TOWN SIZE AND PEDESTRIAN ACCIDENT INJURIES

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Accidents with young pedestrians in traffic remain a priority concern of the institutions responsible for road safety. They are a significant target for their activities. As they affect children, the injuries they can inflict on a community are considerable.

One of the questions regularly confronting road safety authorities is that of the young victims' identity: who are they? Which populations ought preventative measures to be aimed at in order to maximise the benefits from their campaigns? This involves enquiring into the identity of populations at risk, a subject on which several factors are already well known. For example, it has often been said that the age group involved in the greatest number of accidents is that of children aged from six to eight. More boys than girls are involved, with a ratio of 60% to 40% (1*).

Besides age and sex, the social background of child accident victims has been the subject of an attempt at definition. Certain social categories seem to be involved in a greater number of occurrences of these accidents. This was the conclusion of 1. B. Pless (2) after recording certain data on children hospitalised in Montreal following traffic accidents in 1981 and relating them to demographic data on the population. This showed that the rate of pedestrian accidents of children from socially disadvantaged backgrounds was nine times greater than of children from well-off backgrounds.

F. R. Rivara (3) had earlier observed similar results in the city of Memphis. He, however, had taken the investigation further by including data on the design of urban areas. He had thus isolated a high-risk group consisting of children from black, often single parents, families on low incomes, living below the poverty threshold, in overcrowded flats and in densely-populated urban areas. According to these results, on the scale of the city of Memphis, urban density could be regarded as a factor making accidents more likely. This type of research has still not been carried out on a large enough scale to be considered genuinely reliable. The subject has however appeared to be of sufficient interest to justify trying to investigate it in depth. This is the purpose of the study presented here.

The term urban density refers to a quite complex set of data on built-up area, car and pedestrian traffic, population density, etc. Unfortunately there is no easily accessible indicator capable of assessing the variations in children's susceptibility to accidents according to the size of urban areas in which they occur. The term „accident susceptibility" refers to the rate of accidents across the population. Is this rate genuinely higher in large conurbations than in smaller ones, as one would tend to expect?

This view is connected with that one of a quite widespread belief that pedestrian accidents are more common in towns than in rural areas. This is indeed what reading the overall accident statistics published annually would indicate. Nevertheless, given that the majority of the population that lives in urban areas, it is not intrinsically surprising that they should be more accidents in towns. It is necessary to assess the rate of accidents across these populations if one is be able to confirm that urban density is genuinely a factor making for greater susceptibility. We have undertaken this study so as to verify this view in a study extending over a national scale.

According to annual figures published in France by SETRA which distinguished between „conurbations" and „outside of conurbations", appears that the number of accidents is much higher in conurbations, in the ratio of 9 to 1 (6). However, what about when one relates these results to those for populations living within conurbations and those for populations living outside conurbations? In addition, what about variations in the rate between conurbations of differing sizes?

1.   METHODOLOGY

The base data is composed of that from 2 databases one of from SETRA, which is the organisation responsible for the annual road traffic census in France, and the other from, which carries out the population census.

In each case, children under 15 were classified under 6 categories of conurbation. Data was therefore obtained from the ratio of the number of children involved in accidents/number of children the rate was calculates per 1,000 children.. The variations in this rate according to conurbation category were looked at.

- The term conurbation refers to the grouping of dwellings in urban units. Where the population of urban unit is under 2,000, they are termed „rural communities" (5).
- Conurbations were classified as follows: less than 5,000 inhabitants; from 5,000 to 20,000; from 20,000 to 50,000; from 50,000 to 100,000; over 100,000 inhabitants; in addition to rural communities *(5)*. The case of Paris was investigated separately.
- The variations in the seriousness of accidents in the differing categories of conurbation was also studied.
- Lastly, for each of the preceding categories, children were classified into three age groups from 0 to4, from 5 to 9, from 10 to 14.

The main criticism of this method is that it presupposes that location of the accident is the same as the place of residence, though it is always possible to suffer from an accident in a conurbation other than one's place of residence. This is often the case with drivers given the length of journeys. This may also be the case with adult pedestrians, using public transport to get to work in a place other than where they live. However, in the case of children, it has been noted that accidents involving them occur in the near vicinity, if not in front of their homes. There are probably exceptions to this rule because of family movements, for example during holidays. However, holidays periods have been proven to be times when the curve on the accident graph is at its lowest. There is probably a bias in the data, but it is regarded as minimal. This type of assessment would not be envisaged for the adult pedestrian population.

Given the interval for the French population census, and the need to use data from the same year for both population and accidents, this study was carried out for a year, 1982, which is already some time ago.

2. RESULTS

2.1. Description of the population

Type of conurbation	0-4 years	5-9 years	10-14 years	Total	%
Rural communities	773,516	1,036,756	1,179,132	2,989,404	26.6
-5,000 inh..	180,096	233,404	270,604	684,104	6.09
5-20,000 inh..	334,692	413,564	470,556	1,218,812	10.85
20-50,000 inh..	217,636	256,544	290,472	764,652	6.08
50-100,000 inh..	224,596	261,656	296,952	783,204	6.97
+100,000 inh..	1,406.748	1,613252	1276,852	4,796,852	42.68
Total	3,137,284	3,815,176	4,284,568	11,237,028 99.99	

Table 1: Distribution of population under 15 by conurbation type.

It can be seen that the population under 15 is not distributed equally in the various types of conurbation. It is more significant in large towns of over 100,000 inhabitants and in rural areas. Pedestrian accidents occurring in this population break down as follows:

Type of conurbation	0-4 years	5-9 years	10-14 years	total	%
Rural communities	221	576	396	1193	9.58
-->5,000 inh..	57	180	108	345	2.77
5-20,000 inh..	155	456	279	890	7.15
20-50,000 inh..	150	538	308	996	8.00
50-100,000 inh..	209	610	355	1174	9.43
+100,000 inh..	1203	3901	2746	7852	63.07
Total	1995	6261	4194	12450	100%
	16.02	50.29	33.69	100%	

Table 2 : Distribution of accidents of population under 15 by conurbation type.

In terms of the gross statistics, accidents to pedestrians under 15 clearly appear to be an urban phenomenon, occurring more particularly in large conurbations of over 100,000 inhabitants, while the rate of these accidents in other categories of urban units is low. They particularly involve children aged 5 to 9, who by themselves represent half the accidents. What about their occurrence in the population involved?

2. 2 Accident rate according to size of conurbations.

The rate of accidents was calculated per 1,000 inhabitants.

2. 2. 1 Across the entire child population

	Population	Accidents	Rate
Rural communities	2,989,404	1193	0.40
-5,000 inh..	684,104	345	0.50
5-20,000 inh..	1,218,812890		0.73
20-50,000 inh..	764,652	996	1.30
50-100,000 inh..	783,204	1174	1.50
-100,000 inh..	4,796,8527852		1.64
Total	11,237,028	12450	1.11

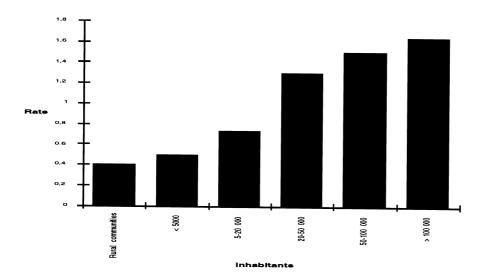Table 3. Calculation of accidents rates by conurbation size

Figure 1. Accident rates in the different types of conurbation.

The results show a quite clear relationship between the size of conurbations and the pedestrian accident rates for those under 15 the larger the conurbation size, the higher the accident rate in the population. In rural communities, it is four times less significant than in conurbations over 100,000 inhabitants; between these 2 extremes, the rate rises quite steadily, with however a more marked rise for conurbations with upwards of 20,000 inhabitants.

Child pedestrian accidents clearly appear to be an urban phenomenon, and according to these results, to be proportional to the size of the conurbations.

With the data we had, it was possible to calculate the distribution of rates within urban units over 100,000 inhabitants which are the most „dangerous" for the children. We started by extracting the Paris conurbation from this category. The results then change somewhat:

	Population	Accidents	Rate
Rural communities	2,989,404	1193	0.40
-5,000 inh..	684,104	345	0.50
5-20,000 inh..	1,218,812	890	0.73
20-50,000 inh..	764,652	996	1.30
50-100,000 inh..	783,204	1174	1.50
-100,000 inh..	3,121,988	4646	1.49
Paris conurbation	1,674,864	3206	1.91
Total	11,237,028	12450	1.11

Table 4: Accident rates distinguishing Paris conurbation from conurbations over 100,000 inhabitants.
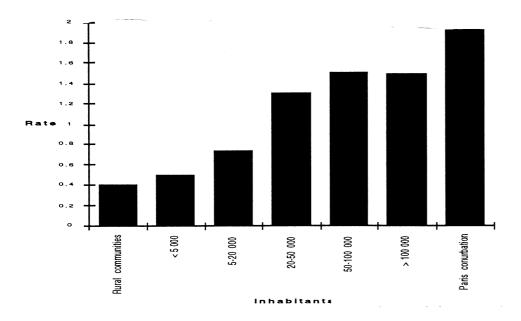

Figure 2. Accident rates in different types of conurbation after (Paris is separate)

The accident rate is higher in the Paris conurbation than in other conurbations over 100,000 inhabitants. The accident rate for towns of 50,000-100,000 inhabitants is the same as that for towns over 100,000 if the Paris conurbation is extracted from the latter. The change is even clearer when the city of Paris itself is extracted from its conurbation, as shown in the bar chart below.

	Population	Accidents	Rate
Rural communities	2,989,404	1193	0.40
-->5,000inh..	684,104	345	0.50
5-20,000inh..	1,218,812	890	0.73
20-50,000 inh..	764,652	996	1.30
50-100,000inh..	783,204	1174	1.50
-100,000inh..	3,121,988	4646	1.49
Paris conurbation	1,382,220	2218	1.60
City of Paris	292~644	988	3.38
Total	11,237,028	12450	1.11

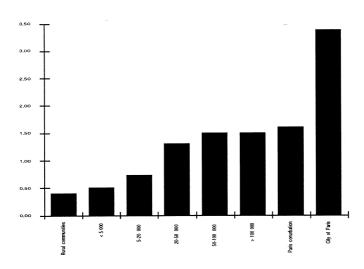Table 5. Accident rates after extracting City of Paris from the Paris conurbation.

Figure 3. Accident rates in different types of conurbation, highlighting the case of Paris

Though, having extracted accidents in the City of Paris, the Paris conurbation is similar to conurbations over 100,000 inhabitants, the City of Paris stands out through its very high rate, more than twice that of the large conurbations. It would of course be necessary to check what this rate is in the large regional metropolitan centres like Marseilles or Lyons. Thus it would be possible to check the relationship between the density of the urban fabric, which is higher within the city of Paris than in its suburbs, and accidents.

There is a gradual growth in the level of occurrences of accidents to children, around three types of conurbation:

- rural areas, villages, and small conurbations with less than 20,000 inhabitants.
- medium-sized conurbations and large towns of over 20,000 inhabitants.
- the city of Paris.

The need remains for an investigation of these groupings.

Beyond the relationship between the size of conurbation and the occurrence of accidents to children, there would probably be an effective relationship between the density of the urban fabric and the accident rate, since in the city of Paris, where the rate is assumed to be high, the rate is over twice that of conurbations of over 100,000 inhabitants, and over eight times that of rural communities. In order to confirm this, other data would be required.

Another aspect of the occurrence of accidents to children is its variation with age. Aware that the age group most involved in accidents is the 5-9 year olds, we attempted to ascertain if this was borne out in all types of conurbation.

2.2.2 Variations in accident rates in conurbations according to children's ages

Given the special case of the city of Paris, the results relating to it were extracted from the Paris conurbation, which is itself treated separately from the other conurbations of over 100,000 inhabitants; they are shown separately.

Type of conurbation	0-4 years	5-9 years	10-14 years	Total
Rural communities	0.29	0.56	0.34	0.40
<5,000 inh..	0.32	0.77	0.40	0.50
5-20,000 inh..	0.46	1.10	0.59	0.73
20-50,000 inh..	0.69	2.10	1.06	1.30
50-100,000 inh..	0.93	2.33	1.20	1.50
>100,000 inh..	0.80	2.22	1.36	1.49
PARIS conurbation	0.76	2.37	1.58	1.60
City of Paris	1.78	4.72	3.59	3.38
Total	0.64	1.64	1.11	1.11

Table 6: Accident rates for different age groups

The accident rates for 5 to 9 year old children are on average 2.5 times as high as those for 0-4 year olds, and *1.5* times as high as those for 10-14 year olds.
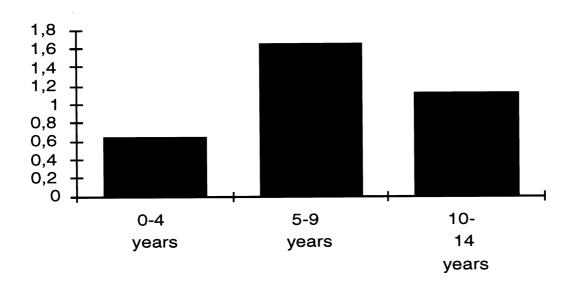

Figure 4. Accidents rates by age (0-4, 5-9 and 10-14 years).

In the different conurbations, the 5-9 year-olds invariably have the highest accident rates, as the following bar chart shows:
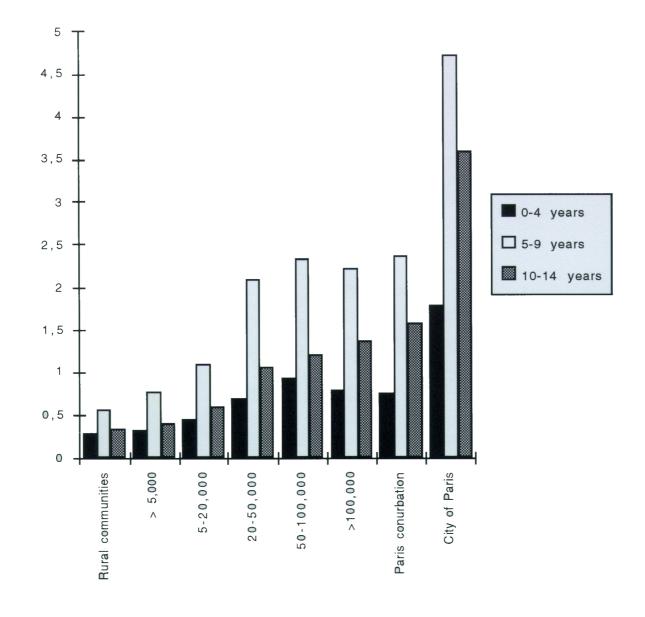
Figure 5. Accident rates by age in the different conurbations.

The difference between age groups meanwhile tends to widen according to the size of conurbations. Among the youngest children and the 5-9 year-olds, it is lower in rural communities and small conurbations than in major conurbations. On the other hand, there is relatively less change, as a function of conurbation size, in the difference between the *5-9* year-olds and the 10-14 year-olds.

Though rates increase with conurbation size, the rates for the 5-9 year-olds in the conurbations of 50,000 and 100,000 inhabitants and the Paris conurbation are virtually the same: 2.3 3, 2.42, 2.47 children per 1,000. For central Paris, on the other hand, it is much higher: 4.72.

2.3   Variation in the seriousness of accidents with the conurbation size

Seriousness may be looked at in two ways: either through the injuries suffered by a population, or from the point of view of an epidemiology targeted on road safety, the first approach would be more satisfactory. However, as fatal accidents remain fortunately rare, rates observed for these are perhaps of minor significance. By way of illustration, here how they break down in this instance. The rate is assessed per 100,000 inhabitants.

Type of conurbation	No. of deaths	Population	Rate
Rural communities	97	2,989,404	3.24
<5,000 inh..	17	684,104	2.49
5-20,000 inh..	24	1,218,812	1.97
20-50,000 inh..	21	764,652	2.75
50-100,000 inh..	13	783,204	1.66
>100,000 inh..	75	3,121,988	2.40
PARIS conurbation	19	1,382,220	1.37
City of Paris	3	292.644	1.03
Total	269	11,237,028	

Table 7. Fatality rates attributable to pedestrian accidents according to conurbation size.

According to these results, there would appear to be a reduction in fatal accidents with increasing size of conurbations, with nevertheless two exceptions ; in conurbations of 20 to 50,000 inhabitants, and in conurbations of over 100,000 inhabitants. In the latter instances the rate reaches a level comparable to that of conurbations of less than 5,000 inhabitants. These three urban categories exhibit the highest level of seriousness of child accidents after rural communities.

Nevertheless, the disproportion between the phenomenon observed and the size of population (cf table 7) makes it difficult to draw conclusions without further supporting evidence. It was therefore attempted to define the severity of accidents by calculating fatal accident rates. this involves the ratio: number of death/total number of accidents for an age group.

The initial observation was of a slight increase in fatal accidents according to the ages of victims.

2. 3. 1 Variation of accident seriousness with age of child

	Deaths	Serious injury	Minor injury	Total	Seriousness
0- 4 years	79	515	1,401	1,995	3.96
5- 9 years	128	1819	4,314	6,261	2.04
10-14years	62	1156	2.976	4.194	1.48
	269	3490	8,691	12,450	2.16

Table 8. Variation in seriousness of accidents with age of   child

The most severe accidents occur most frequently to the youngest children, those under *5;* the seriousness of accidents tends to decline thereafter.

2. 3. 2 Variations in accident seriousness with conurbation size.

These results point in the same direction as the foregoing ones, i. E; a decrease with increasing conurbation size, though with greater regularity.

Even though an increasingly significant accident rate as a function of increasing conurbation size had been observed, the same change, but in the opposite direction, was observed with regard to their seriousness: the larger the conurbation, the less serious the accidents occurring there.

Type of conurbation	Deaths	Serious injuries	Minor injuries	Total	Seriousness
Rural communities	97	610	486	1193	8.13
<5,000 inh..	17	174	154	345	4.93
5-20,000 inh..	24	381	485	890	2.70
20-50,000 inh..	21	334	641	996	2.11
50-100,000 inh..	13	400	761	1174	1.11
>100,000 inh..	75	1137	3434	4646	1.61
PARIS conurbation	19	391	1808	2218	0.86
City of Paris	3	63	922	988	0.30
Total	269	3490	8691	12450	2.16
%	2.16	28.03	69.81	100	

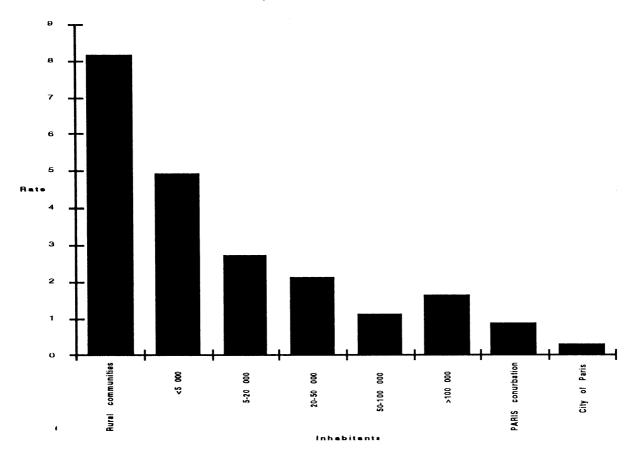Table 9. Calculation of accident seriousness by conurbation size.

Figure 6. Accident seriousness rates by size of conurbations where accident occurs.

It is shown that accident seriousness changes quite noticeably between the different types of conurbation, going from less than 1 child killed per 100 accidents in Paris to 8 per 100 in rural communities. It is surprising to have confirmed the inversion of these results by comparison with the foregoing results on accident rates in the population.

The quite marked steady trend in these results probably indicates a relationship between accident seriousness and the size of the conurbation in which the accident occurs, in the opposite direction to that of accident rates. The larger the conurbation, the higher size is nevertheless not completely steady: it is slightly higher in conurbations of over 100,000 inhabitants than for conurbations of 50 to 100,000 inhabitants (figure 10).

3 Examination and Findings

According to the results which have been put forward, it would appear that a conurbation's size bears a relationship to the rates and seriousness of accidents to child pedestrians which occur there. The larger the conurbation, the higher the accident rate increased. In addition, groupings in conurbation categories become evident this is so with regard to accident rates in conurbations upwards of 200,000 inhabitants, and still more from 50,000 inhabitants. From 20,000 inhabitants and upwards, the effect of urban concentration on the accident rate appears to be the same, except for on the city of Paris, where it is twice as high.

A certain symmetry in the results between rate and seriousness becomes apparent; it is particularly evident between rate and severity of accidents. It is generally conceded that the speed of traffic bears a relationship to the seriousness of accidents. From the point of view, it is therefore not surprising to find that the seriousness is lower in the large conurbations and high in rural areas. Nevertheless, according to our results, it decreases steadily with conurbation size, which would seem, at first sight, inexplicable speed may be higher in villages than in conurbation of over 100,000 inhabitants, but is this also the case for example between towns of 50,000 inhabitants and those of 100,000? In these categories where the rate is identical, the seriousness goes up.

This study, in the way it has been framed, is to be regarded as a step in the investigation of this field. The data we have had available to us are in the final analysis rather too limited for us to have gone into the problem in genuine depth. We have treated the case of the city of Paris separately as we had data for it, but the accident rate may not be a peculiarity of the capital.

These results lead to two types of conclusions: one on child accidentology, the other on road safety.

3.1. Child accidentology in traffic.

These results have shown a clear distinction between the large conurbations and the rural areas. When an urban area is developed to the limits of its capacity, as in the case of Paris, it becomes a focal point for traffics accidents to children, which is not the case in rural areas and in small and medium-sized conurbations in which public spaces provide more freedom and autonomy to their various users.

This observation may bear some relationship to the presumed factors in child accidents as set out for example by Thomson (6). According to this writer, these factors were linked to the complexity of the task, as is the case in dense urban setting, the higher the risks of failure. This might explain the variations in the accident rate between rural areas or small conurbations and the large towns and Paris, without explaining to the same extent the steady progression in the accident rate between these two extremes.

In order to study the reasons for this progression, we at present envisage carrying out a series of complementary investigations: comparison of the accident rate in several large metropolitan centres, using complementary statistics enabling an improved investigation of urban concentration, such as occupancy of the built environment, population density and traffic density. Observations on the availability of public space for children's games and the extent of pedestrian zones are also factors to which would need to be directed in order to explain these results.

In conclusion, it seems quite likely that traffic is a constraint on pedestrians generally, across all age groups, in large towns as in villages and rural areas, and that this situation is more difficult still for the children to manage, who not only have problems coping with situations such as traffic but also need and independent urban space giving them the opportunity to play their games.

3.2. Prevention of child pedestrian accidents

From the point of view of road safety, it would seem necessary to consider what has been said on the greater susceptibility of children in the large conurbations, or at least, to make a choice of criteria for assessing this susceptibility. If the objective of road safety measures is to protect individuals against accidents, it is the populations of the large towns who ought to be their priority target. If they are aimed at reducing fatality rates, it is the populations of the rural and semi-rural areas which ought to be protected.

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