COMPARISON OF RISKS FOR RESTRAINED DRIVERS AND THEIR FRONT PASSENGER IN FRONTAL COLLISIONS

by

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ABSTRACT

The over-risk for the driver due to the steering system can be highlighted if drivers'state is compared with front passengers', provided no other significant side effects are involved, such as asymmetrical intrusion or rear over-loading.

The comparison is made in a sample of 112 cars involved in frontal collision. No significant difference is observed between the proportion of severe injuries among drivers and passengers, but severe thoracic injuries are more frequent for passengers, severe injuries to lower members are more frequent for drivers.

It cannot be affirmed that steering system generates a manifest over-risk for drivers. Improving protection for front restrained occupants involved in frontal collisions will consist, for the main part, in better ride-down between restrained occupant and passenger compartment. That will result in reducing load on the thorax and frequency and seriousness of lower members contacts.

INTRODUCTION

In frontal collisions in the PEUGEOT-RENAULT investigation, a death rate of : 2.8 can be observed from among the 553 restrained drivers as against 2.5 for the 300 restrained passengers. Various reasons can explain the difference :

- presence of steering system,
- the greater violence of frontal collisions for cars having just the driver on board,
- the higher frequency of intrusion phenomena on the driver's side because of the number of head-on collisions with offset on the left-hand side of the vehicles.

The over-risk for the driver due to the steering assembly in frontal collisions can be validly highlighted if the drivers' state is compared with the front passengers', provided no other significant side effects are involved such as asymmetrical intrusion or rear over-loading.

The results of this comparison, "driver/passenger", are given after defining the characteristics of the sample used.

CHARACTERISTICS OF THE SAMPLE

A sample of 112 cars involved in frontal collisions was drawn from the accident files analysed by the PEUGEOT-RENAULT Association investigation team. (The file contained 2,171 frontal collisions as of 13 February, 1980). The selection criteria were as follows :

- two front occupants wearing 3-point belts
- parameters of frontal collision violence estimated, i.e. ΔV (occupant velocity variation) and mean γ (mean vehicle deceleration).
- no or very low intrusion (less than 25 cm reduction of dimensions 3 and (or) 5 in "Vehicle Interior Deformation Index" - V.I.D.I.)
- no rear occupant more than 10 years old.

REPRESENTATIVENESS OF COLLISION SEVERITY IN SAMPLE

The sample of 112 frontal collisions selected differs but little from the population from which it is drawn, both as far as the ΔV parameter and mean deceleration are concerned (Fig. 1).

Figure 2 gives the values of "ΔV occupant" and mean car deceleration for the 112 cars in the sample.

AGE AND SEX OF OCCUPANTS

From the 79 pairs whose ages are known, 47 satisfy as far as possible the pairing conditions : less than 10 years difference in age (Table I).

		Age classes of drivers					
		≤ 30	31-40	41-50	51-60	> 60	TOTAL
Age classes of passengers	≤ 30	24	7	6	2	-	39
	31-40	1	4	1	1	1	8
	41-50	-	-	5	2	-	7
	51-60	-	1	5	7	3	16
	> 60	-	-	2	-	7	9
	TOTAL	25	12	19	12.	11	79

TABLE 1 : BREAKDOWN OF AGE CLASSES OF BOTH FRONT OCCUPANTS WHOSE AGES ARE KNOWN.

The drivers are male in 89 cases ; the passengers are women in 74 cases (information on the sex is not known in 14 cases).
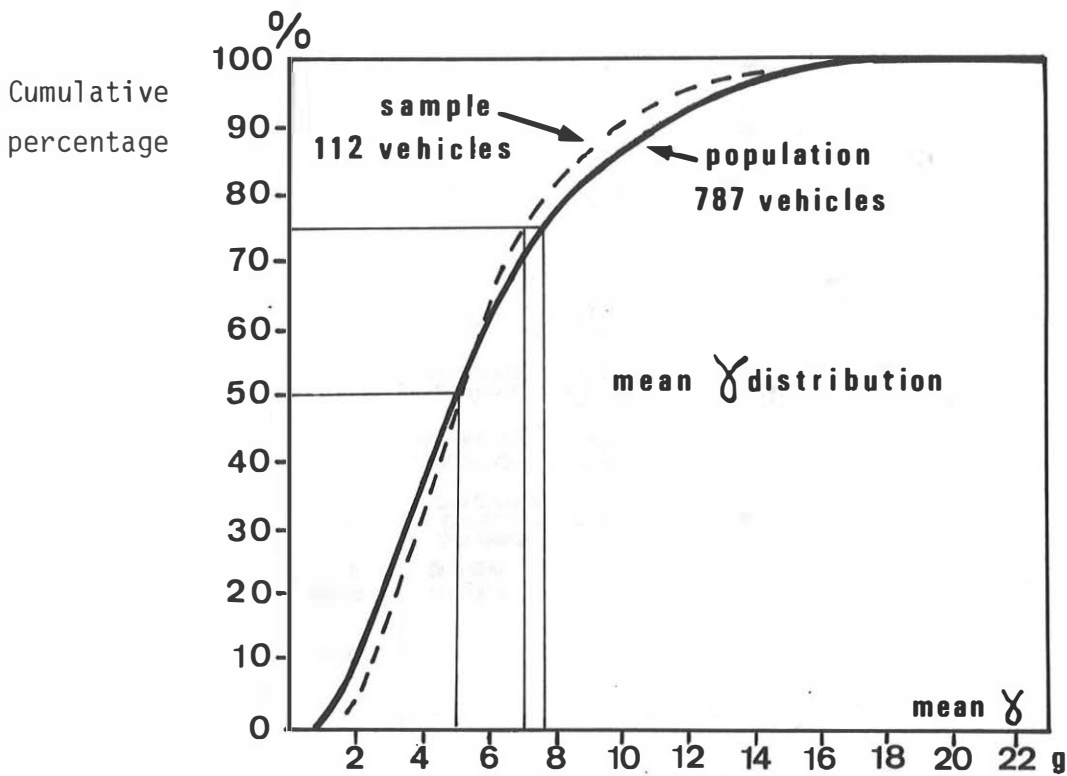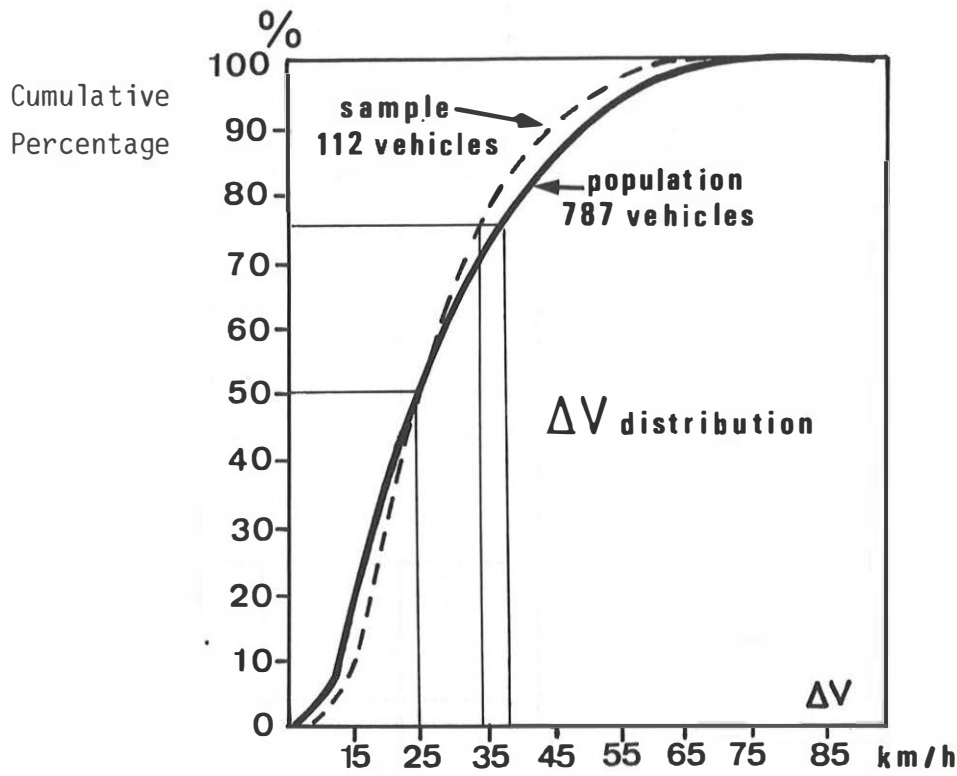
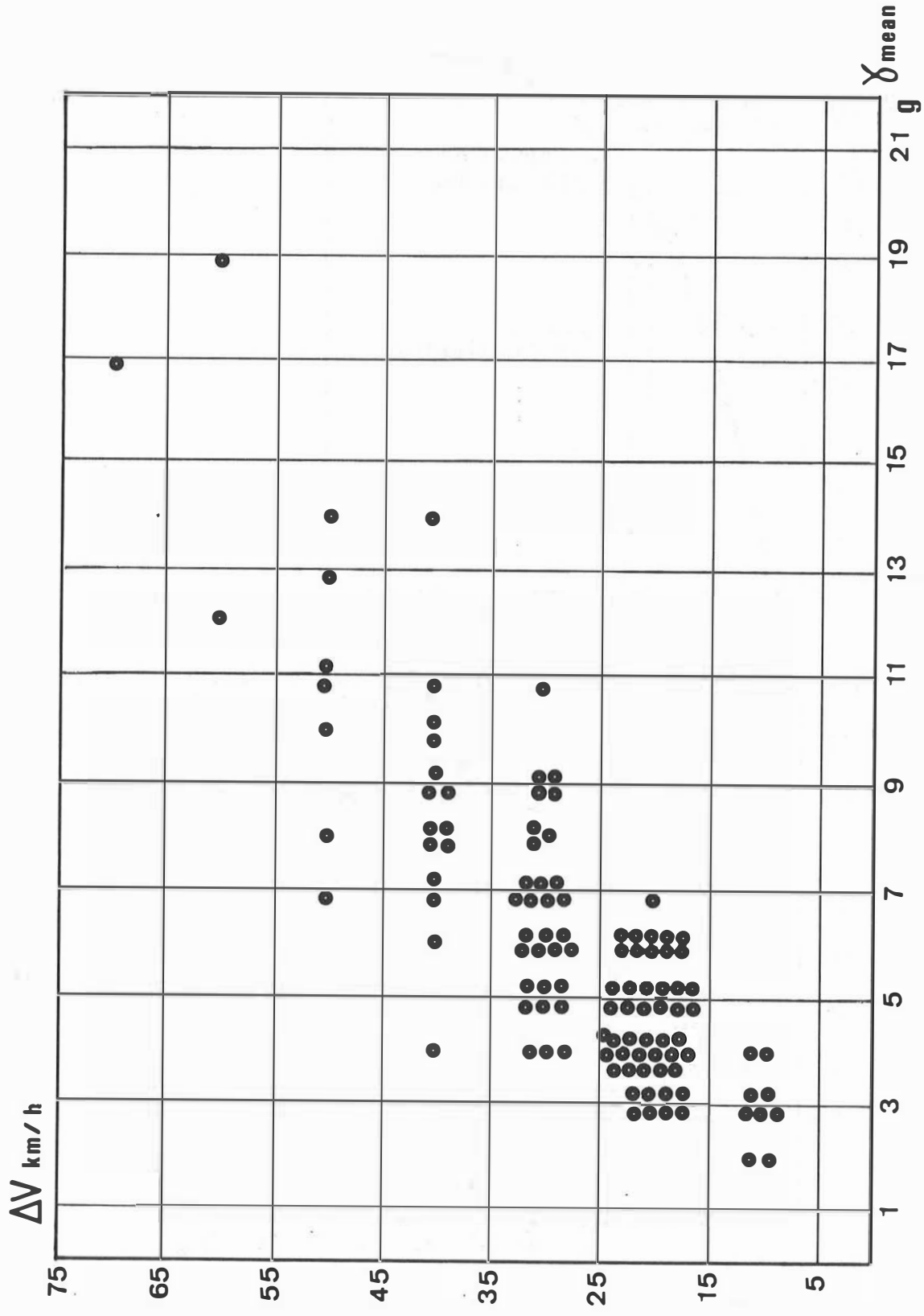Fig. 1 : ΔV and mean γ distributions in the sample and in the whole population.

Fig. 2 : Position of the 112 cases from the sample analysed in diagram "ΔV, mean γ ".

BELT WEARING

Belt wearing quality for driver

		Correct	Slack	Unknown	TOTAL
Belt wearing	Correct	57	5	3	65
quality for	Slack	5	16	2	23
the passenger	Unknown	3	4	17	24
	TOTAL	65	25	22	112

TABLE 2 : SEAT BELT WEARING QUALITY ESTIMATED FOR DRIVERS AND
PASSENGERS.

Wearing quality is known for both front occupants in 83 cases (Table 2).
Wearing for both occupants was correct in 57 cases and slack in 16 cases. In
5 cases, the driver wore his belt correctly, whereas the passenger wore it
slack. The opposite - slack wearing for the driver, and correct wearing for the
passenger - was observed in the same number of cases (5 times).

The differences in weight and size between the front occupants were not analy-
zed. In short, the main disproportion in the sample resides in the over- repre-
sentation of males among the drivers, and, inversely, the over-representation
of females among the front passengers.

The level of knowledge being what it is at the present time, it is not possible
to indicate with certainty the exact influence of this disproportion of results
from the "driver-passenger" comparison.

RESULTS

The comparison of the 112 pairs of front restrained occupants involved in fron-
tal collisions (with no unsymmetrical intrusion or rear over-loading) is evalua-
ted by :

- the overall injury severity (O. AIS scale)

- the frequency and severity of injuries per body area.

1 - OVERALL SEVERITY OF INJURIES TO DRIVERS AND FRONT RESTRAINED PASSENGERS.

The comparison of the O.AIS for drivers and their passengers, in pairs, is gi-
ven in the following table 3 .
Among the seriously injured (O.AIS $\geqslant$ 3) there were 10 drivers (1 O.AIS 5 and
1 killed - O.AIS 6) as against 14 front passengers. Among the uninjured, there
were 47 drivers for 39 front passengers.

Drivers

O.AIS	0	1	2	3	4	5	6	TOTAL
0	26	12	1	0	0	0	0	39
1	13	28	2	5	0	0	0	48
2	1	6	2	2	0	0	0	11
3	7	2	2	0	0	0	1	12
4	0	0	0	1	0	1	0	2
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0
TOTAL	47	48	7	8	0	1	1	112

Front Passengers (row labels for 0–6)

TABLE 3 : BREAKDOWN OF OVERALL SEVERITY OF INJURIES (O.AIS) FOR DRIVERS AND PASSENGERS

The differences in O.AIS are rather unfavourable for the passengers as shown in the following table :

O.AIS differences in the 112 pairs

	Differences unfavourable for drivers			Equality	Differences unfavourable for passengers		
ΔO.AIS	1	2	3	0	1	2	3
N° pairs	17	6	1	56	22	3	7

In the 7 cars in which the driver was much more injured than his passenger (ΔO.AIS > 1), the difference can be explained for 4 of them by the injuries to the lower members, and for the 3 others by injury to the thorax ; in the 10 cars in which the passenger was much more injured than the driver, the difference was due 7 times to the thorax, twice to the lower members and once to the upper members.

The over-risk of the steering wheel to the driver, particularly in the shape of facial, skull or brain injuries, is not evident.

2 - INJURIES PER BODY AREA

   2.1. Differences between the driver group and the passenger group.

   There were 15 serious injuries (O.AIS > 3) to drivers as against 18 to front passengers. (Table 4)
   For the drivers, they are located particularly on the lower members (6 O.AIS > 3) and the thorax (5 O.AIS > 3).
   Half the 18 serious injuries to the passengers were thoracic injuries. (Fig. 3).

DRIVERS

PASSENGERS

AIS

$\geqslant 2$ | $\geqslant 3$

$\geqslant 2$ | $\geqslant 3$

5 (1)   4 (0)

0 (0)   0 (0)

0 (0)   2 (2)

7 (5)   16 (9)

2 (1)   4 (2)

1 (1)   1 (1)

3 (1)   1 (1)

8 (6)   4 (3)
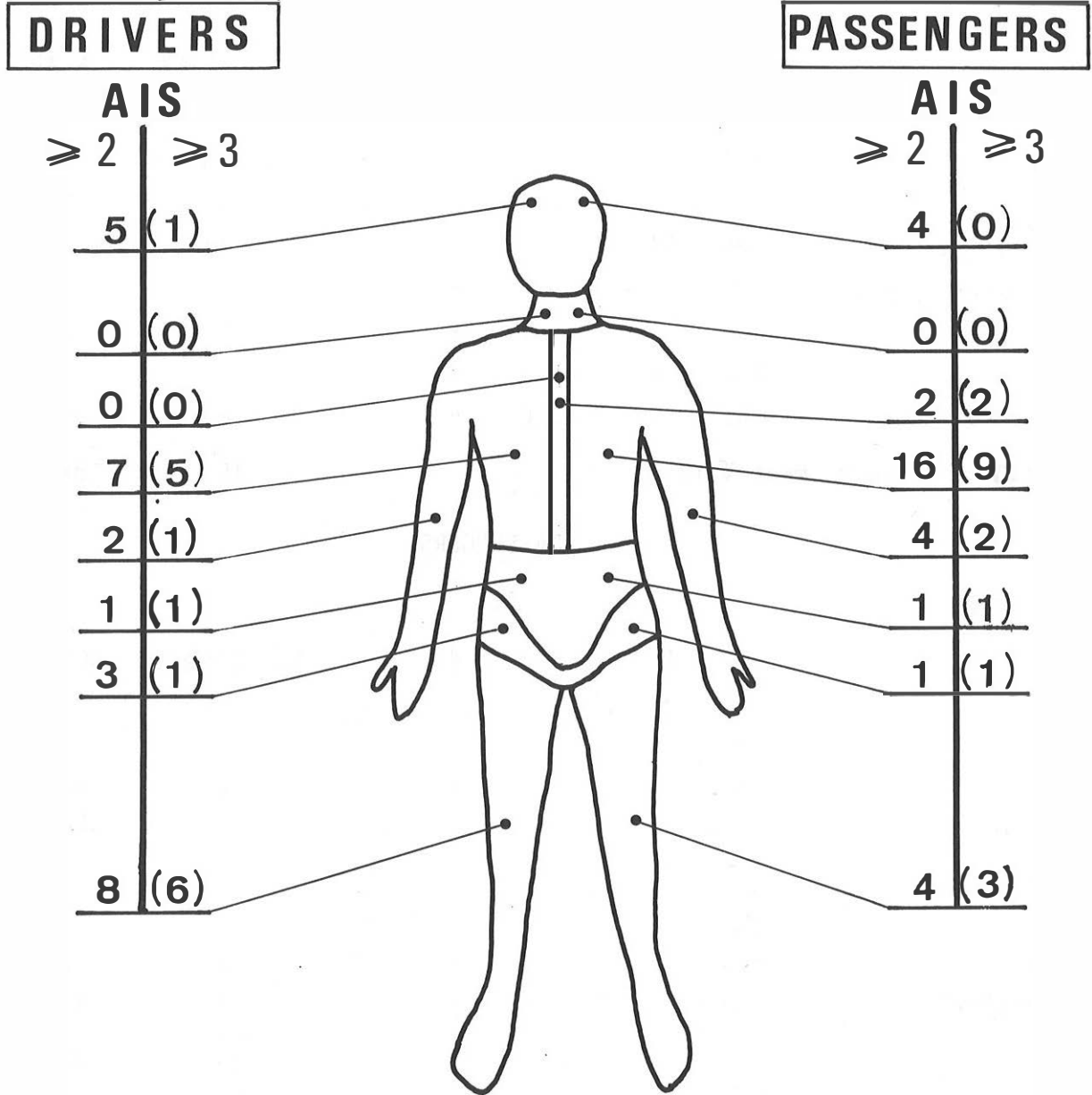
Fig. 3 : Breakdown of injuries with a severity AIS $\geqslant$ 2
(in brackets AIS $\geqslant$ 3) for drivers and passengers
per body area.

DRIVERS

Body areas	AIS						Nb. AIS ≥ 3	Σ AIS³
	0	1	2	3	4	5		
Head	89	18	4	-	-	1+	1	175
Neck	104	8	-	-	-	-	0	8
Thorax	73	32	2	4	-	1	5	281
Upper members	96	14	1	1	-	-	1	49
Dorso-lumbar column	107	5	-	-	-	-	0	5
Pelvis	106	3	2	1	-	-	1	46
Abdomen	108	3	-	-	1	-	1	67
Lower members	69	35	2	6	-	-	6	213
							15	844

+ : ΔV : 70 km/h, mean γ 18 g.

PASSENGERS

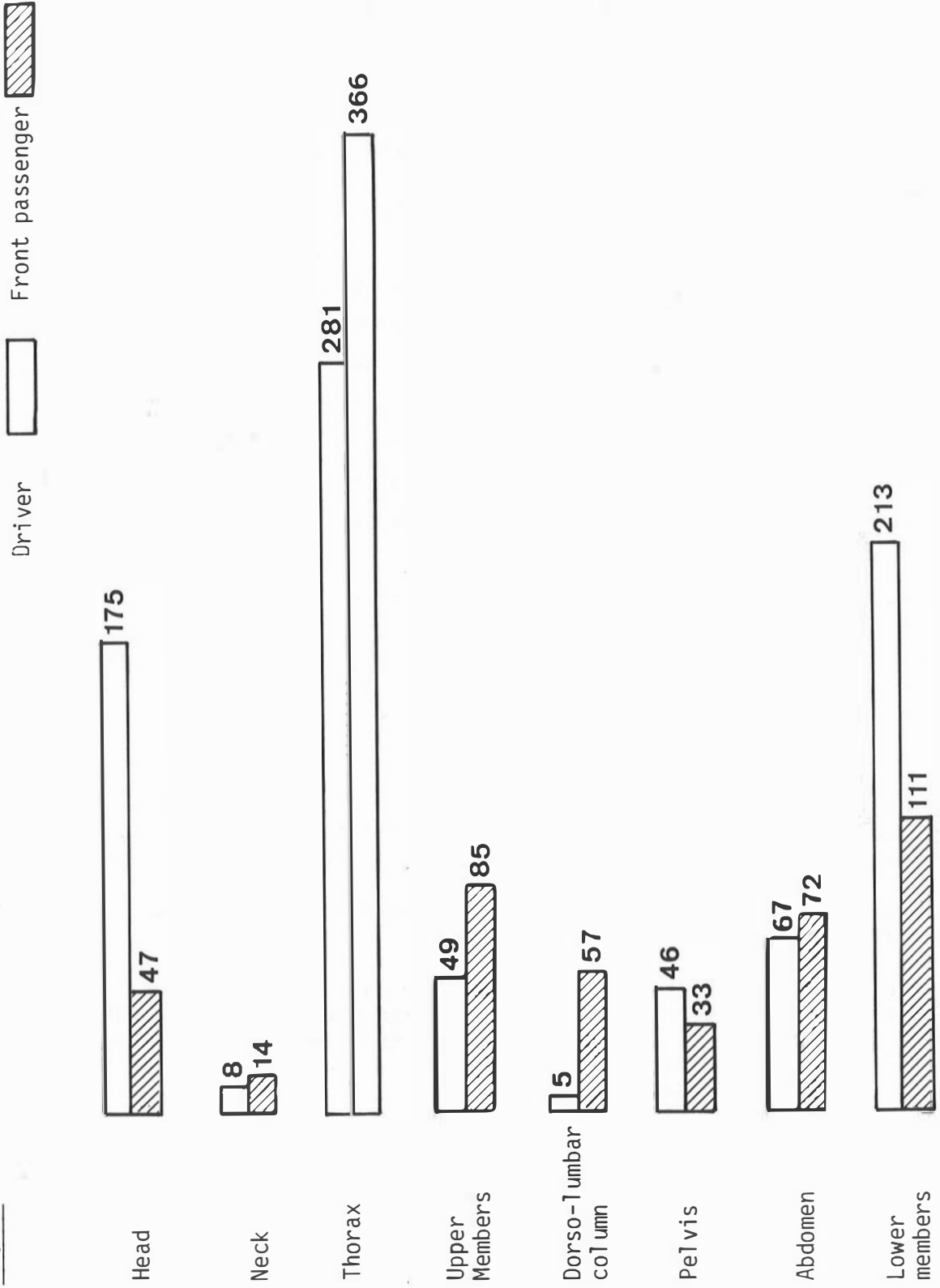| Body areas	AIS						Nb. AIS ≥ 3	Σ AIS³
	0	1	2	3	4	5		
Head	93	15	4	-	-	-	0	47
Neck	98	14	-	-	-	-	0	14
Thorax	66	30	7	8	1	-	9	366
Upper members	93	15	2	2	-	-	2	85
Dorso-lumbar column	107	3	-	2	-	-	2	57
Pelvis	105	6	-	1	-	-	1	33
Abdomen	103	8	-	-	1	-	1	72
Lower members	86	22	1	3	-	-	3	111
							18	785

TABLE 4 : BREAKDOWN OF INJURIES TO DRIVERS AND PASSENGERS ACCORDING TO FREQUENCY AND SERIOUSNESS PER BODY AREA.

Calculating the sum of AIS's per body area raised to power 3 shows that the thorax followed by the lower members, heads the list of frequency and seriousness of injuries, both for the drivers and the passengers. (table 4, Fig. 4).

It can be seen that the lower member injuries to the drivers are twice as high as for the passengers. For the drivers, head injuries are only third in the list.

Fig. 4 : Breakdown of ΣAIS³ per body area.

Driver   Front passenger

Body area	Driver	Front passenger
Head	175	47
Neck	8	14
Thorax	281	366
Upper Members	49	85
Dorso-lumbar column	5	57
Pelvis	46	33
Abdomen	67	72
Lower members	213	111

2.2. Differences in risk per body area for the driver and passenger in the 112 pairs.

The differences in AIS per body area for the drivers and respective passengers are broken down as follows (table) :

DIFFERENCES IN AIS FOR THE 112 PAIRS

ΔAIS	Unfavourable for the driver					Equality	Unfavourable for the passenger				
	1	2	3	4	5	0	1	2	3	4	5
Head	12	3	-	-	1	83	11	2	-	-	-
Neck	6	-	-	-	-	94	12	-	-	-	-
Thorax	11	3	2	-	-	73	11	5	7	-	-
Upper members	4	1	1	-	-	95	9	-	2	-	-
Dorso-lumbar column	4	-	-	-	-	103	3	1	1	-	-
Pelvis	3	1	1	-	-	100	7	-	-	-	-
Abdomen	2	-	-	-	-	103	7	-	-	-	-
Lower members	22	2	5	-	-	72	7	2	2	-	-

The risks for the dorso-lumbar column, the abdomen and the pelvis are better divided. The protection of thorax and lower members is less uniform, and likewise for the head to a lesser degree.

CONCLUSIONS

Before evaluating the specific influence of the steering system on restrained drivers involved in frontal collisions, a sample of 112 cars was formed to compare the state of drivers with their respective front restrained passengers'.

Frontal collisions with considerable intrusion or rear over-load, are eliminated from the sample.

The presence of the steering column is the main difference for the driver with relation to his passenger. A second difference related to the over-representation of male drivers (86 %) and the over-representation of female passengers (73 %) also holds. This parameter, if it had been taken into account, would have considerably reduced the sample.

The differences in age and quality of belt wearing between the drivers and passengers are not significant.

The results of comparing pairs of front restrained occupants give the following results :

1 - No significant difference is observed between the proportion of restrained serious casualties (O.AIS > 3) among drivers (10/112) and the front passengers (14/112).

2 - The most wounded body areas are, in order : the thorax, followed by the lower members, both for the drivers and their passengers.

Serious thoracic injury (AIS $\geq$ 3) is, however, more frequent for the passengers than for the drivers (respectively 9 cases and 5 cases).

On the other hand, serious injury to the lower members is more frequent for the drivers than the passengers (respectively 6 and 3 cases).

3 - Serious "head" injuries for the drivers are only third in the list by order of importance. In actual fact, only one case of "head-steering wheel" contact was recorded ; it was a serious injury (AIS 5) which occured in a very violent collision (ΔV 70 km/hr, mean γ 18 g).

In short, when there is no considerable intrusion or rear over-load, it cannot be affirmed that the steering system generates a manifest over-risk of serious injury.

Under the previously-stated conditions, improving protection for front restrained occupants involved in frontal collisions will consist for the main part in better ride-down between the restrained occupant and the passenger compartment. This will result in reducing the load on the thorax and the frequency and seriousness of lower members contacts.