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Deprived neighbourhoods and risk of road trauma (incidence and severity) among under 25 year-olds in the Rhône Département (France)

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Abstract

Previous research has shown that there are inequalities with regard to traffic accident risk between different social categories. This study describes the influence of the type of residential municipality (with or without deprived urban areas, “ZUS, zones urbaines sensibles”), used as an indicator of contextual deprivation, on the incidence and severity of road trauma involving people of under 25 years of age in the Rhône.

Injury data was taken from The Rhône Road Trauma Registry. The study covers the 2004-2007 period, totalling 13,589 young casualties. The incidences of traffic injury of all severities were computed according to the type of municipality, the age, gender and type of road user. The ratios of the incidences of deprived municipalities, compared with others were calculated. Subsequently the severity factors and incidences according to the severity level (ISS 1-8, ISS 9+) were studied.

For the main types of road users except motorized two-wheeler users, the incidences were higher in the deprived municipalities: the greatest difference was for pedestrians, where the incidences were almost twice those of other municipalities. This excess risk, constituting a health inequality topic rarely considered, was even greater in municipalities with 2 or 3 ZUS’s. It was essentially observed for minor injuries among motorists, cyclists and pedestrians.

While the incidence increased among people less than 25 years of age, the severity of road injuries was lower in deprived neighbourhoods, contrary to what is suggested by other studies. This lower severity disappeared when taking into account the crash characteristics.

Keywords: Contextual deprivation; road trauma; incidence; severity; children; young, health inequalities

1. Introduction

A considerable body of scientific research from various countries has shown that there are inequalities with regard to road traffic injury risk between different social categories, described by individual or contextual variables (Mueller et al. 1990; Roberts 1997; Faelker, Pickett & Brison 2000; Hasselberg, Laflamme & Weitoft 2001; Poulos et al. 2007)

For example in 1997, Abdalla (Abdalla et al. 1997) investigated the links between the socioeconomic characteristics of residential districts and road traffic injury incidences in the former Lothian region of Scotland. The injury rate for all categories of ages and road users was almost double among those living in the most deprived areas. This difference in incidence rates was even greater for pedestrians. More recently Graham (Graham, Glaister & Anderson 2005) and Edwards (Edwards et al. 2008)found that pedestrian and cycle injuries for children under 15 years of age were respectively 4.1 and 3.0 times higher in poor districts than in wealthy districts in England. The authors controlled for the effects of confounding factors such as population size, age and gender.

Little is known about the effect of deprivation on the severity on road injuries (Hasselberg, Vaez & Laflamme 2005; Zambon & Hasselberg 2006).

Our goal is to study the influence of the type of residential municipality, used as an indicator of contextual deprivation, on the incidence and severity of road trauma involving children and young people of under 25 years of age. The only related study conducted in France concerned police data without indication of severity (Fleury et al. 2010).

2. Material and methods

2.1. The deprived urban areas in the Rhône "Département"

The Rhône is a French "département" whose principal city is Lyon. In France, the public authorities have defined deprived urban zones (ZUS – zones urbaines sensibles) which are priority targets for urban policy. They are characterized by the presence of large apartment buildings or poor housing , a considerable imbalance between population and jobs, frequent insecure jobs.

The Rhône contains 293 municipalities and, at the time of the last census in 2006, a population of 1,669,655 inhabitants of whom 11% lived in 30 ZUS's located in 25 municipalties. Some municipalities have 2, or even 3 ZUS's. In 2006, the unemployment rate in the ZUS's in the Rhône was 22.4%, compared with 11.4% for the "département" as a whole. In addition, there were 39.2% of people aged under 25, 33.3% of people without qualifications and 21.5% of single parent families in the ZUS's in the Rhône while for the entire "département", these percentages were respectively 33.0%, 18.7% and 13.6%. Living in a ZUS would seem to be a good indicator of poor social position. However, our data only report residential municipality. We have therefore chosen living in a municipality with one or more ZUS's as a contextual indicator. In such municipalities, on average 35% of persons of under 25 years of age live in a ZUS. In what follows, we shall refer to municipalities with a ZUS as Type A and those without a ZUS as Type B.

In order to better describe this contextual indicator we verified the difference between the two types of municipalities concerning the income: whereas over 75% of type A municipalities have a median income per consumption unit under 16,120 euros, less than 25 % of type B municipalities are in the same situation. Consumption units have been calculated by giving the first adult in household a value of 1.0, 0.7 for any additional adult (older than 16), and 0.5 for each child. These elements support the use of this contextual socioeconomic indicator, the intra-group variations being clearly inferior to variations between the two types of municipalities.

2.2. The Rhône Road Trauma Registry

A road trauma registry has been in operation since 1995 and has been certified by the relevant French ethics authority: Comité National des Registres This registry contains all the persons injured or killed in road traffic accidents in the Rhône Département. The data collection process brings in 245 health care departments performing activities ranging from prehospital care delivered on site by a mobile emergency unit to rehabilitation, and including intensive care, resuscitation and surgery. For deceased casualties, the forensic medicine institutes also supply data (Laumon et al. 1997). Certain characteristics of the accident (location, date, time, vehicles involved) and personal data on the casualty are recorded, but above all the Registry contains a precise description of all the injuries sustained. The injuries are coded using Abbreviated Injury Scale AIS 90 (AAAM 1990). We have used the ISS (Injury Severity Score) as an indicator of overall severity, this being calculated on the basis of the sums of the squares of the AIS scores for the three body regions with the most severe injuries.

The inclusion criteria are the location of the accident (Rhône), an accident involving a moving vehicle (including roller-skates and skateboards), even outside road network, and the presence of at least one AIS injury. Pedestrians who fall on their own are not included.

2.3. Analyses

Our analysis will cover the last 4 available years: 2004-2007. For the 4 years, the Registry includes 29,479 casualties living in Rhône, 13,589 (46.1%) of whom were under 25 years of age, and 1,898 (14.0%) whose residential municipalities were unknown.

Our analyses related to young persons of under 25 years of age living in the Rhône Département (a total of 520,000, 52% of whom lived in municipalities with one or more ZUS's), and for whom we know the residential municipality. A comparison between casualties with a known and an unknown municipality is provided in the first part of the results.

We studied the distribution of casualties on the basis of their type of residential municipality (with a ZUS: A and without: B). In the case of the city of Lyon, each district is considered as a municipality. We calculated the mean annual incidences of traffic injuries according to the type of municipality, the age, gender and type of road user, and the risk ratio RR (RR in Type A vs Type B) with their 95% confidence interval (CI) for each category during the study period. Incidences were computed per 100,000 person-

years, using the population of the Rhône Département, estimated by INSEE (INSEE 2006). Given the numerous statistical tests, the threshold of 0.001 was chosen for RRs significance.

Using logistic regression we also studied the influence of the residential municipality on immediate injury severity, for each type of road user. Severe injuries were defined as those with an ISS of 9 or over and those which proved fatal. An ISS 9 is for example one opened displaced fracture. The adjustment variables for the multivariate analysis were: gender, age in 5-year brackets, type of road (trunk or county road, motorway or ring road, street or municipal road, or other), the impacted object (fixed obstacle or other road user) the zone where the accident occurred (Lyon, the Lyon conurbation or outside a built-up area), the day the accident occurred (weekday or weekend), the time (day or night), seatbelt wearing for casualties in cars and helmet wearing for casualties on motorized two-wheelers (M2W). In order to check heterogeneity between the 293 municipalities in terms of severity we computed the covariance parameter estimate in the five multilevel models (Goldstein, Browne & Rasbash 2002) using glimmix procedure in SAS software (one model for each type of road user).

We calculated the incidences for injuries of all severities together, then separately according to the severity level (ISS 1-8, ISS 9+).

All the statistical analyses were performed using the SAS software package (version 9.2)

3. Results

We studied 11,691 casualties of under 25 years of age living in the Rhône Département, 68.1 % of whom were male. Males living in Type A municipalities accounted for the largest number of casualties, followed by males from Type B, females from Type A and last females from Type B. The 1,898 casualties with an unknown residential municipality were more often seriously (ISS 9+) injured, (14.0 % vs 6.0 %) and young people under 15 years of age (31.7 % vs 25.9%) in comparison with casualties with a known residential municipality.

3.1. Influence of residential municipality on incidences

A risk ratio (RR) of 1.11 for the males, and 1.14 for the females were observed for the overall incidences for the Type A municipalities compared to Type B municipalities (table 1). For males, when individual age groups were compared, the incidence of road trauma was significantly higher only for the 5-9 year-old age group (Type A vs type B: RR = 1.45). For females of deprived municipalities, the incidence of road trauma was higher for the 5-14 year-old age group and lower for the 15-19 year-old age group. The incidences for each type of transport and according to the residential municipality of the casualties (type A or type B) mode are detailed in (fig 1).

Table1: Incidences of road traffic injuries among individuals of under 25 years of age according to gender, age and type of residential municipality

Rhône Registry 2004-2007, September 2009 safeguard

	Type A municipality		Type B municipality		Risk Ratio A/B 95% CI	p
	Number of casualties	Mean annual incidences per 100,000	Number of casualties	Mean annual incidences per 100,000		
males						
[0-5[	164	137.2	119	118.2	1.16 [0.92-1.47]	> 0.05
[5-10[	319	324.7	252	225.2	1.45 [1.23-1.71]	< 0.001
[10-15[	560	585.7	569	509.3	1.15 [1.02-1.29]	< 0.02
[15-20[	1476	1241.1	1524	1325.9	0.93 [0.86-1.01]	> 0.05
[20-25[	1823	1185.7	1149	1118.4	1.06 [0.98-1.14]	> 0.05
TOTAL	**4342**	**740.8**	**3613**	**666.7**	**1.11 [1.06-1.16]**	**< 0.001**
females						
[0-5[	94	83.3	57	58.8	1.42 [1.02-1.97]	< 0.05
[5-10[	237	243.7	174	166.3	1.47 [1.21-1.78]	< 0.001
[10-15[	266	286.7	212	199.3	1.44 [1.20-1.73]	< 0.001
[15-20[	487	387.3	562	511.3	0.75 [0.66-0.85]	< 0.001
[20-25[	1038	585.0	605	577.4	1.01 [0.91-1.12]	> 0.05
TOTAL	**2122**	**350.1**	**1610**	**308.1**	**1.14 [1.07-1.22]**	**< 0.001**

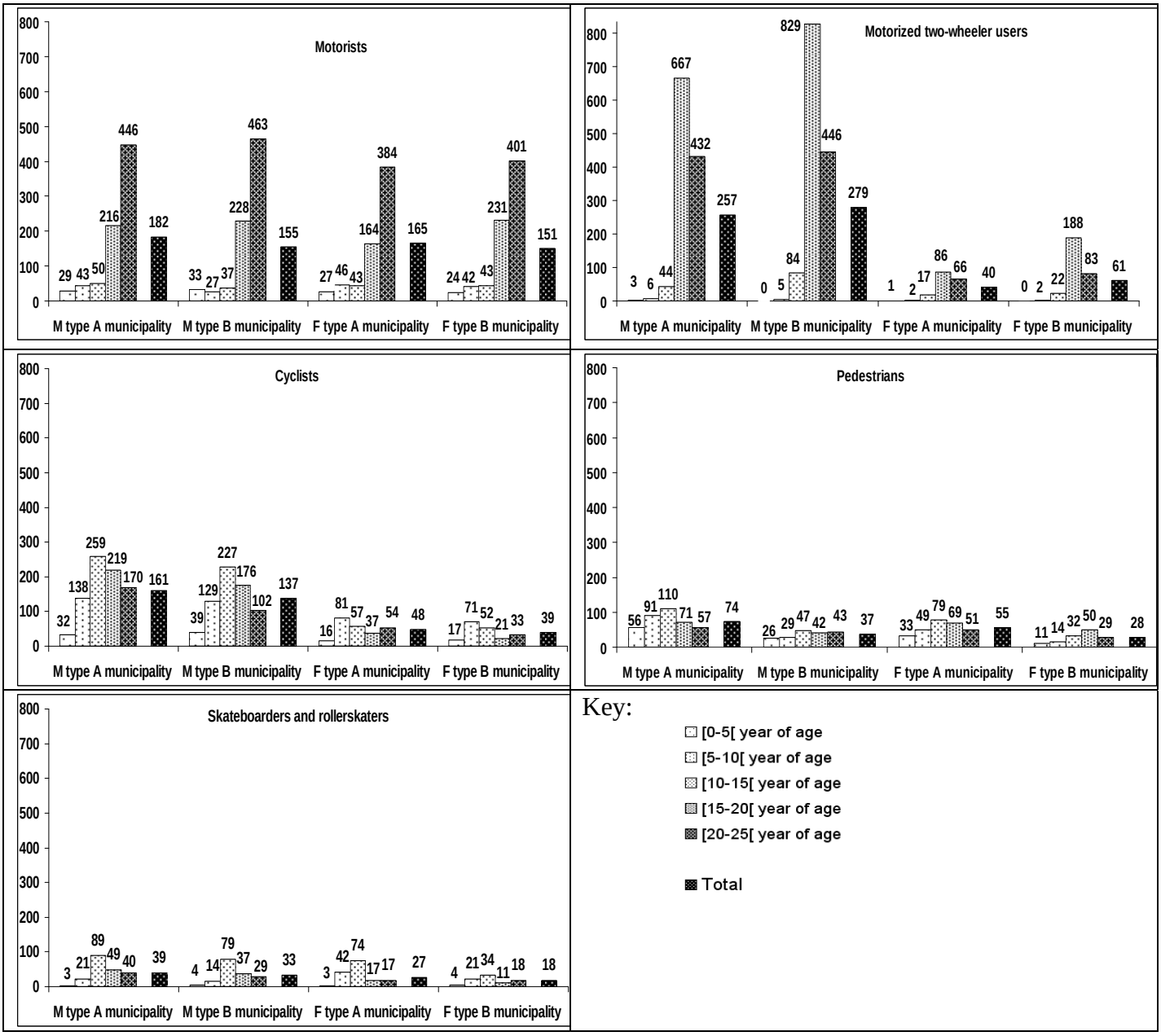

Figure 1 – Mean annual incidence of road trauma per 100,000 inhabitants according to age, gender, and type of residential municipality for each category of road user

Motorist casualties were the most numerous. The Risk Ratio (A/B) was 1.17 [1.07-1.28] for males, all ages grouped. Among females a protective effect was apparent among the 15-19 year-olds: RR = 0.71 [0.59-0.85].

For the male M2W users living in deprived municipalities, the incidence was significantly lower than in other municipalities, between 10 and 14 years of age (type A municipality vs type B municipality: RR = 0.52 [0.36-0.75]) and between 15 and 19 years of age with RR = 0.80 [0.73-0.88]. Among females, the overall RR was 0.66 [0.59-0.81], this "protective" effect being significant only among the 15-19 year-olds whose RR was 0.4 [0.36-0.57].

On the opposite, the males of type A municipalities were more injured while cycling than the residents of type B municipalities, overall RR = 1.17 [1.06-1.29]. Among the 20-24 year-olds, RR was 1.67 [1.33-2.10].

Pedestrian casualties and casualties on rollerskates/skateboards were less frequent than casualties of the other types of road users. However, the largest differences we identified between the two types of municipalities were for pedestrian casualties: the risk was increased for all age groups, with a maximum level between 5 and 9 years of age: RR = 3.18 [2.12-4.76] among males and 3.46 [1.94-6.18] among females.

For rollerskaters/skateboarders, no significant difference was observed for males. For females, the overall RR was 1.53 [1.19-1.97].

To sum up, for both genders, the incidences for type A municipalities were higher than for type B for all types of road users, apart from those using M2W.

For all categories of road user apart from pedestrians, the effect of the residential municipality was less marked than the effect of gender: males had more injuries than females, irrespective of the type of municipality. However, in the case of pedestrians whatever their gender, the young persons living in type A municipalities had more traffic injuries than males and females living in type B municipalities.

3.2. Influence of the residential municipality on injuries severity

The univariate analysis of severity produced with five logistical regression models (one for each type of road user) shows that motorists and pedestrians living in type A municipalities had less sever traffic

injuries with, respectively, an OR = 0.62 [0.45-0.87] and 0.53 [0.34-0.84]. This analysis also shows that males M2W users and motorists had more severe injuries than females. This was not the case for the other categories of road users.

The following factors were associated with both greater severity for all road user categories and the nature of the residential municipality: male gender, trunk roads or county roads, weekend, night, lorry or fixed obstacle impacted, failure to wear a helmet or a seatbelt, the semi-urban or rural nature of the municipality in which the accident occurred (outside the Lyon conurbation).

Taking into account all these factors in five logistical models (not shown), the type of residential municipality had no longer a significant effect on severity (OR = 1.05 [0.70-1.57] for motorists and OR = 0.62 [0.36-1.04] for pedestrians). The injuries of males using M2W were still more severe than those of females OR = 2.15 [1.38-3.33]. This was not the case for motorists' injuries. When taking into account the heterogeneity between the 293 municipalities, the estimates of this heterogeneity were very small (maximum = 0.23 with standard error = 0.17, and minimum = 0). It was hence not necessary to use a multilevel regression analysis.

In order to better analyse the influence of type A on severity, we then calculated separately incidences for severe and minor injuries. In Table 2, the increases in incidences (A vs B) only involved minor injuries for motorists, cyclists, pedestrians of both genders, and female rollerskaters/skateboarders. For M2W, incidences were lower in type A for minor injuries among females, and for severe injuries among males.

Table 2: Incidences per 100,000 according to type of municipality, category of road user and gender and risk ratio of the incidences between type A municipalities and type B municipalities

Rhône Registry 2004-2007, September 2009 safeguard

		Incidence in type A municipalities	Incidence in type B municipalities	Risk Ratio A/B IC 95%	Incidence in type A municipalities	Incidence in type B municipalities	Risk Ratio A/B IC 95%
		Males			**Females**		
Motorists	**ISS < 9**	175.1	145.6	1.20 [1.09-1.32]	161.2	144.3	1.12 [1.02-1.23]
	ISS 9 +	7.2	9.8	0.73 [0.49-1.09]	4.3	6.3	0.68 [0.41-1.14]
M2W users	**ISS < 9**	237.8	248.9	0.96 [0.89-1.04]	38.4	58.4	0.66 [0.56-0.78]
	ISS 9 +	19.5	29.9	0.64 [0.50-0.81]	2.0	2.7	0.74 [0.34-1.60]
Cyclists	**ISS < 9**	154.6	131.0	1.18 [1.07-1.30]	47.2	37.7	1.25 [1.04-1.50]
	ISS 9 +	6.7	6.3	1.06 [0.67-1.68]	1.0	1.1	0.86 [0.28-2.67]
Pedestrians	**ISS < 9**	68.4	32.7	2.10 [1.76-2.51]	52.5	24.9	2.11 [1.72-2.59]
	ISS 9 +	5.5	4.8	1.14 [0.68-1.91]	2.8	2.9	0.98 [0.49-1.96]
Skateboarders and rollerskaters	**ISS < 9**	36.2	31.4	1.15 [0.94-1.41]	26.2	16.6	1.58 [1.22-2.05]
	ISS 9 +	2.7	2.0	1.35 [0.63-2.91]	1.0	1.1	0.86 [0.28-2.67]
Total	**ISS < 9**	698.5	611.5	1.15 [1.10-1.20]	339.1	293.5	1.31 [1.22-1.40]
	ISS 9 +	42.8	55.2	0.78 [0.66-0.92]	11.2	14.5	0.77 [0.56-1.07]

3.3. Were municipalities with 1 ZUS different from those with 2 or 3?

Considering that more ZUS means more exposure, we then tried to see if there was an increase/positive slope in accident occurrences and severities. We observed that this was the case and that risk ratios (to be compared with those in table 1) were higher for residents of municipalities with 2-3 ZUS (for all sex and age categories). Overall, RR was 1.21 [1.15-1.28] for males and 1.20 [1.11-1.30] for females in municipalities with 2-3 ZUS. It was not significant for municipalities with 1 ZUS.

By type of road user, RRs (to be compared with figure 1) were also higher for motorists, pedestrians, and male cyclists from municipalities with 2-3 ZUS. For example, when considering motorists casualties, RR was 1.34 [1.20-1.48] for males and 1.17 [1.04-1.30] for females in municipalities with 2-3 ZUS. It was not significant for municipalities with 1 ZUS. Considering pedestrians, there was a gradient with RRs of 1.49 [1.21-1.82] for males and 1.79 [1.42-2.24] for females from municipalities with one ZUS and 2.46 [2.05-2.95] for males and 2.21 [1.77-2.75] for females from municipalities with 2-3 ZUS's. No gradient was seen for M2W users and skaters.

Taking into account all severity factors in logistic models, pedestrians from municipalities with 2-3 ZUS had a significantly lower severity than those from B municipalities adjusted OR 0.36 [0.19-0.69]. This was not the case for municipalities with 1 ZUS adjuster OR 1.06 [0.59-1.92].

When studying separately incidences of severe and minor injuries, risks ratios for minor injuries were only significant for motorists (RR was 1.38 [1.24-1.54] for males and 1.19 [1.06-1.33] for females) and male cyclists from municipalities with 2-3 ZUS (RR 1.28 [1.14-1.44]).

For pedestrians (both genders) and female skateboarders, there was an increase for minor injuries, the RRs being higher for municipalities with 2-3 ZUS. For example, when considering pedestrians minors injuries RR was 1.54 [1.24-1.91] for males and 1.85[1.46-2.10] for females from municipalities with one ZUS and 2.66 [2.19-3.22] for males and 2.38 [1.90-2.99] for females from municipalities with 2-3 ZUS's.

4. Discussion

We found clear differences between the injury incidences in the two types of residential municipality. Apart from the case of M2W riders, they were generally higher in those municipalities with one or more ZUS's (type A) than in those without a ZUS. There were even higher in those with 2-3 ZUS's

It should be noted that these incidences are under-evaluated because over 14 % of casualties were not considered in the calculation. The collection of data on residential municipality has improved in quality over the years and is now nearly systematic. The casualties with an unknown residential municipality were more severely injured than casualties with a known residential municipality. We observed that in the Rhône Registry when a severe injury occurred, non-medical variables are often less well recorded. The observed differences in age and severity between casualties with a known residential municipality and the 14% whose residential municipality was missing, were too weak to question the differences in observed incidences between the two types of municipality.

The greatest differences between the incidences in the two types of municipalities were for pedestrian injuries, as in Abdalla's study (Abdalla et al. 1997). These exhibited significant differences both overall and for each age group with the exception of the 20-24 years-old for males and 15-19 for females. Our findings confirm those of Graham (Graham, Glaister & Anderson 2005) and those of Edwards (Edwards et al. 2008). They also concur with the findings of Hippisley-Cox (Hippisley-Cox et al. 2002) who used Townsend's (Townsend, Phillimore & Beattie 1988) socioeconomic deprivation score as a measure. These authors suggested that injuries among persons of under 15 years of age with a high Townsend deprivation score whether on bicycles, as pedestrians or when using other transport modes were more frequent than among young persons with low Townsend scores. This study also found that the greatest socioeconomic differences were for pedestrians. The results also provide clear evidence of a social class gradient in morbidity from pedestrian injuries.

With regard to motorized two-wheeler injuries, our study's findings run counter to that of Zambon and Hasselberg (Hasselberg, Laflamme & Weitoft 2001; Zambon & Hasselberg 2006), that related to young Swedes. These scholars suggested that the risks for moped and motorcycle users from the most deprived social groups were between 1.8 and 2.5 times higher than for young persons (aged 16-25 years) from a higher social group. These studies were based on an individual socioeconomic indicator and not a contextual indicator like ours. Conversely a recent study focused on 7-16 years old living in Stockholm

County states that deprived areas had a reduced risk of injuries among M2W riders (Laflamme et al. 2009). Our results for this type of injuries may be explained by the fact that in France young people from privileged residential areas own more mopeds and motorcycles. However we had no exposure variables that inform us about the behaviours in the different types of municipalities (frequencies of use, distances covered, time spent). We plan to use a mobility survey to improve our analysis.

It is not easy to compare our results with those of the Swedish research by Zambon and Hasselberg (Hasselberg, Vaez & Laflamme 2005; Zambon & Hasselberg 2006) who studied the incidences by severity level of injuries involving adults (18-30 years of age) driving cars and young persons (16-25 years of age) driving motorized two-wheelers as a function of individual socioeconomic criteria. In the case of the first group, the underprivileged socioeconomic categories had increased incidences, especially for severe injuries. This was explained by the fact that individuals with a high social position use larger (which are heavier and therefore safer) and more recent cars (in better condition). For the second group, only the incidences increased for the most under-privileged categories in both minor and severe injuries, but not the severity. In our study the increase of incidence only concerned minor injuries, which is different from these studies.

Our results concerning the severity of injuries (obtained with logistic regressions) can be compared with those of a recent Swedish study (Laflamme & Vaez 2007). This study showed a rough severity excess among young motorists in lower social categories, which is different from our results. Nevertheless, like ours, this study showed that, after taking crash characteristics into account, socioeconomic factors had no longer a significant effect on severity.

To our knowledge, the influence of socioeconomic factors on pedestrians' injuries severity has not been described.

Whether or not the residential municipality has a deprived urban zone (ZUS) is an indirect contextual socioeconomic indicator. This is because the presence of a ZUS within a municipality reflects, in an approximate manner, the overall socioeconomic level of the municipality. We have quantified the considerable gap between median incomes of the two types of residential municipalities which thus support the relevance of using this contextual indicator, carried out through the French national policy on cities, and which could be used more largely for studies about contextual inequalities in all of the French territory. It is strongly linked to the socioeconomic level of municipalities. However we don't know if

such classification is available in other countries. It must be emphasized that the analysis of the heterogeneity between the municipalities did not invalidate our results.

Further, by considering only the nature of the municipality (A or B), we have “diluted” our analysis by classifying individuals who live in an A-type municipality but not in the ZUS itself as exposed. Consequently, our assessment of the differences between the two types of municipality can only be an underestimation of the difference between deprived and affluent neighbourhoods.

We have not studied here the influence of individual socioeconomic factors.

In spite of these weak points, we have an outstanding database on road traffic injuries which is as exhaustive as possible. In the Rhône Registry minor injuries, young people, M2W users and the casualties of accidents that occurred without third party were particularly well reported, compared to the police records (Amoros, Martin & Laumon 2006). This could explain that (Fleury et al. 2010) didn’t find an excess of risk in the deprived areas (ZUS). The medical description of the injuries in the Registry provides a very precise indication of their severity.

This study has the advantage of detailing for the first time the effects of social inequalities for all types of road users of people less than 25 years of age.

Why only minor injuries are linked to the deprived neighbourhood is unclear. It seems that in spite of increased risks which could be due to more independent trips by children (e.g. by foot), the characteristics of accidents are less pejorative there. Taking into account in logistic models our available severity factors (mainly type of road, time of the crash, obstacle impacted, urban or rural nature of the municipality in which the accident occurred) generally overrode the association between severity and municipality deprivation. The rough lower severity in such areas was therefore explained by these severity factors.

It can be concluded, however, that in France, the incidence of injuries following a road traffic accident is higher among young people (such as pedestrians, cyclists, and motorists) living in deprived municipalities. These areas should therefore be the targets of dedicated education programs, with a special focus on young pedestrians, but also, for example, on the necessity, even for passengers, to fasten their seat belts.

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