratio mass/power (Figure 6.), the effect of age once again appears as being very important and amplified by the type of vehicle driven as the relative risk is close to 4 when a young person drives a powerful vehicle, the risk being taken as equal to 1 for all vehicles. Young drivers are far more sensitive to the type of vehicle driven than older ones.

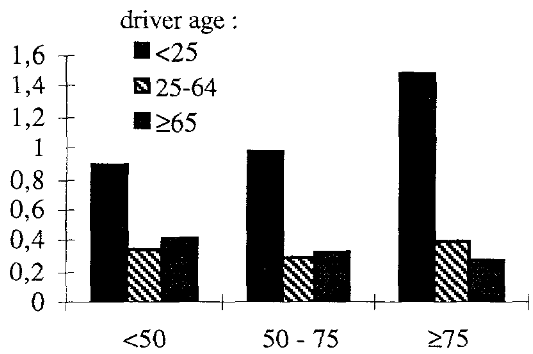

Figure 6. Accident involvement per million km for vehicles less than 10 years old.

CONCLUSION

This analysis of two transport surveys from the risk exposure standpoint show a larger proportion of women and elderly people in the driver population. Comparison with accident data reveals a general decrease in the risk per kilometer traveled, tending to confirm the hypothesis of a general improvement in driving standards. A high level of risk is always observed for young male drivers, while the excess risk previously observed among elderly drivers has decreased substantially. The category of young drivers driving light, powerful sports vehicles stands out as having a high accident involvement risk. The choice of a sports type vehicle often goes hand in hand with high risk taking, but the consequences are more serious for young drivers. The over 25 age group seem a lot less sensitive to the type of vehicle

The results show that male drivers under 25 years of age represent the highest risk group per distance driven and per time spent driving. But whereas women age 65 and over are at greater risk over a given distance than men of their generation, when time spent driving is taken into account, women are at less risk than men for a given driving time whatever the age group. This may be explained by the nature of the journeys made by women, but also by the difference in their driving experience, elderly women often having started to drive later in life. A comparison with the results of a previous travel survey carried out in 1981-82 shows that the difference in the age at which men and women start to drive is tending to disappear, as is the difference in distance traveled. Looking to the future, one can expect an increase in the proportion of elderly drivers on the roads, particularly women, accompanied by a decrease in the accident risk to these drivers. As a result, the relative risk to young drivers will appear higher.

ACKNOWLEDGMENTS

The author wishes to thank the MACIF insurance group, which part-financed this research, and Jean-Paul Hubert for his help in analyzing and exploiting the data.

REFERENCES

ARMOOGUM J., MADRE J.L. (1995) : "Correction de la non-réponse dans l'enquête transport 1993-1994 : l'exemple des déplacements quotidiens", Entretiens Jacques Cartier

ASSEMBLEE PLENIERE DES SOCIETES D'ASSURANCES DOMMAGES (1994). "Recueil de données statistiques sur l'assurance automobile" 11ème édition FFSA, Paris

BRENAC T. (1989) : "Risque d'accident et caractéristiques des déplacements et des conducteurs". Thèse de doctorat, 293p.

CHICH Y. (1991) : "Sécurité routière et solidarité entre les âges" Les cahiers de l'assurance, Risques n°5

CHIPMAN M.L., MAC GREGOR C.G., SMILEY A.M., LEE-GOSSELIN M. (1993) : "The role of exposure in comparisons of crash risk among different drivers and driving environments" Accident Analysis and Prevention Vol 25, n°2 pp. 207-211

FONTAINE H. (1988) : "Usage de l'automobile et risque d'accident" RTS n°20 pp. 5-12

FONTAINE H., GOURLET Y. (1994) : "Sécurité des véhicules et de leurs conducteurs". Rapport INRETS n° 175

FONTAINE H., SAINT-SAENS I. (1988) : "L'exposition au risque des conducteurs de véhicules légers", Rapport INRETS n°64, Arcueil

FONTAINE H.,GOURLET Y. (1996). "Mobilité et accidents, année 1994" Rapport de convention INRETS/DSCR, Arcueil

FONTAINE H.,HUBERT J.P. (1997). "Evolution de l'usage de l'automobile et du risque d'accident". RTS n°57 pp. 7-20

FONTAINE H.,HUBERT J.P., LEJEUNE M. (1997). "Exposition au risque et risque d'accident des conducteurs de véhicules légers". Rapport de convention INRETS/MACIF, Arcueil

GIRARD Y., MICHEL E. (1991). "L'accidentologie des petits véhicules légers rapides par l'analyse approfondie des accidents - 1ère partie : analyse statistique de fichier détaillé". Rapport sur convention d'étude DSCR/INRETS

MADRE J.L. (1996) : "L'utilisation de l'automobile vue à travers différents instruments d'enquête", Conférence de l'Association pour la Statistique et ses Utilisations, Québec

MASSIE D., CAMPBELL K. (1993) : "Accident involvement rate by age and gender" - UMTRI Research Review Vol 23, n°5 - University of Michigan Transportation Research Institute pp. 1-13

ORFEUIL J.P. (1996) : "La mobilité évolue, les problèmes et les solutions également" Colloque ADEME/INRETS

SAGLIO A., MAFFRE J., MARTIN P. (1993) : "Enquête transports 1993-1994, instructions aux enquêteurs", INSEE, Paris