Measures of risk exposure in travel surveys

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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 population density, motorisation rate, number of driving licences, kilometres travelled and journey times. 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 studies such as those carried out by INSEE. Through trip notebook attributed to each vehicle, they provide substantial information about vehicles and their drivers, distances travelled, time spent driving and trip purpose.

The aim of this paper is to present the first 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 by INSEE and police accident data for the same periods. Two indicators are compared : accident per kilometres driven and accident per time driving.

Materials and methods

Data source and population studied

The purpose of the INSEE Transport survey was 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 since the previous survey in 1981-1982, in which the same definitions and principles were used.

The data collected from May 1993 to April 1994 concerned a sample population of 20 000 households surveyed in 8 waves. 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 kilometres travelled 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 licence, camping cars or light utility vehicles (vans). For the purposes of our analysis we shall 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. To make sure the sample was genuinely representative, corrections were made in two stages (Armoogum, 1996) : correction of non-responses by post-stratification and correction of sampling errors by marginal adjustment. Weightings were calculated at different levels : household, person, log book.

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 percent of annual mileage (Madre, 1996).

In the previous INSEE Transport 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 (BAACs) 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[1].

- 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 analyse 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 travelled, 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.

The analysis criteria adopted were driver age and sex. This information was available for those drivers who were members of the survey households, and they represent 98.6% of the journeys. These criteria were chosen initially because many studies have shown their effect on mobility and risk, both separately and together, and these variables link up with social attitudes in respect of risk (Cauzard, 1996; Biecheler et al., 1997).

The journeys were analysed according to distance travelled, 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 kilometres travelled 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 behaviour 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.

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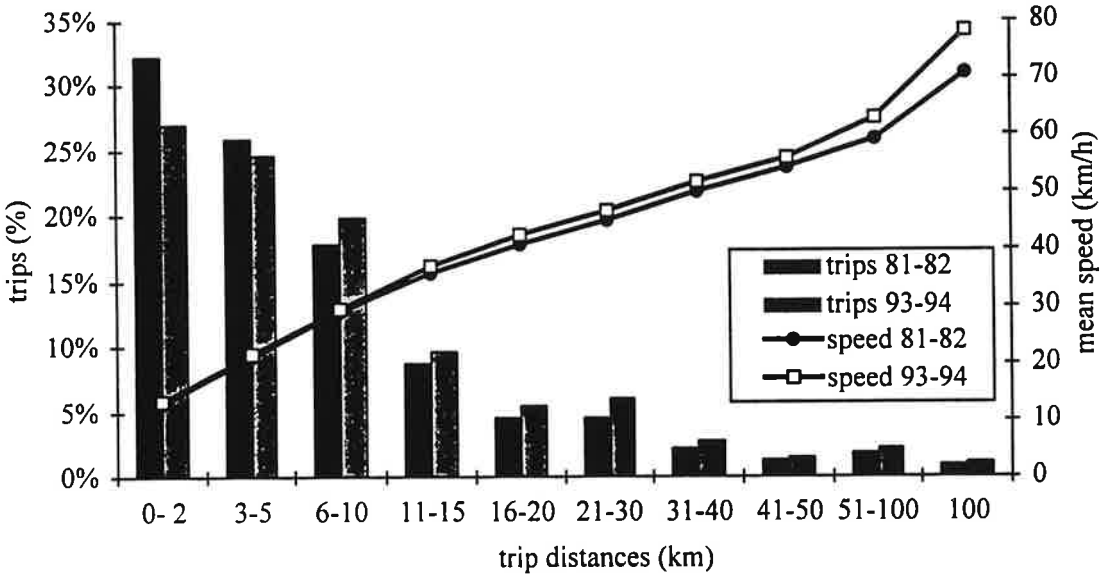
[1] We don't mentioned here exposure indicators based on non at fault drivers (induced exposure method)

Results

Exposure characteristics and changes

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 travelled 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.

Figure 1 : Car journeys and mean speed according to distance travelled



Sources : Transport surveys 1981-1982 and 1993-1994

Average journey speed increases with the distance travelled. 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 travelled and in speed, is found in the analysis of all types of transport (Orfeuil, 1996).

Female drivers accounted for 33.6% of the kilometres travelled 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 travelled 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 no doubt 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.

Table 1 : exposure characteristics according to sex and age of driver

	kilometres travelled %		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	18.4	19.8	10.9	12.7	17.9	19.2	36.4	39.6
³65	3.7	6.6	11.1	11.3	18.1	18.7	36.6	36.3
Together	100	100	10.1	11.8	16.5	17.7	36.7	40.1

Sources : Transport surveys 1981-1982 and 1993-1994

The ageing 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 kilometres driven by drivers age 65 or over increased from 3.7% in 1981 to 6.6% in 1993. Mean journey length varies little with driver age, but the highest mean speeds were observed in the under-20 age group in 1981-82 and in the 20-24 age group in 1993-94. The lowest speeds were 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 revealed a decrease in the share of mileage travelled 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.

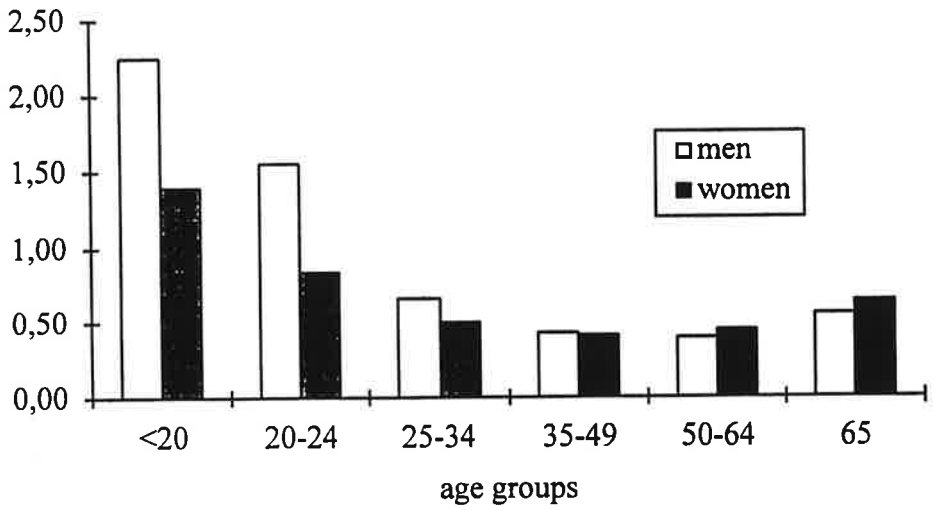
Risk evaluation

Between the periods analysed, 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 kilometre travelled decreased. For the car driver population the risk decreased by 61%, from 1.5 injury accidents per million km travelled in 1981-82 to 0.6 injury accidents per million km travelled in 1993-94.

This decrease in risk, observed in numerous countries, confirms the frequently voiced 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-kilometres.

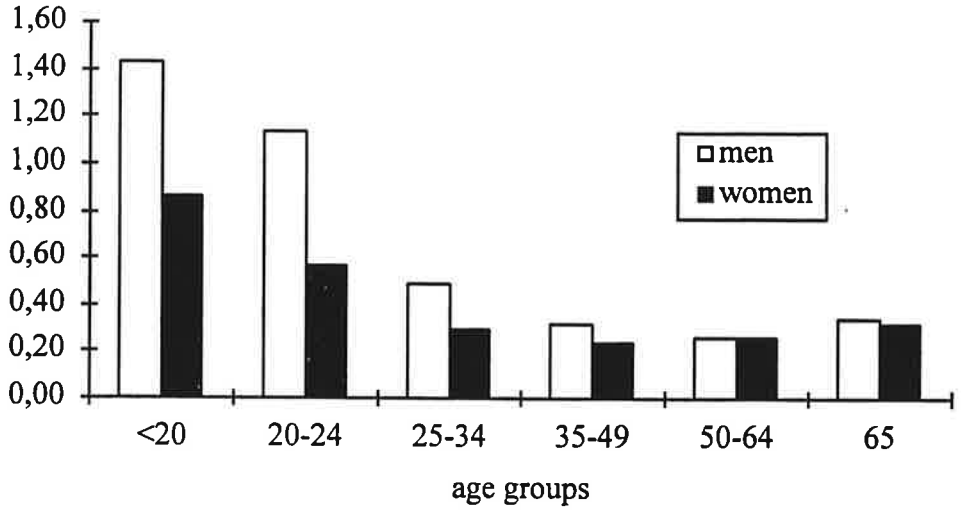
For the 1993-94 period, the rates per million kilometres driven (figure 2) exhibit the traditional curve with risk higher than average for the youngest and the oldest drivers, but the curve is much less marked in the case of women. Young men are at much greater risk than young women. This excess risk 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.

Figure 2 : accident rate per million driver-km



Sources : Transport surveys 1993-1994, BAAC 1993-1994

Figure 3 : accident rate per million driver-hours



Sources : Transport surveys 1993-1994, BAAC 1993-1994

When time spent driving is considered as exposure measure (figure 3), 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 30.2 km/h, compared with 38 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), as is the difference in mileage travelled. So it is possible to assume that the excess accident risk per km driven to elderly women compared with elderly men will decrease further.

The high-risk groups are the same in both cases : male drivers under 25 years of age. The behaviour 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 20.00h and 05.00h, 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.

Conclusion

This analysis of two transport surveys from the risk exposure standpoint, and comparison with accident figures for the corresponding periods, revealed a general decrease in the accident rates, which tends to confirm the hypothesis of a general improvement in driving standards.

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 travelled. 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.

Time and distance are not equivalent measures of exposure. Time spent driving seems to be a better indicator than distance driven insofar as the time drivers take to cover a given distance is the reflection of their perception of risk. However traffic conditions have also an influence on trip duration. Kilometres driven are not homogeneous as regards safety. Driving at night is more difficult than during the day and different driver groups drive in different conditions according to their trip purpose. When comparing the two indicators, the environment criterion must be checked so as not to confuse congested urban traffic situations and difficult driving conditions on small country roads.

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References

ARMOOGUM J. (1996) : "La pondération de l'enquête transports et communications 1993-94", INSEE, note interne.

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

BIECHELER M.B., CAUZARD J.P., COMYN M. FONTAINE H. (1997) : "Synthèse mobilité, attitudes et accidents" Rapport de convention DRAST/INRETS

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

CAUZARD J.P. (1996) in SARTRE : "Les conducteurs européens et la sécurité routière" Edition Paradigme

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

CHIPMAN M.L., MACGREGOR 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. et GOURLET Y. (1996). "Mobilité et accident - année 1994" Rapport de convention INRETS / DSCR

FONTAINE H., HUBERT J.P. (1997) : "Evolution de l'usage de l'automobile et du risque d'accident". RTS n°56 to be published.

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

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 Vol23, 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