Physical Impairment and Medical Care Spending by Road Accident Victims

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Abstract

In addition to the immediate physical injuries they suffer, road accident victims may also be subject to ongoing deterioration of their state of health in terms of permanent physical and mental problems, disabilities, etc. These various health shocks entail recourse to care and treatment, the upshot being increases in health expenses. In France little is known about the financial impact of accidents on victims.

This paper uses data from a sample of 777 individuals suffering from road accident-induced physical impairment. Information about these individuals includes details of their personal and socioprofessional characteristics, together with data provided by their health insurance offices regarding their use of treatment and their medical expenses.

The analysis of these data reveals that the costs incurred by road accident victims are significantly associated with such factors as age, seriousness of impairment, and marital status. Interaction effects are also noted between these explanatory factors: for example, the effect of the seriousness of impairment on the costs involved differs according to the age of the victim.

Keywords: Road accident victims, physical impairment, physical consequences, medical expenses.

1 INTRODUCTION

The consequences of traffic accidents are many and varied. They include a significant number of deaths together with disability situations and a wide variety of health problems for survivors. These consequences constitute a major burden for society: according to the World Health Organisation's Global Burden of Disease (GBD) estimate, road traffic accidents rank ninth among the top ten causes of disease around the world.[1] Experts estimate that by 2030 road accidents will have become the third main contributing factor in the global burden of disease.

The economic repercussions of road accidents most especially concern the victims. They are the ones who suffer the physical injuries and must bear the physical and financial consequences. The financial consequences are vital here, for two main reasons: firstly because people injured in road accidents may or must stop work on a temporary or permanent basis, thus losing their principal source of income; and secondly, the state of health of a road accident victim involves medical expenses that can be very substantial – all the more so in that accidents can mean lasting damage to the victim's health. These expenses stem from repeated visits to doctors, more or less extended hospital stays, rehabilitation, etc.

For many years research into the consequences of traffic accidents utilised a macroeconomic approach, emphasising estimates of the social cost of the road accidents.

More recent research has been looking into the consequences of accidents for victims and their families. The repercussions of accidents on victim income and employment have been by far the most studied aspects (Carnis et Al., 2011; Juillard 2010; Dano 2004). This research foregrounds the financial issues entailed by road accidents for the victims. This microeconomic approach has led to fresh investigations of the financial consequences of road accidents in terms of the medical expenses they involve.

Dano's study, for example, uses panel data from a very broad sample: 1/10 of the population of Denmark. These data allow for checking of changes in road accident victims' financial and professional situations over a period of 20 years, from 1981 to 2000. The results obtained show that in the long term road accident victims have significantly lower incomes and employment rates than those who have not been victims of such accidents.

[1] "The WHO global burden of disease (GBD) measures burden of disease using the disability-adjusted life year (DALY). This time-based measure combines years of life lost due to premature mortality and years of life lost due to time lived in states of less than full health. The DALY metric was developed in the original GBD 1990 study to assess the burden of disease consistently across diseases, risk factors and regions." http://www.who.int/topics/global_burden_of_disease/en.

Duguet and Le Clainche (2012) have analysed the impact of illnesses and accidents (including road accidents) on individual professional trajectories in France. Their study employs the propensity score matching technique, also used by Dano, which enables estimation of what income levels and employment rates would have been if the person concerned was not involved in a traffic accident. This is a counterfactual approach: comparing what is to what might have been. The authors conclude that chronic illnesses, but also accidents, have a negative effect on victims' professional trajectory and their income.

The repercussions of accidents on medical expenses have been studied by Phipps, Berger and Piland (1997), who look into the treatment cost consequences for road accident victims according to whether or not they were wearing seatbelts. The authors conclude that the wearing of seatbelts substantially reduces the seriousness of bodily damage in road accident victims, as well as the time spent in hospital and treatment costs. Lawrence, Max and Miller (2003) came up with similar findings regarding treatment costs for helmeted and unhelmeted motorcyclists involved in accidents.

The study by Kumar et al. (2012) analyses treatment costs and the burden of out-of-pocket expenses for road traffic injuries in India. It highlights the expensiveness of treatment for road accident victims in that country and raises the issue of financial protection mechanisms for them.

Haas and Goldman (1994) and Doyle (2002) examine the effect of medical coverage on costs for road accident victims. The authors note that those without health insurance receive less care and present a higher mortality rate than those who have such insurance, and conclude that the patient's ability to pay plays a significant part in the quantity of care and treatment received. They also consider that additional care and treatment can bring major health improvements.

The ESPARR-ECO[2] study focused on the socioeconomic consequences of road accidents for a cohort of victims, using data collected over three years. The study looked at the effects in terms of finance (loss of income, etc.), employment (interruptions, loss of job, etc.) and housing, while taking account of the seriousness of the accident and the victim's level of social precarity (Carnis et al. 2011). Its conclusion was that the seriousness of the

[2] ESPARR is the acronym for «Etude de Suivi d'une Population d'Accidentés de la Route dans le Rhône». ESPARR-ECO is a study dedicated to the analysis of the socio-economic consequences of road accidents.

accident has a significant influence on the various socioeconomic consequences, and that the latter are aggravated when the victim is in a situation of social precarity.

The present contribution sets out to analyse in detail the medical expenses incurred by road accident victims. It thus aims to identify and determine the effects of different variables on victims' care and treatment expenditure. Drawing on original data which so far have not been used at all in France, it brings fresh light to bear on the issue and addresses the situation of road accident victims in terms of a medical economy which until now had been subjected to no detailed investigation.

Section 2 presents the contribution's data and methodology. Section 3 deals with the results obtained. Section 4 discusses these results.

2 DATA AND MODEL

2.1. The data

The data used are drawn from the "HSM" or "Disability and Health" survey carried out in France in 2008, and more specifically from its "Household" section. Focusing on persons suffering from a disability,[3] the survey was itself preceded by a "Daily Life and Health" screening survey of 140,000 households carried out in 2007.[4] The final total for the sample was 29,954 individuals, from whom various items of information were collected: personal and social characteristics, state of health, types of illness, detailed description of physical disabilities and their causes, and particulars of accessibility problems and assistance received on an everyday basis.

Of this group, 777 people – 2.6% of those declaring themselves handicapped – stated that their disability was the outcome of a traffic accident. Processing of the data refined this sample down to 601 people for whom we had detailed information regarding recourse to treatment and medical expenses during the year covered by the survey. Provided by the various local health insurance offices, these data outlined the hospital and out-of-hospital expenses incurred by the road accident victims, together with those entailed by follow-up and rehabilitation. Thus the information was relatively detailed.

[3] The concept of disability underlying the HSM survey involved interaction between the limitations of a person's functional state and surrounding environmental factors. In this context the disability situation is considered more serious when the person concerned suffers from a functional deficit and from mobility constraints relating to the non-availability of facilities, technical assistance, etc.

[4] One of the screening questions, for example, was "Do you consider yourself as suffering from a disability?"

2.2. The model

A linear regression model was used to explain the level of medical expenses for the various road accident victims. More specifically, the aim was to explain the total cost of out-of-hospital care (DSV) during the year of the survey, and the total cost of out-of-hospital care plus follow-up and rehabilitation (DSVSSR). The variable relating to hospital costs for road accident victims was not included in our analysis. These costs are relevant only to a limited period corresponding to the first days or months following the accident, and so could not appear in the database for those of the victims whose accident had taken place some years before. The fact that information on this aspect was incomplete could have substantially distorted the analysis. This does not mean that this aspect is unimportant, simply that the database available to us did not enable its inclusion in our analysis.

The independent variables bear on the seriousness of the harm suffered: the seriousness of physical impairment (4 levels according to the degree of paralysis) plus the fact that the injury may have necessitated modification of the domicile. They also cover personal characteristics: age brackets, sex and marital status. Socioeconomic considerations are also taken into account – the victim's employment situation, income (5 categories) and the fact of being a complementary universal health care coverage beneficiary[5] – together with variables relating to the state of health: hospitalisation, exemption from the user fee in the case of long-term illness or copayment.[6] In addition to these variables, the model takes account of interaction between age and seriousness of impairment.

Finally we have two explanatory models that can be described as follows:

$$\textit{Model 1: } DSV_{\text{individual i}} = \alpha_1 + \beta_1 age_i + \beta_2 seriousness_i + \beta_3 sex_i \ \ldots \ + \beta_{12}\, age_i \times seriousness_i$$

$$\textit{Model 2: } DSVSSR_{\text{individual i}} = \alpha_2 + \delta_1 age_i + \delta_2 seriousness_i + \delta_3 sex_i \ \ldots \ + \delta_{12}\, age_i \times seriousness_i$$

with, $\beta_{1\ -\ 1.2\ ,}\ \delta_{1\ -\ 12:}$ the coefficients associated with the explanatory variables and the interaction effects

[5] In France, complementary universal health care coverage is open to persons whose income does not exceed a given ceiling (in 2012, 7934 euros per annum for a person living alone). It covers 100% of medical expenses, with no initial outlay by the person concerned.

[6] The user fee is the proportion of medical expenses remaining to be paid by the patient after reimbursement by the state health insurance scheme. The rate varies according to the types of treatment and medication, the patient's circumstances and adhesion (or not) to the coordinated healthcare circuit. Supplementary insurance may cover all or part of the user fee. Exemption from the user fee may apply to persons requiring regular treatment in a context of long-term illness, and enables them to avoid paying out substantial sums for the care they need.

3 RESULTS

3.1 Descriptive analysis

Before looking further into the analysis of the average expenses incurred by the various victims, we can examine the types of health impairment undergone by the individuals making up our sample. Table 1 presents the ICD (International Classification of Diseases) codes for the five commonest conditions in the sample. It can be observed a predominance of such chronic conditions as dorsopathies[7] (32.95% of the sample) and arthropathies[8] (27.54%). While it is hard to prove that these complaints were exclusively due to the road accident in question, they nonetheless constitute a source of recurring expense for the victims.

Table 1: List of the five commonest disorders[9]

ICD classification	**N=777 individuals**	
	Number	%
Dorsopathies	256	32.95%
Arthropathies	214	27.54%
Injury, poisoning and certain other consequences of external causes	171	22.01%
Episodic and paroxysmal disorders	134	17.25%
Diseases of veins, lymphatic vessels and lymph nodes	82	10.55%

Table 2 presents the weighted average of treatment expenses incurred by road accident victims according to the seriousness of their physical impairment. Distribution according to physical impairment shows over 70% of victims declaring significant discomfort, and almost 20% total or partial paralysis. The average expense increases markedly in line with the seriousness of the impairment, whatever the nature of the care involved. Persons suffering from total paralysis present particularly high costs, especially in terms of nursing care and pharmaceuticals.

Table 2: Seriousness of physical impairment and medical expenses for road accident victims

Average expense	***Total paralysis***	***Partial paralysis, amputation***	***Major joint discomfort***	***Loss of muscular strength***	***Average***
N	**36**	**82**	**388**	**37**	**601**
Out-of-hospital care	11712.33	3662.11	2070.46	1588.81	2366.52
Transport	1381.83	625.46	116.30	236.52	216.32
Nursing care	4004.64	180.38	133.54	36.12	218.79
Pharmaceuticals	2388.15	754.91	718.43	461.25	708.80
Physiotherapy	643.87	464.41	163.21	182.98	196.96
Out-of-hospital care + follow-up and rehabilitation	11741.32	6041.60	2098.07	2424.25	2722.65

[7] Dorsopathy is the technical medical term for back pain. This health consequence is called "car accident back pain" in the case of road accident.

[8] Arthropathy is characterized as a disease of joints. In the case of road accidents, the knee joints are often affected because of the shock with dashboard. This phenomenon is called "dashboard syndrome".

[9] The percentages total more than 100%: a victim may suffer from more than one disorder.

Table 3: Average out-of-hospital expenses according to certain personal characteristics of road accident victims

Variables	**N**	**Weighted average of out-of-hospital expenditure**	***Significance***
Home Modification			*0.0008*
Modified	77	4977.42	
Not modified	524	2167.85	
Age bracket			*0.0055*
>25	30	1773.54	
25-60	387	2962.18	
60-70	60	3632.36	
>70	124	4724.62	
Sex			*0.8132*
Male	314	3382.60	
Female	287	3279.50	
Marital status			*0.0115*
Unmarried	184	1372.34	
Married	270	2443.84	
Widowed	56	4803.54	
Divorced	91	3363.89	
Employment status			*<0.0001*
Not working	428	3031.97	
Working	173	1351.19	
Universal Supplementary Health Benefit			0.0457
Non-recipient	534	2471.31	
Recipient	67	1361.61	
Income			*0.6844*
< RMI (Minimum Welfare Benefit)	108	2371.76	
RMI-SMIG (RMI-Minimum wage)	176	2376.63	
SMIG-2SMIG	236	2288.20	
2SMIG-3SMIG	62	2420.23	
>3SMIG	19	2833.67	
State of health			*<0.0001*
Good	138	1220.89	
Average	204	1961.25	
Poor	212	3824.87	
Very poor	47	8248.49	
Hospitalisation			*<0.0001*
Hospitalised	153	4301.77	
Non-hospitalised	448	1825.91	
Exemption from user fee			*<0.0001*
Exempt	386	4303.20	
Not exempt	215	1592.20	

Table 3 presents other descriptive statistics relating to our sample. This table demonstrates the existence of significant differences regarding average out-of-hospital expenses according to certain explanatory variables. Equality of means tests (Student, ANOVA) have been carried out. It is clear that medical expenditure by road accident victims varies significantly in line with such variables as age, state of health, marital status, employment and Universal Supplementary Health Benefit. This is not the case, however, for the sex and income variables.

3.2 Results of the econometric analysis

The results of the econometric model were obtained using the SAS software's GLMSELECT procedure. This procedure offers the advantage of being able to integrate qualitative variables into the linear model.

The number of observations taken into account for estimating the model was 601. This figure represents 77% of the total sample and corresponds to the number of individuals for whom information regarding care expenses was available. The different explanatory variables have been divided into 4 categories indicating the individuals' personal characteristics, the seriousness of their physical impairment, their state of health and their socioeconomic situation.

Overall there are substantial similarities between the results from the two explanatory models. The different explanatory variables influence the total of out-of-hospital expenditure in the same direction and in similar proportions, as well as that of out-of-hospital plus follow-up and rehabilitation expenditure.

The results of the two linear models allow for the assertion that the level of treatment expenses for road accident victims is primarily influenced by the seriousness of the physical impairment. The coefficients associated with the different modalities of the "seriousness of physical impairment" variable show that this expenditure increases in line with the severity of the harm to the road accident victim. Moreover, those individuals whose disability does not require home modification are faced with significantly lower medical expenses than those obliged to undertake such modification.

The models also offer interesting results in respect of personal characteristics. After controlling for the effect of the "seriousness of physical impairment" variable, the results show that medical expenses for traffic accident victims increase significantly with age. On the other hand, the sex variable has no influence on total costs: whether the victim is male or female seems to count for very little, at least as far as medical expenses are concerned. As for

marital status, widowed and married individuals show significantly greater spending than unmarried ones. All things considered, membership of a family would seem to lead to higher expenditure. This variable may reflect differences of wealth that enable the obtaining of better health coverage. Single individual could be also less inclined to take care of himself.

The health variables have a significant influence on road accident victims' expenditure on care. This expenditure increases when the victim's health is bad, whether as a result of the accident itself or of some earlier condition.[10] The accident has the effect of accelerating the deterioration of the victim's health capital. Exemption from the user fee also has a significant effect on care expenditure ($p=0.0015$), as it frees the beneficiary of certain expenses in cases of chronic illness, certain specific disorders and polypathologies. Exemption gives rise to two effects regarding medical expenditure: on the one hand, its beneficiaries are people who have to cope with one or more illnesses demanding recurring expenses; exemption might thus be described as pointing to a chronic or long-term condition and, consequently, to increased consumption of medication. On the other hand, full coverage of medical expenses frees patients of budgetary constraints and can lead to a form of overconsumption. In addition, the persons hospitalised during the year of the survey continue to incur very considerable out-of-hospital costs.

Road accident victims' socioeconomic characteristics have a limited effect on the level of spending. The influence of the "income" and "employment status" variables is not significant. It may be that the effect associated with marital status has partially captured this influence: examination of the correlations between income levels and marital status shows that married or widowed individuals have significantly higher incomes than those who are unmarried. In this respect the socioeconomic effect would have more to do with a wealth effect (long-term planning) than with a short-term income variable. By contrast those individuals whose income level excludes them from Universal Supplementary Health Benefit show greater expenditure on medical care.

3 DISCUSSION

To our knowledge this study is among the first to have analysed medical expenses incurred by road accident victims in France. It was made possible by the availability of detailed data on the medical expenses of a number of such victims.

[10] Our data provide no information on victims' original state of health.

The study is not exempt from the limitations specific to empirical research: there are certain limitations to the data used and the statistical analyses effected. Firstly, the data regarding medical expenses bear only on costs for which road accident victims have asked to be reimbursed. Other, non-refundable expenses have not been analysed because they do not appear in the databases of the health insurance offices. There is no way of determining the extent of non-refundable expenses or of specifying exactly what they are.

Secondly, certain variables which might have been clearly relevant to our analysis could not be integrated into the explanatory model, as they were not clearly established in the database. The date of physical injury variable, for example, is important here, as it would have enabled us to take into consideration the possible existence of relatively substantial expenses incurred during the months immediately following the accident.

Despite these limitations, this study comes up with original results worthy of analysis and further investigation. The estimated models, for example, enable us to analyse the weight of the different explanatory variables. The level of spending on medical care by road accident victims is mainly influenced by the age and seriousness of physical impairment variables, which are thus essential aspects of the question. The effect of the variables relating to state of health is less marked, an observation that bears out the study by Mock and his co-authors (2001) on the economic consequences of road accidents. In that study the authors, by cross-referencing their statistics, showed that average medical care spending by road accident victims varies significantly with age and the severity of the physical harm suffered.

Overall, the significant effect of the age and state of health variables seems fairly intuitive, and many studies have been devoted to the connection between individuals' state of health and their medical care spending (Raynaud 2005). This study, however, goes further in that it identifies an effect of interaction between the seriousness of physical impairment and age variables. The significance of this connection shows that the effect of the seriousness of physical impairment on the level of expenditure differs according to the age of the accident victim. The seriousness effect has a greater impact on aged victims, who are characterised by a longer period of consolidation and a higher rate of complications.

Another outcome of this research is the highlighting of a socioeconomic side to medical care spending. Coverage of such spending via the user fee and Universal Supplementary Health Benefit influences spending by victims. Marital status, too, is not without its influence. The socioeconomic aspect is quite complicated in that it involves both

long and short-term outlooks for health capital, a wealth effect and an income effect, refundable payments by the victim and direct coverage by a state body.

4 CONCLUSION

This study has enabled us to analyse the financial weight medical care expenses represent for road accident victims. The statistical analyses carried out on our sample show that these victims are often subject to chronic deterioration of their state of health. This leads to increased recourse to medical care and increased expenditure. Thus the physical impairment due to the accident causes a further, financial problem for the victims, with study of the medical consequences raising issues to do with time horizons. The road accident is in no way a short-term phenomenon, for it generates lasting consequences which involve recurring costs.

Medical care spending depends on the seriousness of the impairment, at the same time as it reflects a clear socioeconomic dimension. The human body can be analysed as a capital to be maintained and, when necessary, repaired. In this respect it relies on the socioeconomic status of individuals and their level of willingness to preserve it.

The microeconomic approach to the consequences of road accidents via medical care expenditure also foregrounds the issues masked by macroeconomic analyses, with their emphasis on an approach aggregated by the social cost. This eliminates not only specific individual characteristics, but even more so the essential fact that the victims are individuals who are not alike.

Table 4: Linear regression model for evaluating medical care spending by road accident victims

Number of observations read: 777 **Number of observations used: 601**			**The modelled variable: Total amount spent on**			
Variables	**Reference category**	**Category**	**Out-of-hospital care**		**Out-of-hospital care + follow-up and rehab.**	
			coefficient	**Pr>T**	**coefficient**	**Pr>T**
constant			33024	<.0001***	31134	<.0001***
Seriousness of bodily injury						
Seriousness of physical impairment	Total paralysis	Partial paralysis	-27968	<.0001***	-27639	0.0001***
		Major discomfort	-28647	<.0001***	-28885	<.0001***
		Loss of muscular strength	-28922	<.0001***	-29332	<.0001***
Modification of domicile	yes	no	-2187.3934	0.0005***	-27028	0.0001***
Personal characteristics						
Age	>70 years	<25 years	-25891	0.0001***	-24841	0.0099***
		25-60 years	-23424	<.0001***	-23121	0.0009***
		60-70 years	-20586	0.0001***	-20186	0.0082***
Sex	Female	Male	-181.55	0.6629	162.50	0.7859
Marital status	unmarried	Married	1212.74	0.0207**	1855.41	0.0137**
		Widowed	2294.74	0.0080***	3366.98	0.0068***
		Divorced	865.84	0.1749	779.59	0.3948
Socioeconomic situation						
Employment status	working	unemployed	750.06	0.1710	1064.38	0.1761
Universal Supplementary Health Benefit	yes	no	1674.09	0.0207*	2111.61	0.0420*
Income per unit of consumption	<Minimum Welfare Benefit (RMI) (671.97)	RMI-SMIG (minimum wage)	-1145.39	0.0710*	-1033.88	0.2560
		SMIG-2 SMIG	-391.58	0.5362	-474.58	0.6017
		2 SMIG-3 SMIG	-932.33	0.2690	-1294.05	0.2854
		> 3 SMIG	-600.06	0.6280	-764.95	0.6672
Health						
State of health	Very bad	Good	-4002.09	<.0001***	-3810.91	0.0023***
		Average	-3563.99	<.0001***	-3279.72	0.0044***
		Poor	-3490.04	<.0001***	-2764.59	0.0138*
Hospitalisation	no	yes	1626.59	0.0005***	2792.27	<.0001***
Exemption from user fee	Not exempted	Exempted	1594.57	0.0006***	1544.69	0.0201*
Interaction effect						
Seriousness* age	Partial paralysis	<25 years	33843	<.0001***	54790	<.0001***
	Partial paralysis	25-60 years	23595	<.0001***	25214	0.0005***
	Partial paralysis	60-70 years	18808	0.0011***	18293	0.0266*
	Major discomfort	<25 years	26166	0.0001***	25926	0.0082***
	Major discomfort	25-60 years	23516	<.0001***	23788	0.0007***
	Major discomfort	60 -70 years	20839	0.0001***	20818	0.0072***
	Loss of muscular strength	<25 years	24576	0.0007***	24193	0.0203*
	Loss of muscular strength	25-60 years	23378	<.0001***	24597	0.0009***
	Loss of muscular strength	60 -70 years	18340	0.0031***	20067	0.0239*

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